CONNECT

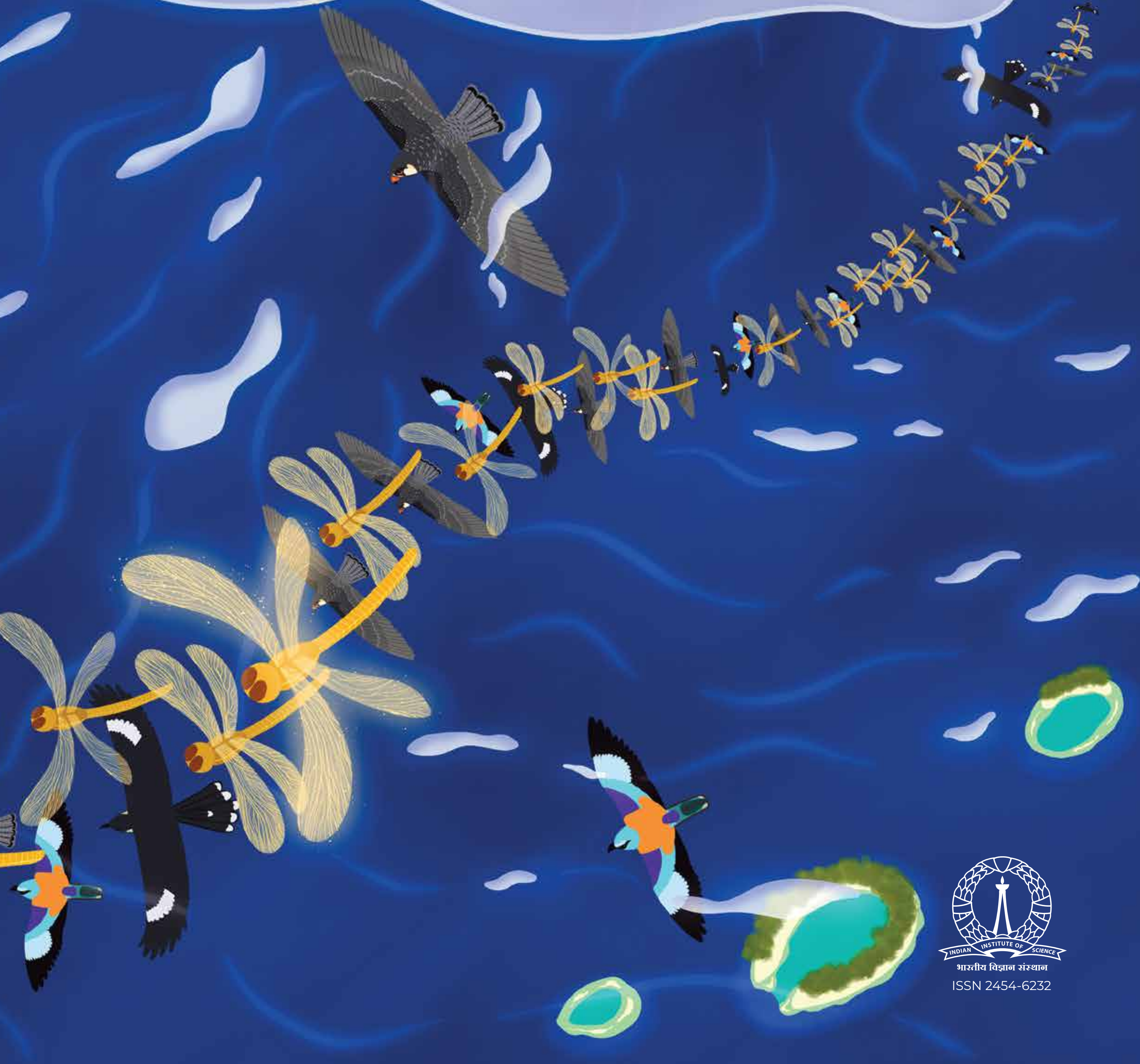
WITH THE INDIAN INSTITUTE OF SCIENCE

Volume 9 Issue 4 December 2022

Cloud-watching
What do we really know?

Kollegala Sharma
Talking science in Kannada

Sickle cell anaemia
Fighting a neglected disease



INDIAN INSTITUTE OF SCIENCE
भारतीय विज्ञान संस्थान

ISSN 2454-6232

IN THIS ISSUE

Editorial

From sustaining life to dispersing pollutants, air is a ubiquitous force of nature. In this issue of *CONNECT*, we focus on this invisible element, and the ways in which it influences humans and non-humans alike. Air is the vehicle clouds use, and is also the medium in which aerosols spread — the latter is one of the reasons why a climate observatory was set up at IISc's Challakere campus, a place we revisit in this issue.

With a revolutionary new AI chatbot making waves in the news, we take a closer look at the challenges and concerns related to developing such technologies. Researchers from physics, biology, mathematics and engineering are coming together to study the mechanical forces at play between cells. We also speak to Kollegala Sharma about the importance of communicating science in vernacular languages. A retired librarian from the Division of Biological Sciences talks about his journey from field assistant to information scientist.

In stories from the campus community, faculty members share their experiences of using social media for professional networking and science outreach, and students tell us how they manage their finances. Read about how historical aircraft on the campus are getting a makeover.

Finally, in a longform feature, we take a deep dive into how researchers, doctors and communities are coming together to battle against a neglected genetic disease.

Happy reading!

Team Connect

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Design: Magnetyz

Cover illustration: Swadha Pardesi

Printer: Sri Sudhindra Offset Process

Reading OUR SKIES

- Narmada Khare

After centuries of sky-watching, we are yet to understand the complex nature of clouds

Photo: Narmada Khare

Fog over Avalahalli Lake, Bangalore on a cold November morning

It's an early winter dawn. The lake seems to be steaming, but it is not. A cloud is being born.

I am on a hilltop, watching a village in the valley sparkling in the early morning rays when a white sheet of thick fog rolls down along the slopes to shroud it completely. This fog is a cloud.

The contrail left behind on the clear blue sky by a passing plane, the mist created when I blow warm moist air from my mouth into the cold, dry morning – those too are clouds.

More spectacular, of course, are the actors in the cosmic drama that we have been witnessing in the skies over Bangalore these last few months. Gossamer white puffs shoved aside in seconds by a roiling army of elephantine greys. Bulbous, discrete clouds merging into a thick, amorphous sheet breached occasionally by crackling branches of lightning. And after the rains, the calming of the skies, disappearing clouds, soft pink brush-strokes, orange swirls and curls left behind, glowing in the setting sun.

Poets and artists have been fascinated by the shapes and colours of clouds, and their movements. So mysterious were they that ancient religions placed gods in charge of controlling clouds. But what about scientists and philosophers? For a phenomenon in nature that is so hard to ignore – clouds cover up to 70% of the globe at any given time – and something that so fundamentally affects our lives, systematic studies of clouds are few and far in between.

"What Jupiter? Do not trifle. There is no Jupiter."

It isn't as if civilisations weren't trying to understand clouds. Aristophanes, the Greek playwright, wrote his play "The Clouds" in the fifth century BCE. The character of Socrates, the philosopher, while denying the need for the thunder god Jupiter to create rain, explains beautifully how water-bearing clouds roll and thunder, burst and clap, and are borne along by vortex. A surprisingly accurate account for its time. About 10 centuries later, the poet Kalidasa, in his Sanskrit play "Meghaduta" (Cloud Messenger), charts the journey of a cloud, rising from the streams, moving north, guided by winds, followed by migrating birds, colliding with cliffs, watched by thirsty fields. This description of the movement of a monsoon cloud is also considered quite accurate. And yet, it was not until much later that scientists like Robert Hooke (17th century) and Jean-Baptiste Lamark (18th century) attempted to actually name different forms of clouds.

Hooke's suggestions for formally naming the skies – "cleer, hazy, thick, hairy, water'd, Mackeril" and so on – did not take root, but this is considered by some the beginning of the new science of meteorology, as recorded by Humphrey Jennings in his book on contemporary history, *Pandaemonium*. Eventually, in 1802, Luke Howard, a pharmacist from London, put forth an elegant, universal method of classifying clouds – "water suspended in the atmosphere" – by their appearances, thus putting an end to the notion that their study was "a useless pursuit of shadows".

Young sun and frozen Earth

Let's put aside for the moment the cloud-making gods, but there is no denying that many cosmic mysteries need solving before we understand how water started cycling upon our planet – for the water cycle is the main reason why there is life here.

In its early days, Earth may have had all its water either trapped in terrestrial crevices or as hard, icy cliffs. In 1972, noted astronomer Carl Sagan presented a possibility from astrophysical calculations that when the sun was young, it was only 70% as luminous as it is today. Prosenjit Ghosh, Professor at the Centre for Earth Sciences at IISc, who studies paleoclimatology, says, "This faint young sun was not heating the Earth much, and you would expect it to be covered with cold ice. But geologists have found evidence of prehistoric sedimentation along water bodies, which could only happen if there was flowing water."

Photo: Prosenjit Ghosh

2,500 million years-old "pillow lava" at Mardihalli, Chitradurga, from submarine volcanoes that solidified abruptly on contact with liquid water

The only explanation for what drove this water circulation in spite of the faint sun is the presence of greenhouse gases – CO_2 and methane – that warmed up the Earth's atmosphere like a blanket, thus thawing the ice. "For a billion years after its birth, the Earth was loaded with CO_2," says Prosenjit, "not unlike the atmospheres on Venus and Mars. But unlike those planets, it had plenty of water that evaporated, filling the skies with clouds."

And what did these clouds do? The same thing that they do today: They both cooled and heated the Earth, depending on how thick they were and at what height. “Low, thick clouds reflect a lot of the Sun’s heat, often cooling the planet,” explains fluid dynamicist Rama Govindarajan, Professor at the International Centre for Theoretical Sciences (ICTS), at a talk given at The Institute of Mathematical Sciences (IMSc) in 2016. “High, thin clouds are often nearly transparent to incoming sunlight. They let it in rather than reflecting it, but then absorb the heat that radiates out from the Earth.” However, it is difficult to predict what the Indian monsoon cloud – the cumulonimbus – would do, she explains. “It is tall, starting at low altitude and reaching a few kilometers above, and can in principle both reflect and absorb.”

“Which is no shape at all, or every shape”

Photo: Narmada Khare

Several types of clouds over Bangalore on a monsoon evening

What *is* a cloud then? “When warm moist air rises from the ground, and it reaches the level at which water vapour will condense, that’s where you begin to see a cloud,” explains the late Roddam Narasimha, a fluid dynamicist and former Professor at the Department of Aerospace Engineering, IISc, in his talk given at the Science Gallery Bengaluru in 2020. The World Meteorological Organisation (WMO) defines it more literally, as “a visible aggregate of minute particles of water or ice, or both, in the free air.”

Back in the 17th century, Luke Howard named the three major forms of cloud as cumulus (heap), stratus (sheet) and cirrus (filament). And the fourth, a cloud containing rain, was named nimbus. Cirrus clouds are seen high in the sky. They are feathery and made up of icicles. Cumulus clouds start at a lower altitude but can grow tall and become bulbous. They are made of condensed water. Stratus clouds are sheets of either cirrus or cumulus clouds, and may be seen at different heights. Every cloud we see is one or a combination of these.

“To understand how clouds form, we need to understand the vertical temperature and humidity structure of the atmosphere,” says GS Bhat, Professor at the Centre for Atmospheric and Oceanic Sciences (CAOS), IISc. The atmosphere envelopes the planet, and has no upper limit – it ultimately leads up to space. The troposphere is the layer of atmosphere closest to the surface – about eight km at the poles to about 15-18 km at the equator – and this is where most clouds hang out. Very few move beyond, into the stratosphere.

Bhat, who studies rainclouds of the Indian monsoons, describes the shape of a tall cumulonimbus cloud. Such a cloud has roots near the Earth’s surface, from where water vapour rises as a plume – narrow at the root and wide above. As it rises and as the water vapour in it starts to condense, two things happen. One, the condensing part of the plume becomes visible as a cloud – with a nearly flat bottom demarking where condensation begins. Two, when vapour molecules condense, they release heat. If we assume that all vapour molecules condense, and account for all the heat that is released, then the difference in temperature at the base and at the top of a cumulonimbus could be 50°C, earning them the name “hot towers”. “However, we must remember that the rising air expands and cools down, eventually consuming all the heat,” Bhat explains in his 2021 *Resonance* article “Clouds”.

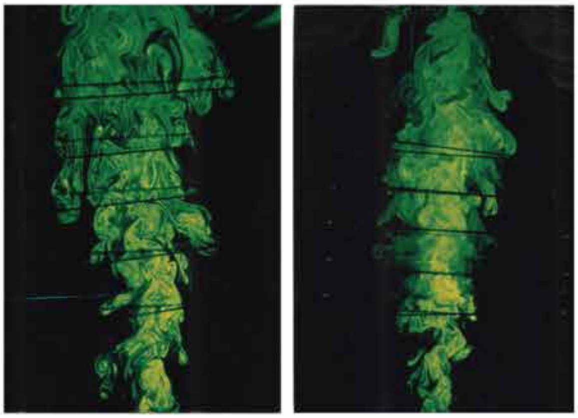
Clouds in the lab

Clouds are shape-shifters. They are transient. Scientists have been sending sensors into them to detect what’s happening inside, but this can be dangerous because of turbulence and electrical activity. This has led them to attempt making clouds inside a lab.

One great leap in our understanding of clouds came about by pure chance; author Cynthia Barnett tells this story in her engaging book “Rain, a natural and cultural history”. Meteorologist Vincent Schaefer was working at the General Electric Research Laboratory in 1946. World War II was raging, and governments were pushing for the development of technologies to use in military tactics. For example, creating cloud-screens for hiding, or icing enemy aircrafts. But the scientist had had little success in triggering condensation of supercooled water vapour inside a cloud-chamber to form snowflakes or raindrops. Then one day, Schaefer threw some dry ice into a chamber in an attempt to cool it down further. Instantly, millions of tiny ice crystals appeared in the cold cloud inside the chamber. “We’ve got to get into the atmosphere and see if we can do things with natural clouds,” said his boss, Irving Langmuir, a Nobel laureate. They rented a plane, flew into a cold cloud over a mountain and dropped dry ice pellets into it. The cloud, writes Schaefer, “almost exploded” with ice crystals. This was how scientists figured out that minute solid particles, be it dry ice, dust or pollen, were crucial for inducing condensation of water molecules in vapour.

Bhat also talks about a groundbreaking experiment carried out at IISc that addressed a baffling observation about a process called "entrainment". A rising plume of cloud is turbulent, and has eddies of varying sizes. Entrainment is a process at the edges of any plume (smoke or cloud) where outside air is sucked in and mixed with the air inside the plume. The question essentially was how a plume of hot, moist air, rising from the Earth and climbing up to several kilometres does not just fizzle out. Smoke from a chimney or steam from a steamboat disappears within moments, but not clouds. Also, the height of a cloud did not fit the mathematical calculations. "If the entrainment was happening as we expected, then the height of a cloud should be half [of] what we observe, particularly for a tall cloud," Bhat says. But nobody knew why.

Photo courtesy: GS Bhat



Clouds created in the lab. The one on the left, created without the application of heat, shows entrainment, seen as turbulence

While entrainment was a well-studied process, Narasimha realised that those studies hadn't accounted for the rise in temperature in a cloud as water molecules started condensing. Bhat and Narasimha decided to tackle this question by modelling a cloud in the laboratory. They modified existing technology to allow them to heat specific areas of the plume. The results were astonishing. Not only could they change the shape and density of a cloud by modulating temperature, they also found that entrainment near the base increased, resulting in the drawing in of air from the surrounding at this site, but there was hardly any entrainment in the middle and top parts of the cloud. It implied that in a natural cloud too, there is reduced entry of relatively dry mid-tropospheric air, which allows it to grow taller.

"How can I study from below, that which is above?"

There are urgent questions in cloud research, unanswered because of currently insurmountable hurdles. A world map created as part of a comprehensive study by the Royal Society predicting vulnerability to droughts and extreme flood events in 2090 has India blazing in colours with the highest numbers. "We are talking about advancing India in many other ways," Rama surmises in her talk, "First of all, let's make sure we have an inhabitable climate." Numerous talks and articles stress upon how much we still don't know about clouds. What makes cloud study so challenging?

An interesting if desperate appeal appears in an article published in *Nature* in 2015 – "Physicists, your planet needs you – climatologists highlight cloud mysteries in an attempt to lure physicists to their field." It is undeniable that clouds are at the heart of our climate, and that they cannot be understood by applying any one area of science. Overcoming uncertainties in predicting climate needs every arrow in the quiver – from mathematicians and physicists to computer engineers, geologists and fluid mechanicians.

In one of his last talks given at the Science Gallery Bengaluru in January 2020, Narasimha explains what makes research on clouds so tough to tackle. Imagine a stream of fluid – anything that flows, be it liquid or gas. The smoke coming from a resting cigarette, or water running from a tap barely open. The flow starts out smooth, but then becomes turbulent. The smooth, laminar flow follows rules that scientists understand and can compute. The turbulent part of the flow however, is chaotic, irregular. "Even when the basic laws governing turbulent flows are known and have been known for 200 years," Narasimha says, "turbulent flows remain largely ununderstood." And clouds are turbulent flows.

Rama, in her talk at ICTS, also underscores a fundamental problem faced by cloud researchers. "Can we understand a simple, lone cloud?" She asks. "One small puffy object (a parcel of air) which is evaporating from the ocean, a little bit warmer and wetter than its surroundings; how does it climb a few kilometres and then condense to become a cloud? Even the most innocent looking cloud is often in violent turbulence. The water vapour, droplets, aerosols, all are moving within the large-scale eddies inside the cloud. Droplet thermodynamics contributes to this turbulence. Not all such puffs become clouds, but which ones do? How long will a cloud last? And which among so many will become a raincloud?"

"To predict anything about clouds, we have to solve incredibly complicated differential and partial differential equations," she adds. "We know this, but we do not have the computing [power] required to resolve these. We cannot predict weather with great accuracy over long lead times using present day computers, and need much better instruments and much better satellite-based observations to get local weather right."

Like all natural phenomena, our awe of clouds continues. Our dependence on them, the calamities they can cause, our ignorance about their nature, all add to the fascination we have for these floating objects, which appear so insubstantial, and yet are not.

UP IN THE AIR

- *Bitasta Das*

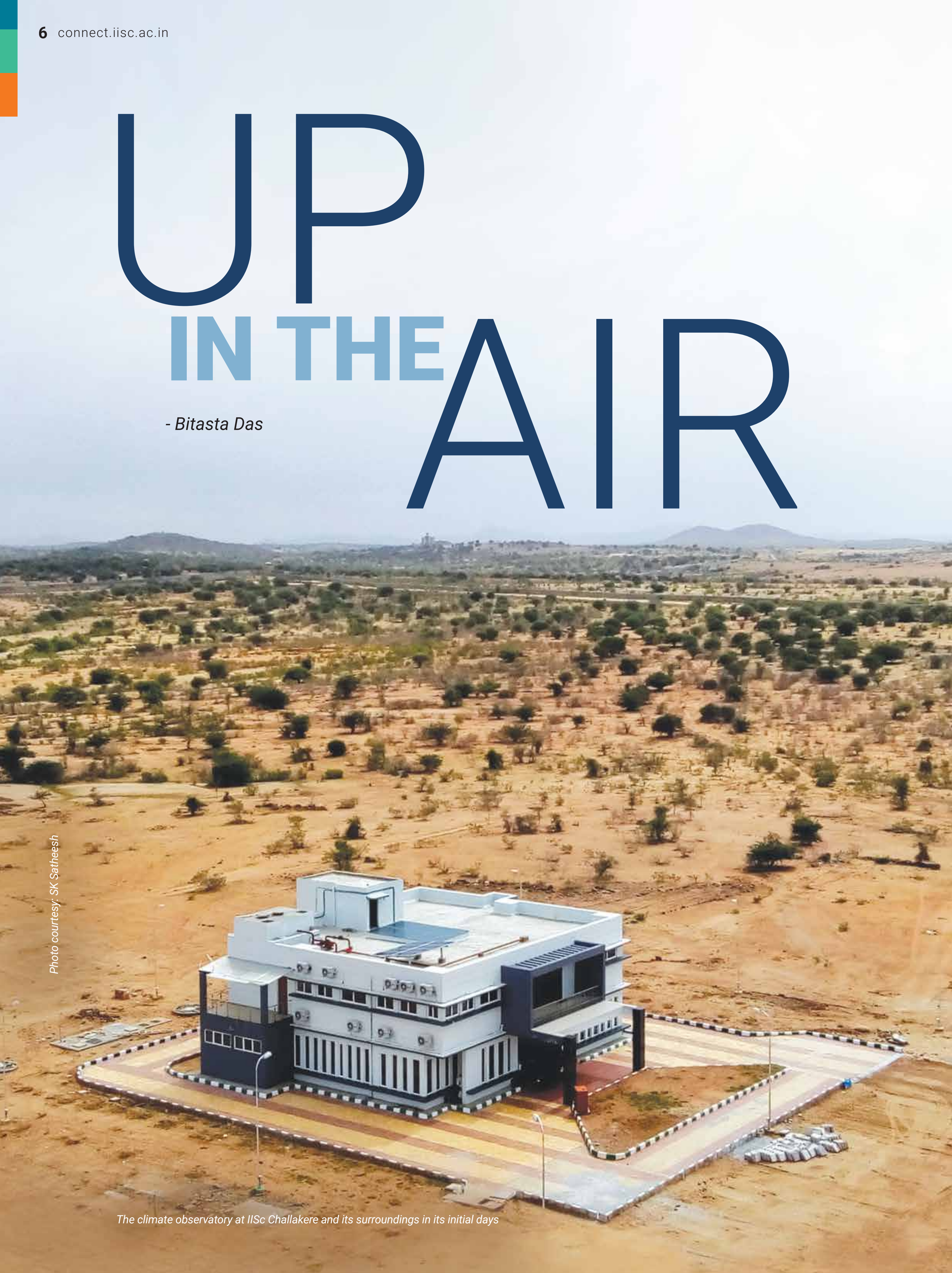


Photo courtesy: SK Satheesh

The climate observatory at IISc Challakere and its surroundings in its initial days

IISc's second campus at Challakere provides an ideal locale to study aerosols and their impact on climate

Travelling down the National Highway from Bangalore to Challakere in the Chitradurga district of Karnataka, and past the city limits, I noticed the air becoming fresher to breathe. Could it have been because of the reduced pollution, particularly the lower amounts of aerosols in the atmosphere, as the population density thins out?

Aerosols – tiny solid particles or liquid droplets suspended in air or gas in the atmosphere – have become a key player in the climate change saga. They can be found in the air over forests, seas, mountains, deserts, and even glaciers. No ecosystem is devoid of aerosols. Scientists believe that these ubiquitous tiny particles can have a colossal impact on human health and climate change. How do aerosols contribute to global warming and ozone layer depletion? How do they change rainfall patterns? In what ways do they impact human health? How do human activities contribute to aerosol generation?

It is to answer burning questions like these that a climate observatory was established in IISc's second campus at Challakere in 2009. It was one of the first structures to come up on the new campus. Today, it has grown into an active research site where aerosols are tracked round-the-clock by a team of dedicated researchers.

Understanding aerosols

Since the 1980s and 1990s, the word "aerosol" has been splashed across newspapers, brought into sharp focus by the depletion of the ozone layer. It was used to specifically refer to the harmful chlorofluorocarbons emitted from devices such as hair sprays, spray paints, and perfume bottles. More recently, the word became popular in association with the transmission of the SARS-CoV-2 virus that caused the COVID-19 pandemic.

An aerosol is typically less than 1 μm in diameter. Aerosols can be of natural origin – in fact, these aerosols make up about 90% of what we find in the atmosphere. For example, volcanoes eject enormous amounts of ash, sulphur dioxide, and other gases that yield sulphate aerosols; oceanic microalgae produce a sulphurous gas called dimethyl sulphide that can be converted into sulphates in the atmosphere. Desert dust storms and forest fires also produce huge amounts of aerosols.

The remaining 10% of aerosols are anthropogenic, or human-made. There has been a rapid increase in the amount of anthropogenic aerosols since the start of the industrial revolution in the 18th century. Alarmingly, the current generation of anthropogenic sulphate aerosols has surpassed the amount produced naturally. Fossil fuel combustion produces large amounts of sulphur dioxide, which reacts with water vapour and other gases in the atmosphere to create sulphate aerosols. Biomass burning yields smoke mainly comprised of organic carbon and black carbon. Automobiles, incinerators, smelters, and power plants are among the large producers of sulphates, nitrates, black carbon, and other particles. Human activities like deforestation, overgrazing, and excessive irrigation change the land surface, increasing the rate at which dust aerosols are released into the atmosphere. Things we use in our daily lives – cooking stoves, fireplaces, candles, even cigarettes – are sources of aerosols. The complexity of the problem posed by the aerosols is compounded due to their interaction with clouds. Aerosols change cloud properties, alter precipitation patterns and hence alter the hydrological balance of the Earth.

Photo: Bitasta Das

Project associate Ramamohan Lohia next to an aethalometer and nephelometer at the climate observatory

Because these aerosols have such a huge impact on our climate – arguably even on humanity's future on this planet – scientists have been racing to study their nature and impacts for the last few decades.

It is in this context that the climate observatory at Challakere was established. The goal was to study the climate in general, but also specifically the long-term effects of aerosols on the climate in a relatively undisturbed location. The sparsely populated locale, which was then a barren land without human inhabitants for a 15 km radius, provided the perfect setting to study the natural climate unadulterated by anthropogenic activities.

In the initial days, with limited people and resources, setting up the observatory was fairly challenging, explains SK Satheesh, Chair, Divecha Centre for Climate Change, IISc, who led the efforts. The campus did not have electricity, water, or an internet connection and ran entirely on solar power. Even now, several activities at the Challakere campus rely on solar power. Since the time that the observatory was set up, there has been a steady increase in the population density in and around the campus. "We have witnessed an increase in the human population in the region, and so also the number of aerosols," explains Ramamohan Lohia, a project associate at the climate observatory. This has allowed the researchers to track the increasing impact of human activity on the atmosphere closely.

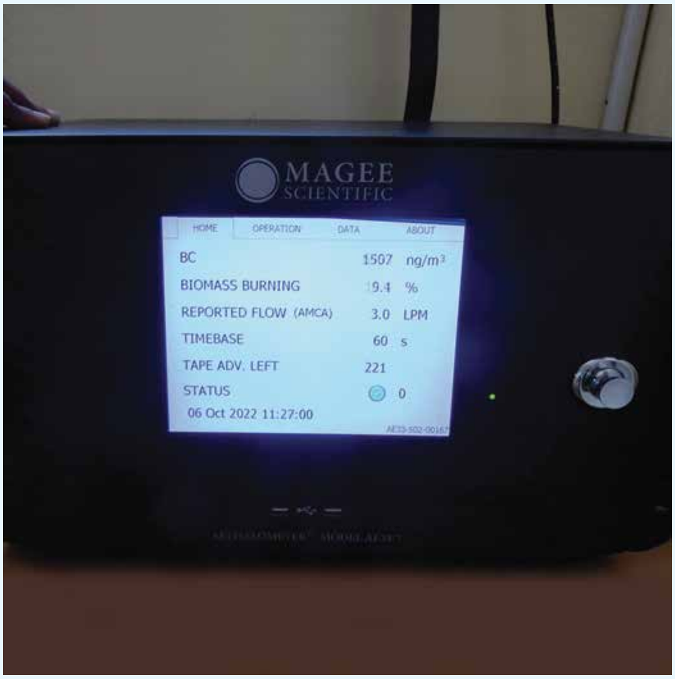


Photo: Bitasta Das

Aethalometer readings showing real-time data like black carbon concentration, biomass burning and so on

Like Ramamohan, there are two more project associates stationed at the observatory. These project associates operate the various instruments and monitor the data that the devices pick up. Among the sophisticated devices set up here are an aethalometer, which measures the amount of black carbon in a specific location, and a nephelometer or aerosol photometer which calculates the concentration of suspended particulates. The observatory also has a multi-wavelength solar radiometer, which is operated when the sky is clear for measuring the optical aerosol depth, as well as a microtops, which is a hand-held sun photometer for measuring aerosol optical thickness. In addition to these, there is a 32-metre-high meteorological tower for boundary layer studies which has sensors at different heights to track wind speed and direction, relative humidity, temperature, and rainfall levels. All these devices are operated throughout the year and around the clock. Some devices, like a dust deposition gauge, are used when needed – such a device enables monitoring of the deposited particulate matter that rapidly settles from the air.

Ramamohan says that he finds the work they do at the observatory quite interesting. Although human visitors to the campus are far and few between, he particularly enjoys the quietness of the campus.

In pursuit of soot

In addition to serenity and solitude, what motivated Satheesh to start long-term climate studies at Challakere was also its weather. Challakere, he says, represents a typical "continental" location characterised by long, dry summers and scanty rainfall, coupled with negligible atmospheric pollution. This makes it an ideal place to study background continental aerosols and surface radiation.

There is another advantage to studying Challakere's climate, he explains. Climate labs in other parts of India do not have skies as clear and as clean as Challakere does, and therefore they struggle to separate atmospheric disturbances from aerosol measurements. The observatory, therefore, also serves as a calibration facility that provides data to correct for these aberrations.

Most aerosols reflect the sun's energy back into space, and therefore, have a cooling effect. However, there is one particularly dangerous type of aerosol – soot, also known as black carbon – that contributes to global warming by boosting the effects of greenhouse gases in the atmosphere. Aerosols originating from sea spray, mineral dust, and volcanoes are coarse and have short atmospheric lifetimes, typically only a few days. But combustion processes, biomass burning, and plant or microbial materials are sources of carbonaceous aerosols, both organic carbon and solid black carbon. Black carbon is the main anthropogenic light-absorbing constituent present in such aerosols. They are generated primarily from the combustion of fossil fuels (such as gasoline and oil), and coal, wood, and other biomass.

Since the industrial revolution, human activity has pushed more and more black carbon aerosols into the air which has aggravated global warming significantly. They are the third largest contributors to global warming after carbon dioxide and methane, according to an Intergovernmental Panel on Climate Change (IPCC) report. However, the same IPCC report indicates that a detailed understanding of how black carbon aerosols contribute to global warming calls for more research, especially on the aerosol shape, refractive index and lifetime, as well as the exact extent of emissions worldwide.


Photo: Bitasta Das

Meteorological tower at the Challakere campus

It is these aerosols, particularly the absorbing species known as black carbon or soot, that have consumed much of Satheesh's attention over the past 25 years. His team at IISc has been measuring and analysing the levels and impact of black carbon aerosols in the atmosphere for many years – and they have continued these studies at the Challakere campus too. This has enabled them to better understand the role of these particles on climate change, precipitation, and human health. One of the key contributions of these studies, for example, was to upend the popular belief that natural aerosols are not connected to anthropogenic effects on the atmosphere. His team showed that natural aerosols tend to combine with anthropogenic aerosols and form a new type of aerosol that affects climate and pollution in completely different ways. Smaller, anthropogenic black carbon particles cling onto larger, natural dust particles, covering them and contributing to global warming even more.

The way forward

Currently, apart from the studies on aerosols, research on the atmospheric boundary layer has also been initiated at the climate observatory. Satheesh says, "Data on the atmospheric boundary layer or the lowest layer of the atmosphere is sparse in India. There are a few study stations, but getting a flat land like Challakere is very difficult. That is why organisations like ISRO use our data." He adds that knowledge about the atmospheric boundary layer is crucial because this is where radiation from the sun and the Earth's surface interact. The sophisticated instruments at the climate observatory enable them to obtain a three-dimensional view of atmospheric turbulence, which is the chaotic flow of air in the Earth's atmosphere, and to understand the effectiveness of the atmospheric boundary layer in the dispersion of aerosols. These data are critical for climate-related studies.

Satheesh also hopes that the data collected by the observatory will "provide ground truth for satellite data" – essentially serve to corroborate or verify data captured by satellites. "The advantage of satellite data is that it gives broad coverage. For continuous measurements, satellite data is the only option. However, satellites capture data from 800 km above," he says. As the data is beamed back to the Earth and passed through the atmosphere, it can potentially suffer from distortions."It has to be calibrated on a site on the ground. Now we can make continuous measurements at Challakere. So, I see it as a very good satellite validation site."

Satheesh also aspires to extend the observatory's reach beyond the Challakere campus. He envisions researchers from other universities visiting and calibrating their measuring instruments in the campus's unique environment. Radiometric calibration, or the conversion of the digital data recorded by satellites into physical units, is among the other future goals that he has for the observatory.

Another important role that the climate observatory at Challakere aims to fulfil is training young PhD and Master's students in operating climate-related instruments.

The facility also intends to support students and entrepreneurs in building climate-related instruments and products. Satheesh recalls how, as a student, he learned to build a sunphotometer on his own. Young people have lost this type of skill; the current trend is all "plug-and-play," he says. He hopes that the observatory at Challakere will help revive this practice.

IISc's Aircraft, All Decked Up

- *Karthik Ramaswamy*

Photo: Shiva Shankar BM

The Hunter after it was restored

The Department of Aerospace Engineering is in the process of restoring its plane exhibits

In 2004, the Abdus Salam International Centre for Theoretical Physics at Trieste, Italy, published a book titled *One Hundred Reasons to be a Scientist*. One of the contributors to the book was Roddam Narasimha, whose article, *How I Became a Scientist*, recounts an unforgettable experience he had when he was a young student in the early 1950s. At that time, he was studying mechanical engineering at the University of Visvesvaraya College of Engineering, then the Government Engineering College, in Bangalore. His moment of inspiration, described in the article, came when he visited IISc on its Open Day.

"In the quadrangle of the Department of Aeronautical Engineering (which had just recently been started) stood a lovely World War II Spitfire, loaned for the occasion by the Indian Air Force. That was my first close encounter with an aircraft, and it opened another world for me. What struck me at that time was how smooth and graceful the exterior of the Spitfire looked (in particular its beautiful elliptic wings), but how complicated it was if I looked at the insides – which seemed like a jungle of cables, pipes, ducts, valves and so on. It seemed astonishing to me that beneath those graceful curves and surfaces (which I took to come from mathematics) lay hidden a bewilderingly complex technology – and I marvelled at those extraordinary people who had apparently mastered both," he writes.

The sight of the Spitfire, the legendary British World War II aircraft, led Narasimha to pursue his true calling – he did a Diploma (equivalent to a Master's degree) in IISc's Department of Aeronautical Engineering, now called Aerospace Engineering, and eventually became one of the most well-known aerospace scientists and fluid dynamicists in the world.

The impact of seeing an aircraft like the Spitfire at close quarters on visitors is not lost on the Department. "It can be inspiring to see it up close. If I were five or even 10 years old, it would seem more accessible to me [as compared to a large civilian plane]. And I would think, 'I could fly this one.' One may never see the flight deck of a big plane. Whereas in this, you could see the cockpit," says Joseph Mathew, Chair of the Department of Aerospace Engineering at IISc. He feels that being able to see and touch an aircraft can also fuel a passion for them in young minds, much like it did for Narasimha.

Aircraft on display

The Department currently has three aircraft displayed on its lawns: an HAL HT-2, an HUL-26 Pushpak, and a Hawker Hunter. They are popular attractions, particularly on Open Day, when thousands of people throng the campus of IISc.

The HAL HT-2, a military trainer first produced in 1953 by Hindustan Aeronautics Limited (HAL), was the earliest acquisition. "The HT-2 is very interesting. Its history is closely tied to the history of this Department," says Duvvuri Subrahmanyam, Assistant Professor at the Department. "It was designed by VM Ghatage, who helped establish the Department in 1942," elaborates BN Raghunandan, former Chair of the Department. Ghatage had been working at HAL before he came to IISc. After his tenure at the Institute ended in 1948, he returned to the public sector aerospace organisation as its chief designer. Moreover, the HT-2 was the first aircraft to be designed and built in India. "In that sense, it was India's first indigenous aircraft."

The aircraft, Raghunandan says, was acquired by the Institute in the 1960s. "It was already there when I came to IISc in 1971 for my PhD. Unfortunately, back then, I was not aware of its history."

Like the HT-2, the HUL-26 Pushpak is another 1950s lightweight aircraft from HAL. Based on the design of the American Aeronca Chief, the Pushpak too has a special place in the Department's history but for a different reason – it was an integral part of the Department's teaching curriculum.

The Pushpak was also acquired by the Institute in the 1960s. "During the year, the flight course [part of the Department's ME programme] has received further impetus by the acquisition of a Pushpak airplane," states IISc's Annual Report from 1966-67. "The airplane is instrumented to facilitate instruction in some aspects of flight mechanics. The inter-institutional course on flight testing and instrumentation has been continued by the IAF officers and others from the Hindustan Aeronautics Ltd., Bangalore. Greater emphasis was laid on the practical aspects of this course this year."

The plane continued to be a part of the Department for over four decades. "You may be surprised to know that the Aerospace Department used to have a licensed pilot on its staff to fly this aircraft," says Raghunandan, who has flown in it several times both as a student and as a faculty member. "It used to be kept either in the hangar at HAL or sometimes at IISc. The pilot would go to the HAL airport [if it was parked there], take off from there and land it at IISc's airstrip."

A few years ago, however, the Department decommissioned the Pushpak. Mathew, who has also taken to the skies in it, explains why: "Many years ago, some of our students may not even have seen an aircraft up close. Most may not have ever flown in one. So, it was important to give them that experience. [But] that kind of flight experience is no longer relevant." Once the Pushpak was retired, the Department retained the aircraft as an exhibit outside its new building.

The third aircraft on display is a Hawker Hunter. Unlike the HT-2 and the Pushpak which are propeller aircraft, the Hunter is powered by a jet engine. Developed by Hawker Aircraft Limited, the British aircraft was popular around the world, says Subrahmanyam. The Indian Air Force (IAF) first acquired the Hunter in 1958. It was in service for more than 40 years and played a crucial role in the 1971 war against Pakistan. "The Hunter won its pilots a large number of gallantry awards and is among the longest-serving aircraft of the IAF," reads the plaque next to IISc's Hunter.

The aircraft at IISc was purchased in 1965 from the Dutch Air Force as part of a tripartite agreement between India, the Netherlands and the manufacturer, Hawker, which refurbished it before it was sent to India. "It was on standby during the 1971 war at Pathankot and ready to go," discloses Subrahmanyam. The aircraft continued to serve the IAF even after it was withdrawn from active military service. "This particular aircraft, along with the other Hunters in the squadron, was stationed in Kalaikunda Air Force Station in West Bengal. Towards the end, they were mostly used for training and target practice."

Raghunandan, who was the Chair of the Department when the Hunter came to IISc in 2008, reveals the story behind its acquisition. "We wanted a bigger military aircraft which could be of instructional value. Therefore, I wrote to the IAF asking for one and they responded after a long time saying that we can pick up a Hunter aircraft from Kalaikunda." But there was a rider. "They told us that it would cost us Rs 5 lakh. I wrote to the Director [P Balaram] saying that we need this money for the aircraft, which he readily sanctioned."

Raghunandan sent a team of three members from the Department to Kalaikunda to bring the Hunter to IISc. But when the team reached the Air Force Station, they found that the aircraft was in pieces, with the parts strewn all over the place. "They were disappointed. But since we had paid for it, I told them to collect all the parts and transport them by road. They then loaded the parts, except for the engine, and it came to IISc two weeks later."

The plane's parts arrived on campus late in the night. "I was happy that it arrived when nobody could see the state it was in. The team moved the parts to the hangar where it was assembled with the help of experts from Hyderabad who had the experience of maintaining the Hunter." Raghunandan also had it painted.

"I then took Prof Balaram to the hangar. I showed him the aircraft and told him that this is what we got for Rs 5 lakh."

Braving the elements

The Department's aircraft, however, have been sitting outdoors without any protection for many years now. And it has taken a toll on them.

"The Pushpak is a fabric-covered aircraft. The fabric becomes brittle over time and begins to tear," says Mathew. The condition was so bad that the Department considered covering it up when the last Open Day was held before the COVID-19 pandemic. Finally, they made a teachable moment out of it. "One of my colleagues, who was helping with Open Day, decided to strip the fabric off one wing completely so that you could explain to people what it looked like under the fabric."

And even though the Hunter was the most recent acquisition, it was also showing signs of ageing. "The Hunter had been sitting [around] for over 11 or 12 years when I joined. It has been at the mercy of the rain and sun for all these years," says Subrahmanyam, who joined the Institute in late 2018.

Photo: Joseph Mathew

Stripped down Pushpak during restoration revealing the wooden ribs

The oldest of the aircraft, the HT-2, was fortunate enough to have undergone a bout of renovation a few years ago. "When I became the Chair, I found that one of the wings and the wheels were in bad shape. So, we decided to repair it. This was sometime in 2004-05," says Raghunandan. But now, this plane too is ready for some TLC.

The restoration

A couple of years ago, the Department decided to give all the three aircraft – the Pushpak, Hunter, and HT-2, in that order – a facelift. But it is not easy to find the expertise required. "For these kinds of jobs, it is important to find the right kind of people. And not treat it as a commercial job," says Subrahmanyam. Fortunately for the Department, they knew two people who had the right chops for it: Sukumaran S and Baby Murali, dye and tool makers by profession. "We have a place near Ramaiah Hospital [near IISc's campus in Bangalore] called Suraj Engineering," says Sukumaran, who is passionate about working on old aircraft.

Photo: Duvvuri Subrahmanyam

The team of Sukumaran, Murali and Manjunath (from left to right) standing in front of the restored Pushpak

"They [Sukumaran and Murali] were the people who helped set right the HT-2 earlier," says Mathew. The duo was also familiar with the Hunter aircraft because they had assisted the Department when it was put together and painted back in 2008.

Sukumaran and Murali along with Murali's son, M Manjunath, worked on the Pushpak in 2020. "We first had to remove the fabric and also the wooden pieces," says Sukumaran. The wooden pieces Sukumaran is referring to are the wooden ribs used in the fuselage of old aircraft.

The next step was to fit the aircraft with aluminium sheeting (the Department decided not to use fabric again). "The sheeting is only about 6 mm thick," says Mathew. This was followed by painting the aircraft. "The Department also used the opportunity to redo the cockpit."

Photo: Shiva Shankar BM

The Hunter during restoration

It took Sukumaran and his colleagues four months to finish the project. Their hard work paid off. "Their passion for airplanes is clearly seen in the quality of their work," says Subrahmayam.

In 2021, the Department once again called upon Sukumaran and Murali to work on the Hunter. The challenge to restore this more modern aircraft was slightly different. "They had to peel off the old paint. And then do an anti-corrosion treatment for the metal," says Subrahmanyam. "After that, we had to put putty and make it level," adds Sukumaran.

Once this was done, it was time for the paint job for which a special kind of car paint was used, says Sukumaran. "It is quite costly. We need to make sure that it is dust and rainproof." The Department decided to retain the original design which included the logo of IAF. "[So] we used photographs of the old plane to make sure that the colours and design are the same," he points out.

Work on the Hunter, however, was impeded by incessant rains towards the tail end of the monsoon. "It had to be done outside. Just like this year, it rained a lot last year, especially late in the calendar year. So, there were constant interruptions. You start in the morning and if it rains later, then the day's work is lost," says Subrahmanyam. But despite the rains, the restoration of the Hunter was completed on schedule.

Photo: Karthik Ramaswamy

The HT-2 awaiting restoration

Now that both the Pushpak and the Hunter have been refurbished, the Department is ready to turn its attention to the HT-2. "We now have funds for the HT-2. We will get going on that soon," promises Mathew. This means that come IISc's next Open Day, all the three planes will have been restored. The many young visitors to the campus who encounter these aircraft will have an opportunity to make a connection with the flying machines, just like Narasimha made with the Spitfire more than 70 years ago.

BLOWIN' IN THE WIND

- Joel P Joseph

The influence of wind currents on humans and non-humans

Image courtesy: NOAA/Wikimedia Commons

A satellite image showing that storms in the northern hemisphere rotate counter-clockwise, while southern hemisphere storms rotate clockwise

Chennai. 13 December 2016.

I woke up in the morning and headed to the tea stall nearby for my daily dose of morning *chai*. It was windier than usual: my outfit ruffled heavily, and the umbrella I was carrying to protect me from the drizzle was almost flying away. I returned to my room and looked up the weather forecast – a cyclone warning had been issued for the day.

The wind speed increased enormously in the next few hours, uprooting temporary structures made of tarpaulin and zinc sheets, even as the cyclone made landfall in Chennai. For the first time in my life, I truly appreciated the power of the wind. Scientists, however, have acknowledged it and attempted to study it in many different ways since the 14th century.

Wind currents: What are they?

Wind currents are formed when air flows across the Earth from regions of higher atmospheric pressure to those of lower pressure. This difference in pressure is created due to the unequal heating of the Earth's surface, and is also influenced by its rotation. For instance, land near the equator heats up faster during summer, reaching higher temperatures than the water in oceans. As the land surface gets warmer, air above the land expands creating an area of low pressure. The air above the oceans, on the other hand, remains at a higher pressure as the water remains cooler than land. This difference in pressure causes wind to blow from the region of higher pressure to that of lower pressure – from the ocean to land. However, when the air rises above the land, it cools and loses its ability to hold water, thus bringing rain. During the winter, the cycle reverses, and air flows from land to the ocean, causing precipitation over the oceans.

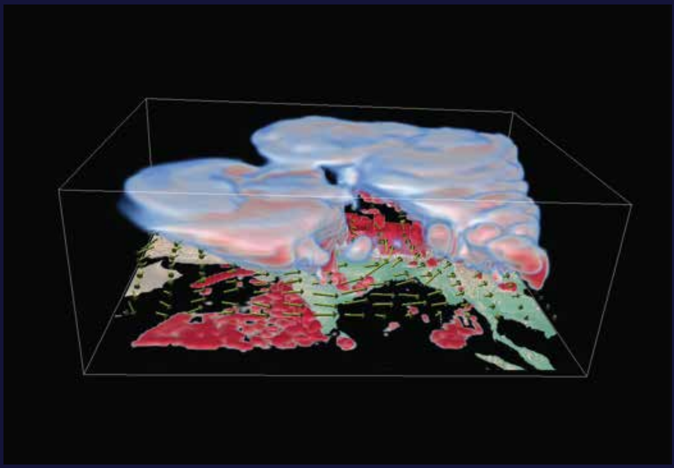


Image courtesy: Pradeep Kushwaha

Wind movement from sea to land also results in the formation of cyclones

The amount of rainfall we receive on land, in turn, has far-reaching implications for an agrarian economy like India. An adage in our school textbooks also stands as a testament: "Indian agriculture is a gamble of monsoon." Wind currents have a direct impact on us through the roles they play in determining the climate, but they are equally influential in the lives of certain other creatures we share the planet with.

Bird flyways

More than 1,000 bird species from nearly 30 countries migrate to India every year. These migratory birds fly to and from India via one of three flyways, the Central Asian Flyway, the East Asian-Australian Flyway, or the Asian-East African Flyway. Scientists have established that there are nine major flyways – routes in the sky – that birds use to migrate across the vast oceans and the high mountains, to different parts of the world. Among the major factors that these birds consider before or during their flight are different attributes of wind currents: speed, direction, and temperature. "Wind currents shape the direction and duration of avian migration," says Nishant Kumar, Visiting Fellow at the Edward Grey Institute of Field Ornithology, University of Oxford, UK. He explains how these currents influence Black-eared kites' choice to cross the highest peaks of the Himalayas (about 6,000 metres above sea level) to reach India.

"We found that kites used this route to utilise the tailwinds that blow from Trans-Himalayas towards Mongolia, and in doing so, avoid a much longer route over the Tibetan plateau," Nishant says. He adds that birds which are unable to use winds optimally are "less likely to survive in the long run, especially in the face of rapid anthropogenic transformations on Earth."

The Central Asian flyway, which is used by the Black-eared kites, is known to be used by waterbirds as well, such as ducks and geese. But the wind speed and direction on the ground differ from what they are high up in the sky, and the birds must be able to gauge all of this from below, says Taej Mundkur, Senior Advisor at Wetlands International Global Office, Netherlands. For example, birds flying south from the Arctic to enter southern Asia must cross several latitudes and several winds circling the Earth, as they migrate. "You have these winds moving southwards, but also rotating with the rotation of the Earth. The birds use these high-altitude, fast-moving tailwinds to push them forward," Taej adds.

Birds like the Bar-tailed godwit that migrate non-stop from Alaska to New Zealand and Australia across the Pacific Ocean make another compelling case. These birds, travelling around 1,000 km a day, rely on wind currents to push them through. "They use strong, high-velocity wind currents at altitudes between a few 1,000 metres and higher to undertake their annual migration," Taej says. "We know that different birds migrate at different altitudes, and it may be some time before we understand how they make this choice. But what drives these differences is linked to the topography of the ground, wind speeds, and temperature." Take for instance, the Bar-headed goose: a waterbird that migrates from Mongolia to India, crossing the high Himalayas. While their physiology enables them to fly at such high altitudes, wind currents and temperature also play crucial roles. Taej recalls a first-hand experience of unexpectedly witnessing bird migration in China one late November a few years ago. "There was a cold front that approached us from the North. And with that southward wind came all the birds. Overnight we heard the calls as thousands of geese and swans and ducks arrived and were around us in the morning light," Taej says. "It was an amazing feeling to see the migration actually happening."

Photo courtesy: Taej Mundkur

Migrating Black-tailed godwits

Sailing with the wind

Unlike birds, insect migration is not so organised with well-defined flyways. Instead, they migrate along a broad front. "Most insects that fly high and use winds ultimately depend completely on wind direction because they can't make headway against these fast winds, which are much faster than they can fly themselves," Jason Chapman, Associate Professor at the University of Exeter, UK, says. As Chapman explains, insects have short lifespans and cannot afford long migrations with stopovers. So, they rely on winds to help them migrate long distances in a few days.

The Americas and East Asia tend to have favourable wind patterns for insect migration. "In the spring, warm air moves northwards from Mexico through Central America. And the insects take advantage of this. But in the autumn, there is a succession of cold fronts moving south with winds blowing from the north. That gives a helping hand to the insects migrating south," Chapman says. Thus, wind patterns generally favour insect migration northwards during spring and southwards during autumn.

The same is true of East Asia too, where the summer monsoons help insects migrate north, and the monsoons in the autumn help them migrate south. "And I think it's no coincidence that these two parts of the world have massive insect migrations and pest problems in these seasons," Chapman says.

A great example of insects migrating long distances is the globe skimmer. This dragonfly, weighing less than one gram, migrates from India to East Africa, across the Indian Ocean. If one were to account for body weight, globe skimmers are the longest non-stop migrants among any living organism. The secret behind this feat is in the way they use wind currents for their advantage.

Johanna SU Hedlund, from the Centre for Animal Movement Research at Lund University in Sweden, and colleagues, including Chapman, modelled the migration of globe skimmers in a study they published in *Frontiers in Ecology and Evolution* in August 2019. They suggest that dragonflies use two strategies to fly: active flapping and gliding. This combination helps them fly for nearly 290 hours. If they were to only flap their wings, they would not be able to fly for more than four hours. Even the combination can only help them cross the Indian Ocean via the shortest route when there is little wind opposing them. But experimental findings suggested that the globe skimmers fly farther across to migrate longer distances nonstop. So, the team concluded that "wind assistance is essential" for the globe skimmers to cross the Indian Ocean. They further suggest that the globe skimmers may be using the intertropical convergence zone – the region over the world's oceans where the northeast and southeast trade winds converge – to help their flight. This zone shifts with seasons, moving southwards in the autumn as winds blow from India and northwards in the spring as winds blow towards India. Globe skimmers use these wind directions to migrate over the Indian Ocean from India to Africa or vice versa.

Photo courtesy: P Jeganathan/Wikimedia Commons

A swarm of migrating globe skimmers

Another insect, whose flight over seas was first speculated about a century ago, is the Crimson rose butterfly. A recent report suggests that these butterflies fly from Dhanushkodi – the southern tip of India in the Rameswaram Island – to Sri Lanka, across the Indian Ocean. Their migration pattern and time indicate that they possibly use monsoons to glide their way across the ocean.

Although these studies and others have discovered how insects use wind currents for migration, the findings may only be the tip of the iceberg. Climate change is affecting these wind patterns, and in turn, the migration routes of these winged creatures. When the monsoons failed in 2016, the crimson rose butterflies too were missing from their migratory pathways. Although we have a long way to go in understanding who uses these highways in the sky, these changing patterns serve as a warning. In the words of Roger Tory Peterson, an American ornithologist, "Birds are indicators of the environment. If they are in trouble, we know we'll soon be in trouble."

Joel P Joseph is a PhD student at the Centre for BioSystems Science and Engineering (BSSE), and a former science writing intern at the Office of Communications, IISc

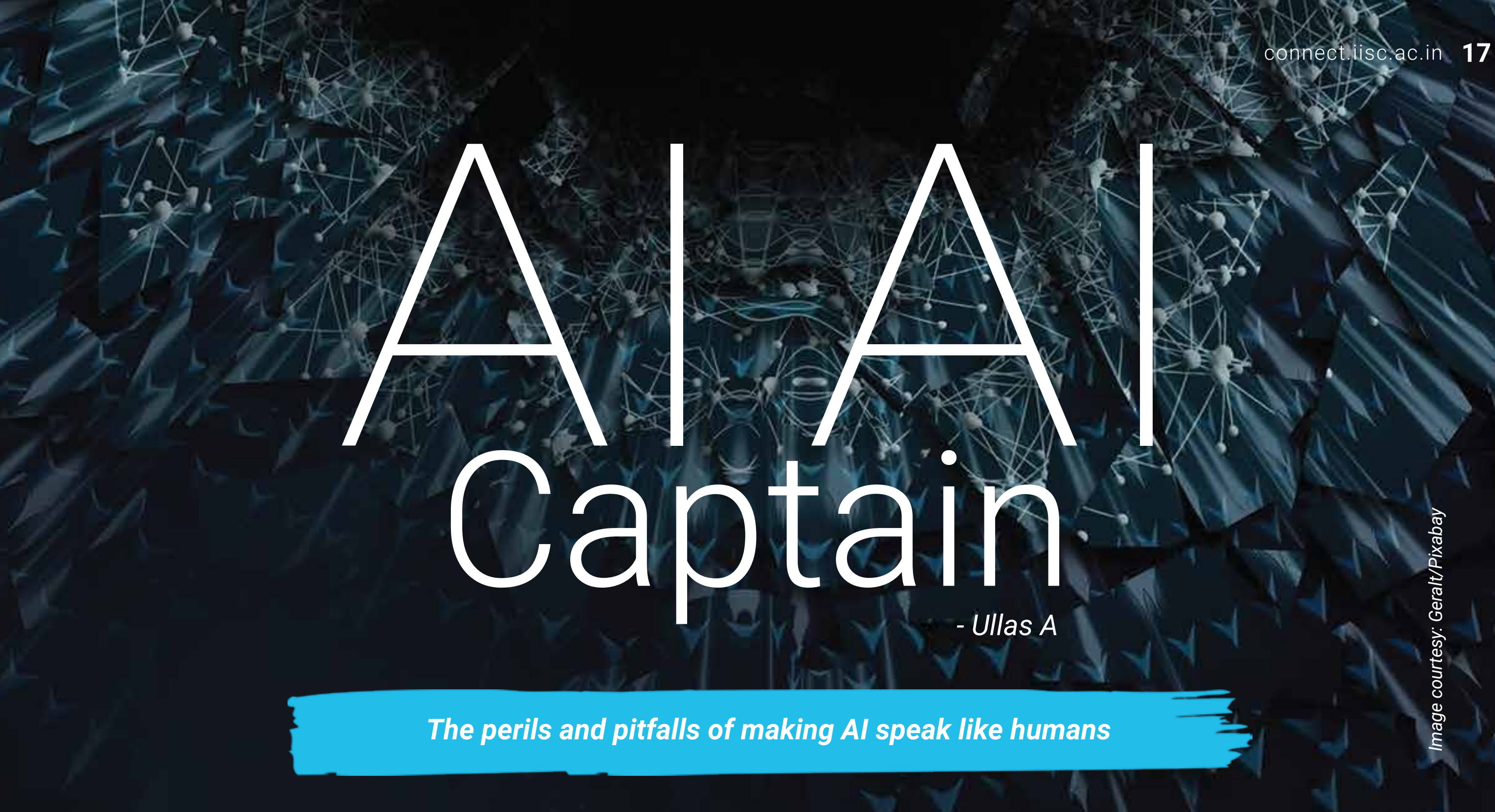


Image courtesy: Geralt/Pixabay

AI AI Captain

- Ullas A

The perils and pitfalls of making AI speak like humans

In June this year, a Google engineer made a bombshell claim: the Artificial Intelligence (AI) system he had been working on had become sentient – it had become aware of its own existence and begun expressing emotions and feelings. Google summarily dismissed his claims and fired the employee, but the incident once again brought into sharp focus the ethical conundrums surrounding the development of AI.

What was particularly interesting in this case was that the project was part of Google's LaMDA (Language Model for Dialogue Applications), which involves developing language models for humans to converse with AI. Instances like this just go to show how language has become the ultimate test for a machine's intelligence. Researchers are grappling with not just the technological challenges of making AI learn languages, but also the social and moral implications of machines becoming more intelligent.

What makes something as ordinary as language (which seems so intuitive to humans) such a hard nut to crack for a computer? One obvious reason is the richness of human languages. With ambiguities, wordplays and innuendos, language is such a complex evolutionary artefact of humans that having AI master it is indeed a lofty goal to strive for.

In the 1960s, Noam Chomsky, a pioneering figure of modern linguistics, introduced the idea of a "Universal Grammar". He posits that every one of us is born with an innate ability to understand language, and that every language has more or less the same laws.

Language is what makes us uniquely human. But can computers ever reach this pinnacle?

'Time flies like an arrow but fruit flies like a banana'

How do we know a machine or AI is intelligent?

Alan Turing, considered the father of modern computer science, proposed an experiment back in 1950. Famously called the Turing Test, the experiment basically gives an operative definition of intelligence (which means that for a machine to be called intelligent, it simply has to pass the test). In this test, a human and a machine are kept in separate rooms and interrogated by a human interrogator whose goal is to identify which of the two 'contestants' is human. The interrogator can ask any kind of questions to both, and if at the end, is unable to make out which is which, this means that the machine has successfully fooled the interrogator into believing it is human. As one robotics researcher put it, an example of an absurd question to ask a machine would be: "How come time flies like an arrow but fruit flies like a banana?" Humans would be able to recognise this as a play on words, but will a machine be able to?

At its core, the test hinges on computers being able to understand natural languages. In other words, classifying a machine as intelligent does not have anything to do with its ability to crunch large numbers or do complex mathematical calculations, but solely depends on its ability to understand and process language.

No machine has satisfactorily been able to pass the Turing Test, although there have been some breakthroughs here and there.

One such remarkable advance has been the development of Generative Pre-trained Transformer-3 (GPT-3). GPT-3 is a neural network-based model that spits out sentences in human languages with very minimal input. Neural networks are mathematical models that mimic the operation of the human brain's neuronal circuitry. Just like how neurons fire in the brain at different rates, driving specific functions, neural networks accept inputs that mimic "high" or "low" voltages, which in turn pass through various hidden layers (of other neurons), and activate other circuitry, eventually producing a desired output. GPT-3 has been heralded as a marvellous feat of engineering, for it has 175 billion parameters – essentially its building blocks – using text found on the internet. The sentences it generates are therefore very realistic, just like one would find on a blog or webpage. Researchers have used it for a plethora of tasks such as summarising a long article, generating questions on a topic given an article, writing program code, even scripts for movies.

"There is enormous potential here," says Hemavati D, a PhD student in the Department of Computer Science and Automation (CSA). "What makes something like GPT-3 possible today is the advent of technology like GPUs (Graphics Processing Units) that have massive parallelism and can harness so much power. To operate on 175 billion parameters is no joke."

"Thanks in large part to Deep Learning, there has been significant progress in language processing over the last few years," explains Partha Pratim Talukdar, Associate Professor (on leave) at the Department of Computational and Data Sciences (CDS), IISc. "Earlier, one had to spend considerable effort at identifying features that could be considered relevant. But over the last decade, Deep Learning has made it possible for it to learn the features on its own."

He explains these features with an interesting example: Suppose you give an image to a machine and ask it to learn to classify whether the image contains a cat or a dog. Earlier, one had to manually identify the relevant features that would distinguish one from the other, and provide those features to the AI – for example, if the image contains pointy ears and has whiskers, it is a cat. "Now, with the advent of Deep Learning, we simply provide the images which are labelled as either cat or dog, and [the AI] learns on its own as to what are the relevant features that make the classification possible. We don't provide the features anymore," he explains. "Of course, we can't make sense of the features that it uses to make the classification, in the sense that they are not intelligible to us, but it works and is successful at downstream tasks. The same principle has been applied to sentences. GPT-3 has been trained likewise on huge amounts of text and it figures out the features on its own as to which pieces of text make for good stories and plots, and other things. As a more recent example, there is PaLM, which has demonstrated tremendous capabilities in numeric reasoning, joke explanation, common sense reasoning and code completion among other things."

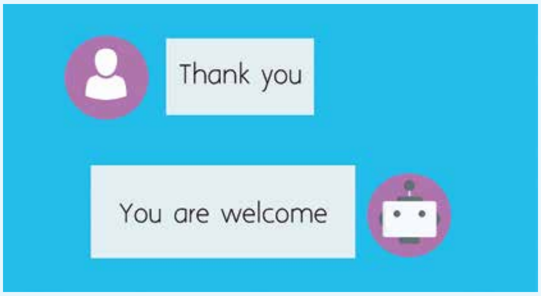


Image courtesy: Mohamed_hassan/Pixabay

Most recently, yet another novel AI tool has been released that many are heralding as a breakthrough – ChatGPT, a prototype chatbot developed by a company called OpenAI, who also developed GPT-3. A user can engage in detailed conversations with ChatGPT about almost anything. For instance, a user could type in that they are experiencing some symptoms of cold, and as a response ChatGPT could ask a few follow-up questions, in much the same way a doctor does, and eventually after engaging in a dialogue, it could even provide a diagnosis and suggest medicines. And many users have reported that the text, syntax and format are uncannily human-like.

Responding like a doctor is not the only thing the chatbot can do – one could engage in dialogues with ChatGPT on any topic whatsoever, because after all, the internet (on which it has been trained) has tons of information on every topic. But having the information out there on the internet is one thing, and being able to engage in conversation the way a human does is another ball game altogether. Which is why training the chatbot involved human AI trainers who provided conversations playing both roles – the user as well as the AI. And from this, over multiple iterations, ChatGPT learnt the nuances of conversations, and became capable of writing computer code, jokes, even essays and short stories based on imaginary prompts from users.

Challenges and concerns

Generating short stories may seem relatively harmless, but things can take a turn if such AI is used for more serious tasks like writing a research paper – which is what Almira Osmanovic Thunström, a researcher at the Institute of Neuroscience and Physiology at the University of Gothenburg did. Not just any research paper, but a research paper on GPT-3 itself (which she then submitted to a peer-reviewed journal). Such experiments can open up a can of worms, both ethically and legally. The irony is that GPT-3 concluded the paper with the words: "Overall, we believe that the benefits of letting GPT-3 write about itself outweigh the risks. However, we recommend that any such writing be closely monitored by researchers in order to mitigate any potential negative consequences."

Viraj Kumar, Visiting Professor at the Kotak-IISc AI-ML Centre, gives another example. The same principles that enable GPT-3 to generate human language sentences can also allow AI to generate program code. "There is a tool called Github Copilot which, given a prompt, automatically generates code for that prompt," he says. "Now as an educator, do I neglect it, or do I police it, and where do I draw the line? How do I give programming assignments to students?"

Another challenge with building such AI is that if the data that is used to train the model has in-built biases, they become imbibed into the AI as well. For instance, owing to the fact that it was trained on text from the whole internet, GPT-3 ended up learning racist biases. For example, it was found to mention violence in the context of Jews, Buddhists and Sikhs once, twice for Christians, but nine times out of ten for Muslims. But by injecting positive text about Muslims in the language model, the mention of violence reduced by about 40%. "One of the ways of mitigating bias is to build models on more representative data," says Partha.

Speech processing is yet another challenge. Unlike written text, there is also a sequence of sounds associated with every sentence that is spoken. “Every language has its own unique characteristics in terms of sounds and the sequence of sounds, which will finally link to the words, the letters and the sentence. When somebody speaks a particular language, the sequence of sounds will be different compared to another language, unless these two languages are very similar,” explains Prasanta Kumar Ghosh, Associate Professor at the Department of Electrical Engineering (EE), IISc. “What the model will need to learn is beyond just words – the sequence of the sounds too.”

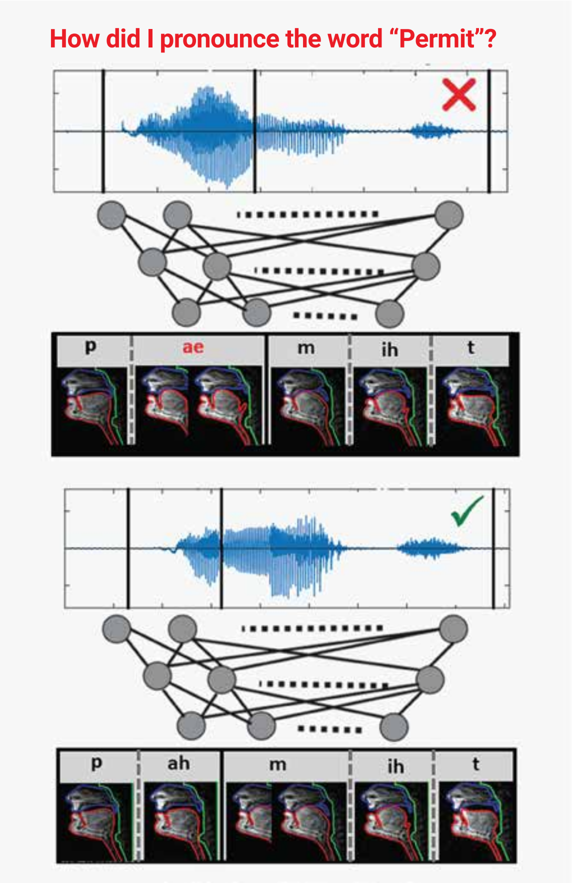


Image courtesy: Prasanta Kumar Ghosh

Data collected using an electromagnetic articulograph that captures each individual’s speech patterns

Although it is similar to language processing, one major difference is that there is no white space in speech – like punctuation – unlike written text, which implies that any AI attempting to understand speech has to understand where a word or a sentence ends. To circumvent this issue, Prasanta explains, the AI is not trained using individual sounds for words, but instead it is trained using speech waveforms of running speech which present a sequence of sounds from different words.

Avoiding selective output is also a challenge, he adds, because if one collects data only from, say, Bengali speakers, the AI ends up learning only those contexts, metaphors and other biases built into that language.

Both Partha and Prasanta strongly advocate training and developing AI using Indian datasets, because most of the AI models we have today have been trained on datasets in the USA, UK or Europe, which may not be as representative of nuances in the Indian context.

These advances in AI are also happening in the backdrop of the widening digital divide in society. "Yes, it [AI] can do great things. But one must be aware that not everyone might have access to such technology – for instance schools with low funding may not have access to devices,” explains Viraj. “So there is every risk that the best AI might go to those who can afford it, increasing the gulf between the 'haves' and the 'have-nots.'"

Soma Biswas, Associate Professor at the Department of Electrical Engineering, IISc, says, “As much as one could use AI for good, one could also misuse such technology for nefarious purposes, like deepfake technology.” Deepfake generates realistic photos and videos of people. One could therefore use it for generating misinformation. Awareness of the perils and pitfalls of AI-based technologies among the general public is also important. “The researchers who work on these technologies need to have an ethical mindset,” says Soma.

There are, therefore, many, many questions that are unresolved. Should we allow the use of AI in creative endeavours like art or even academic writing, and if so, should we be allowed to name the AI as the author or creator? Incidentally, what pronoun or gender do we assign to the AI? Can AI ever really become sentient at some point in the future, like the Google engineer claimed?

Finally, how do you know whether the article you have just read was written by AI or not?

Ullas A is a PhD student in the Department of Computer Science and Automation and a science writing intern at the Office of Communications, IISc

'WHY CAN'T WE MAKE SMALL TALK ABOUT SCIENCE?'

- Pratibha Gopalakrishna

Photo courtesy: Kollegala Sharma

Kollegala Sharma has worked as a science communicator for over 40 years. After quitting his PhD in radiation biology, he worked as an Assistant Editor for** Science Reporter **– CSIR-NIScPR's magazine – then as a Kannada science columnist in the newspaper** Kannada Prabha**, and as a chief scientist at CFTRI, Mysuru. He has written articles about science in English and Kannada, and translated science articles from English to Kannada, in the hope of quenching people's thirst for science in Karnataka. In this interview, he talks about why he chose this field, and why he believes science outreach in regional languages is so important

What sparked your interest in science communication in Kannada?

In primary school, it caught my imagination when one of my teachers told us about the stars, planets, and how Earth rotates. Around the same time, I watched the movie *Dasavatharam*. There was one scene where Varaha avatara brings up the Earth from under the sea. I was totally surprised because I was very young and I never knew that Earth rotates like this and that Earth is a free body. But when I saw that visual, I thought, “What will happen if I go towards the sea while the Earth rotates? Will I drown?” I started reading books in search of the answers.

That was a time when science communication in Kannada was also available. For example, the magazine *Sudha* began in the 1960s and it carried a one-page science column with tidbits and interesting news. When I was in first PU, BGL Swamy had published a book called *Hasuru Honnu*. It got a literary award from the Kendra Sahitya Academy even though it was about popular science. In the book, he went on an educational tour to the evergreen forest with the students and he talked about the taxonomy of all the subjects and introduced various plants in the Western Ghats. I always felt, why can't our teachers teach like this? There was another book called *Nakshatra Loka* written by Roddam Narasimha’s father, RL Narasimhaiah. That book was fantastic and the opening said that one cannot count the number of stars. That caught my attention. If there are so many stars, how do we count them? During my college days, I had read Abraham Kovoor’s book on rationality and superstition called *Gods, Demon & Spirits*, which influenced a lot of us at that time.

Growing up, I saw emphasis on science research, science communication, science education and Kannada, and it seemed that everything was coming together. It was a time when Karnataka Rajya Vignana Parishat was established and it was setting up branches all over Karnataka. All of these influenced me to look at science and science communication.

Why do you think it is important for science communication to be vernacular?

I say that there is a demand for everything – for science content in any form or in any media in almost all languages. And we are not creating enough.

As a science communicator I have always felt a gap between scientists and science communicators. Generally, there is a belief that a science communicator dilutes the understanding of science, but I don’t think this is true.

The third thing is the need. If you think of Karnataka, every year we have about eight lakh students passing out of the 10th standard. After that, only a small group, about 20%, have the opportunity to study science, while most do not. So their connection with science stops at the10th standard level. This is a huge population, and their need for science information has to be satisfied through Kannada only. Do we have that kind of media? Even on the internet, do we have that kind of content available in Kannada? These are the questions that we need to ask.

And how do we fill this gap? Of course, we can always take the help of technology and translate the content into Kannada. But machine translation doesn't understand the subject, so there could be a lot of misinterpretation and mistranslation when using tools like Google. That is why we need to do more science translation in Kannada.

Recently, I translated a few of the press releases sent by IISc into Kannada and sent them to newspapers, web magazines and they were all published. The press release on novel diabetic footwear was published in *Deccan Herald*. I wrote an extended article including other efforts elsewhere and published it in Kannada in *Prajavani*. Though both articles were published by the same firm, the Kannada version received more attention and the newspaper diverted all calls to me. This is just one example of how communication in Kannada can make an impact.

What are the challenges of being a science communicator in Kannada?

The challenge that I have not been able to breach – maybe it is my fault; I don't know – is this gap between the scientists and the science communicators. There is a bit of a trust deficit between the two communities.

Most of the scientists with whom I have spoken feel that science is precise, and therefore when we write it in simple language, the precision is lost. I disagree: not all science is precise. Take for example, anything that you do in molecular biology. We say that yes, we have manipulated this gene with CRISPR, but then again, we talk about the errors. And the population. And the sample size. Oh, nothing is precise. The only thing is – how do we communicate what we are doing? The excitement of that is what a common person needs to know.

If you dissect the language of science that we use within laboratory walls, for the most part, you have only a few concepts that need a precise word. For the rest, any other everyday vocabulary that is available in your language is sufficient to explain that.

Photo courtesy: Kollegala Sharma

At the inauguration of the Science Theatre Festival at Mysuru in 2022

But I'm always surprised that scientists are so reluctant to talk about their work. Anything that we do will always be interesting to people. Not everything has to be formidable and on a pedestal. Why can't we gossip about science and make it part of our everyday lives? I'm putting it in a positive sense, not in the negative sense. So why can't we make small talk about science? What stops us from doing that?

Another problem that we face is with illustrations. Illustrations are absolutely necessary with the science text because they complement some of the metaphorical meanings of science concepts. So many illustrations are available in textbooks and they are in English. And to change them into Kannada, there is a lot of difficulty because of copyright issues. We don't have enough illustrators who can understand science and also provide illustrations with text from Indian languages. That is one thing that is missing and somewhere we need to give a push for that.

What kind of impact have you seen from such science communication efforts in Kannada, especially in rural communities? Are there any interesting anecdotes you can share?

Forty years ago when I wrote about prenatal diagnosis, I met someone at a bus stand in Mangalore. He said that he was married to his relative. The first child had hydrocephalus – it had a huge head and the baby died. He had read my article and he asked me, "Should we go for a second child or not?" That's a difficult question for anybody to answer.

Once a teacher-friend in B Matakere, HD Kote taluk, said that they were finding it difficult to teach the nervous system and coordination to 9th standard students as the school didn't have a biology teacher. They also complained that it was difficult to teach as there were no hands-on activities for these things, whereas physics and mathematics do. So, I took up the challenge, went and stayed there in the school for one week, and started teaching.

There were 99 students, all from tribal areas, and when I read their textbook, it referred to the brain as "mastishka" (ಮಸ್ತಿಷ್ಕ). But when I used that word, the whole class stared at me in silence. So I tried a different word. Do you know "medulu"? (ಮೆದುಳು) No response. So then what could I do? I just changed track; I talked about something else and asked them what they like to eat. And they said that they catch birds. So I asked, birds' "tale maamsa chennagirutta"? (ತಲೆ ಮಾಂಸ ಚೆನ್ನಾಗಿರುತ್ತಾ?) ["Is bird brain meat tasty?" (tale = head)] Oh, the whole class shouted. There were lots of responses about the quality of tale maamsa. Then I pointed out that that is medulu; tale maamsa is medulu. And then I learned from the children how it looks, what its texture is, and other details. I think this is where we are driving people away from science: the language of science is so removed from the terms we use in daily conversation.

Science interests everybody. But the way we teach, the way we tell them, matters. Science communication is a never-ending process. If I know something, it doesn't mean that everybody else knows it already. It also means that I don't have to communicate everything that I know to everyone. Communicate one point at one time: they need to know only a few things at that time, and that gets them interested. Later, if they want to learn more, they will come back to you.

Photo courtesy: Kollegala Sharma

Na Someswara at the Science Sanje programme

You have been hosting a science podcast in Kannada and the Science Sanje talks. Can you tell us a bit more about these initiatives and any new projects you are working on?

The National Centre for Biological Sciences (NCBS) had worked on a project called Science Cafe where you go to a residential colony and gather people and talk to them in an informal setting about science. Taking off from that, once a month we have started what is called as Science Sanje: an evening of science, here in Mysuru, in Kannada. The venue will be where cultural programs are typically held. We chose that because we knew most public lectures on science are held either at IISc or at Mysuru, either in the university auditorium or in CFTRI. These venues are not typically accessible to the general public, and even when they are, people hesitate to come in. We thought, why not go to them?

We have held five programmes so far and we get around 100-150 audience members. These are not captive audiences. Every time, the audience changes and this is something that we are finding very interesting because it tells us that people are interested in science. They want to know about it. We have to take the extra step to go out and tell them about it.

But there are two hurdles to this. One: we need scientists who are ready to come to rural areas and talk to people in their language – that is not difficult. You don't have to speak in academic Kannada, you just have to speak in everyday Kannada, even if there is English mixed in. Two: many scientists hesitate to speak in Kannada. They think that it is very difficult and the concepts cannot be conveyed. That is not true, and I want to assure them that if there are scientists who are ready to come, we can sit together – science communicators and scientists can sit together for half an hour and understand their topic. Then we can plan how that can be curated for the general public.

There are other efforts, of course. DST's Vigyan Prasar is already doing some work to have a project called Bhasha, which I am part of. It is trying to communicate science in different Indian languages. In Kannada, we have a project called Kutuhali and under its banner, we are also publishing a magazine for which we need content and we are training people using workshops and other modes. Translation is another aspect of this project.

In your opinion, what can be done to improve the state of science communication in the country? Do you think there are sufficient support systems/ mechanisms to encourage such efforts?

In science communication, there are two levels that I look at. One is science education where we communicate to the student community in such a way that the students understand the specifics of science. The other is for the general public, where they don't need specifics, but they need to respond to science, and they need to understand the role of science in their society. Both are different, but both can be done in Indian languages.

You want people to know about science and respect science. They do have a lot of respect for science, but they are also afraid of it because they think that it is something that they cannot understand. So, we have to make them love science, and remove that fear. To do that, we need to go to them and talk to them. And we need more scientists ready to go to villages or government schools and talk. As of now, almost all outreach programmes are concentrated in urban areas. We want to do more outside of it and outreach doesn't mean that we show them what we have done. Outreach means we show them that science is not something that is magic. Science is something that they can also do and the next part of that is citizen science.

My concern is the future – climate change or climate action requires a lot of science outreach. And that has to be in citizen science mode. If that has to happen, scientists have to speak in Kannada, in Tamil, Telugu, and work with people. How many scientists are prepared to do this, is the question.

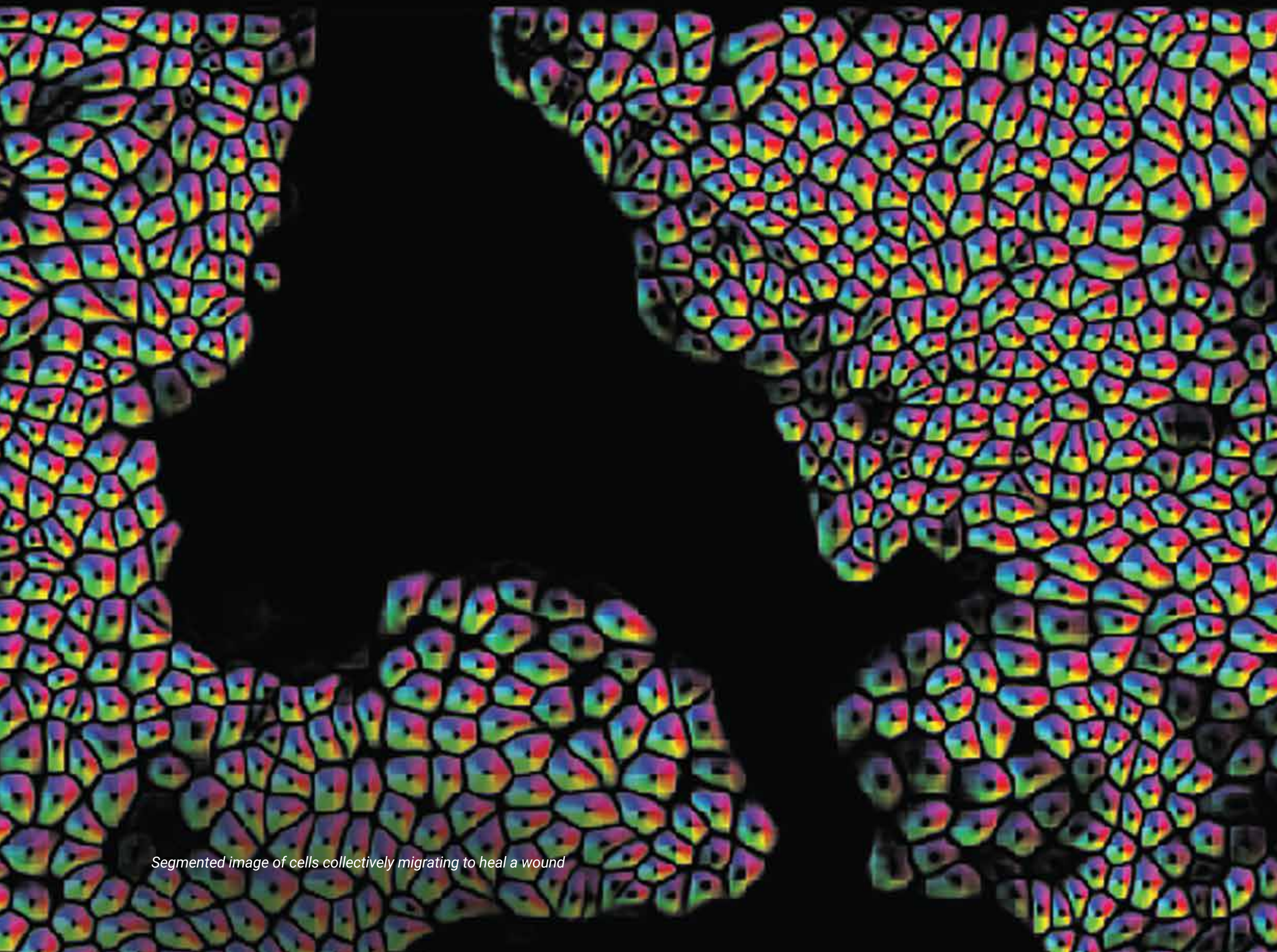
Photo courtesy: Kollegala Sharma

Discussing junk food with homemakers in Dharwad

Can SOLID TISSUES flow?

- Sindhu M

Image: Sindhu M



Segmented image of cells collectively migrating to heal a wound

Cells can apply and sense forces to communicate and coordinate with each other. Scientists and engineers have teamed up under the mechanobiology banner to study these cellular forces

The outermost and the innermost surfaces of any organ are lined by the 'epithelium', a tissue composed of cells arranged in a sheet. For instance, the part of the skin that is visible to us, and the inner surface of the lung exposed to airflow, are both lined by epithelia. Their main function is to protect organs from external particles and germs. Therefore, cells of the epithelia are closely packed and are connected with their neighbours through proteins. They latch onto a jelly-like surface called the 'substrate' that contains an assortment of proteins. In addition, special proteins jutting out of one epithelial cell can bind to similar ones from the neighbouring cells, like holding hands, allowing them to stick to each other. Similar to pulling someone by their hand, cells use these proteins to apply forces on their neighbours, called 'cell-cell forces'. Cells also crawl over their substrate by applying forces on it, like the traction of the wheels of a moving car on the road. Since cells and tissues are microscopic, measuring forces acting upon or exerted by them can be tricky. Understanding such mechanical forces is important in the study of cellular processes, such as cancer, fertilisation and wound-healing. 'Mechanobiology' is an exciting interdisciplinary field that brings biologists, physicists, mathematicians and engineers together to study forces at the cellular level.

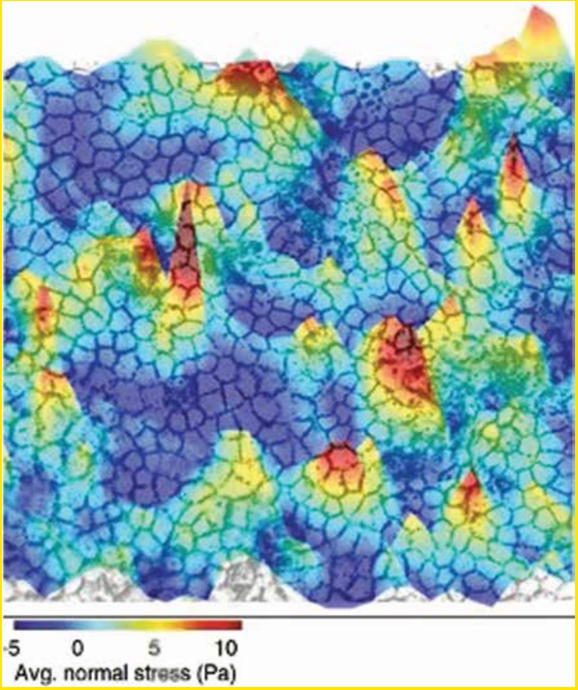
When our skin gets a cut, cells at the site of the wound are scraped away, creating a gap in the epithelial sheet. The cells surrounding the wound coordinate and move together to close the gap. Cells also move collectively when organs are being formed, when the baby is still in the womb of the mother. In the 1960s, several studies observed that the leading edge of a group of moving cells had finger-like protrusions in the direction of movement. This led embryologists and cell biologists to hypothesise that the cells at the leading edge were applying force and pulling the cells behind them. But this idea remained unverified for decades due to the lack of experimental techniques to measure cell-cell forces in tissues. In the late 1990s, Micah Dembo, a theoretical biologist turned mathematician, devised a technique called Traction Force Microscopy (TFM) to measure single-cell forces. In TFM, cells are grown on top of gels containing tiny micron-sized fluorescent beads. This gel is elastic, like a spring. When moving cells apply a force on it, the fluorescent beads in the gel move too. The movement of the beads on the gel can be compared to the movement of an object attached to a spring. Using the stiffness of the gel and the displacement of the beads, we can calculate the force applied by the cell on the gel. Dembo's group first reported the movement of cells from a soft substrate to a stiff substrate. Using TFM, they showed that cells exert higher forces on stiffer substrates. Due to the force imbalance between soft and stiff substrates, cells move toward the latter.

Dembo's method, however, involved extensive calculations which took hours on a supercomputer. James Butler, a particle physicist, simplified the calculations using a specialised mathematical method so that they could be done in seconds on a laptop. And yet, a decade later, biologists were still struggling to measure forces between cells in a tissue, and again, physicists solved their problem.

In 2009, Xavier Trepat and James Butler improved TFM and came up with Monolayer Stress Microscopy (MSM). When they used this technique to look at wound healing by growing cells on top of gels, the results were bizarre. They expected to see either a uniform distribution of forces across the layer of cells, or higher forces at the leading edge near the wound, and little to no forces in the bulk of the cells. But they observed a mosaic distribution of forces in different directions with no apparent pattern in the bulk of cells.

In 2011, they collaborated with the physicist David Weitz and noted an interesting parallel between epithelia and soft matter. Similarities between soft matter and epithelium were reported for the first time in 2001. Ben Fabry, an electrical engineer, used magnetism to study cell forces. After getting some curious results, he knocked on David Weitz's doors, who first noticed the similarity. Soft matter refers to materials whose constituents are not ordered. Substances such as coffee beans and foam come under the umbrella of soft matter. Such substances are associated with a peculiar property called jamming/unjamming. A material is said to be 'jammed' when the movement of its constituents is constrained by their neighbours, similar to a traffic jam. The epithelium is like soft matter – its constituents, the cells, are deformable. This allows it to protect the body from external agents by forming a continuous barrier. When there is a wound, however, the epithelial tissue 'unjams', becomes more fluid, and flows in to fill the gap. As the wound closes, certain cells at the leading edge actively apply force and pull the cells behind them. These specialised cells are called 'leader' cells. Medhavi Vishwakarma, Assistant Professor at the Centre for BioSystems Science and Engineering (BSSE), IISc, studies how leader cells are chosen. Cellular forces fluctuate with space and time in the epithelial tissues. These fluctuations dictate leader cell formation. Just like in animal societies, leader cell formation in epithelial cells is decided by democratic, collective decision making.

Image courtesy: Medhavi Vishwakarma



Forces fluctuating with space and time in the epithelial tissue

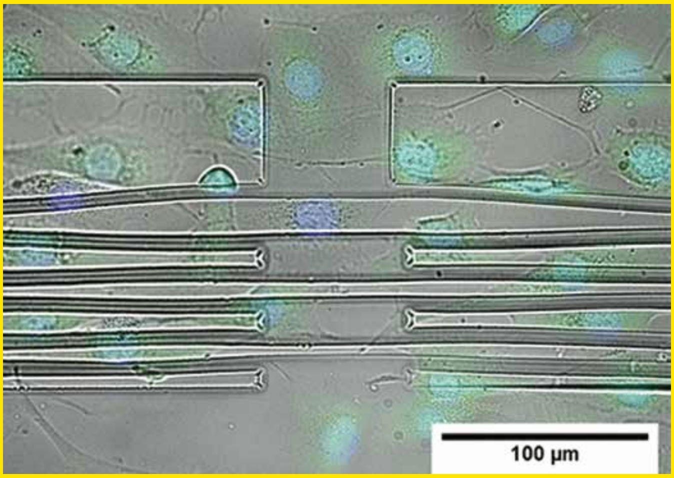
Epithelia are 'viscoelastic' – they are viscous like honey and can flow in the timescale of hours, but are also elastic like spandex, in the timescale of minutes. But why are epithelial tissues viscoelastic? "Epithelial tissues are like a community," explains Medhavi. "They are connected by cell-cell contacts. When one member (cell) experiences stress, it can be passed on to the other members. Therefore, viscoelasticity at the cellular level can be translated into viscoelasticity at the tissue level." To understand how solid tissues can flow, we need to zoom in from tissues to micron-sized cells.

GK Ananthasuresh, Professor at the Department of Mechanical Engineering, also studies the mechanics of cells. He studies the mechanics of flexible objects and designs, and makes micromachined devices. "It occurred to me that I am working on things that are small and flexible, and the biological cell is one of those. We were making miniature tools to understand small things, and we wanted to make tools to understand biological cells; like microscopic fingers to hold and handle cells," says Ananthasuresh. His lab makes 'mini fingers' using a polymer called SU-8. Using these, researchers can probe cells and feel how soft or hard they are.

The idea is that biochemical changes inside the cell would reflect in changes in its mechanical response to these 'fingers'. If these mechanical responses can be measured, then it is possible to predict the biochemical changes that caused them without doing complicated biochemical tests. For instance, a typical eukaryotic cell has a nucleus. The shape and location of the nucleus are perceptibly distinct for different cell types in different conditions. Specific proteins hold the nucleus in place and maintain its shape. In most cells, the nucleus is easy to observe. Hence, by analysing the shape of the nucleus, the researchers can predict the cell type and the protein distribution in that cell, even without biochemical tests. "Biologists are used to measuring parameters directly from experiments. As engineers, we try to deduce parameters that are easy to measure, and from those, calculate the more complex required parameters," says Ananthasuresh.

To measure the mechanical properties of adherent cells, Ananthasuresh's team has devised a specialised substrate with grooves. On stretching the substrate, the cells grown on it are also stretched. Conversely, during cell migration, cells also apply forces on the substrate to sense the stiffness and viscosity of their environment. By measuring the substrate displacement using microscopy, the force applied by the cells can be measured.

Photo: Vikram Somanna Kollimada



Photolithographically micromachined SU-8 cell-stretching device: schematic and photograph showing NIH 3T3 fibroblasts stretched and contracted

At the other end of the campus, Ambarish Ghosh, Professor at the Centre for Nano Science and Engineering (CeNSE), works on heterogeneity inside and outside cells. "Biological materials are so heterogeneous. (Even) at the length of 10 microns, they have several different components and functions," he says. A physicist by training, his interests include colloidal systems and soft matter physics. In colloidal systems, microscopic particles of one substance are spread throughout another substance, like fat particles suspended in milk. However, these systems are not uniformly dispersed, so if we want to understand their mechanical properties such as density, it is not enough to measure it only at one location. For this, we need tools which can take local readings at different points. Conventional tools such as the 'rheometer' can only take an average measurement for the whole sample. "Basically, in analysing the khichdi, you're not differentiating between the rice and the dal," explains Ambarish.

To overcome this problem, Ambarish's group uses tiny positively charged robots which can move around and measure mechanical properties at different locations of the colloidal system. They move like corkscrews when a small magnetic field is applied and so are called 'helical swimmers'. These swimmers can enter cells and swim inside them.

Using the swimmers, the researchers measured variations in mechanical properties, such as stiffness inside the cells. These swimmers were also used to probe the environment outside the cells, where they were allowed to move randomly in a culture dish containing a mix of normal cells and cancer cells. Surprisingly, the researchers noticed that the swimmers seemed to be trapped near the cancer cells but not near the normal cells. They found that only cancer cells secreted negatively charged acid into their external environment. Therefore, due to electrostatic interactions, the positively charged helical swimmers were stuck near them. "Not only are we taking measurements, but because the electrostatic and mechanical properties change (around a tumour), we are in a way targeting cancer cells. This can have tremendous implications for cancer imaging and drug delivery," says Ambarish.

The reason why the environment inside cells is not homogenous, as Ambarish pointed out earlier, is because the inside of the cell is packed with proteins, carbohydrates and fats of different sizes and stiffness. We need to zoom in further from the micrometre-sized cells to nanometer-sized proteins. Techniques such as Förster Resonance Energy Transfer (FRET) allow us to calculate the tension in a protein molecule. For example, the protein Talin is like a spring. Talin can exist in two forms: extended and compressed. In the compressed form, the two ends of Talin are close to each other, and in the extended state, they are far apart. In FRET, the two ends of a protein are tagged with fluorescent molecules using genetic manipulation. When the protein is compressed, the two fluorophores come close to each other, and interact to give a fluorescent signal. The greater the fluorescent signal, the more the compression in the protein. Talin is normally present in the closed form near the cell membrane. When an external force is applied on the cell, Talin opens up to the extended form, which can be visualised by FRET.

Proteins inside the cell can assemble or break down or change their form dynamically. Therefore, their mechanical properties such as elasticity keep changing with time, making proteins also viscoelastic. Viscoelasticity at the protein level leads to viscoelasticity of cells and subsequently to viscoelasticity of tissues. This explains how tissues can flow like a fluid to heal wounds even though they are solid under normal conditions.

Mechanical changes in cells can trigger biochemical changes and vice versa. "'Chem' and 'Mech' are in fact anagrams," chuckles Ananthasuresh. Mechanobiologists are primarily interested in the mechanical properties of cells, while cell biologists are mostly concerned with biochemical pathways in cells. The way ahead in mechanobiology is to understand the crosstalk between mechanical forces and biochemical pathways, according to Medhavi and Ambarish.

It may soon be possible to detect diseases by measuring the mechanical properties of tissues and cells. A familiar example of a change in mechanics due to disease is the stiffening of the breast with breast cancer. Scientists are also trying to detect malaria by estimating the change in the stiffness of infected red blood cells. Mechanical tools and treatments are also finding their way into healthcare settings. An IISc-based startup called SpOvum uses mechanobiology to improve the success rate of in vitro fertilisation (IVF). In IVF, fertilisation of the ovum by the sperm happens outside in a Petri dish. After fertilisation, the embryo grows in the lab until it forms a ball of cells called the 'blastocyst'. A crucial step in the IVF process is biopsying the blastocyst – a few cells are removed from the ball of cells to analyse the health of the blastocyst. Handling the blastocyst with a micropipette may sometimes damage the blastocyst during biopsy. SpOvum has devised robots to hold blastocysts and handle them during biopsy, reducing damage to the blastocyst. "The field is moving towards 'mechanodiagnostics' – diagnosing diseases using mechanical responses," says Ananthasuresh. We are headed in the direction of Richard Feynman's vision of 'swallowing the surgeon', or nanobots performing surgeries and replacing surgeons.

Sindhu M is a PhD student in the Centre for BioSystems and Engineering (BSSE), IISc, and a science writing intern at the Office of Communications, IISc

THE GOOD, THE BAD AND THE AMBIVALENT:
Social Media to Scientists

- Seemadri Subhadarshini

Image courtesy: Gerd Altmann/Pixabay

Researchers at IISc talk about their social media presence and its influence on their professional lives

There has long been a perception that scientists are reclusive and asocial. However, this stereotype is being challenged by the rising number of them who tweet and post on Facebook and LinkedIn. Scientists today have more opportunities than ever before to use social media to share their work and engage with a global audience. During and post-pandemic, there has been an undeniable surge in the digital presence of science investigators on various social media platforms. They are swarming their feeds with information, actively engaging with the scientific community, facilitating collaborations, and amplifying their social media visibility. "I missed interacting with other scientists during the pandemic, and Twitter felt like a digital corridor," says Anand Srivastava, Associate Professor at the Molecular Biophysics Unit.

Social media has also brought scientists closer to the public and vice versa. This increased access to science has transformed it from a seemingly esoteric field to something everyone can access and even participate in. However, the scientific community seems to view this change with ambivalence.

Networking and collaboration

Social media platforms are effective ways to stay up-to-date on current literature, upcoming conferences, and professional networking opportunities. Kavita Babu, an Associate Professor at the Centre for Neuroscience, recalls how she joined the bandwagon. "I was organising a meeting on *C. elegans* in 2018, and a couple of colleagues were tweeting about it. I wanted to see what they were posting, and so I joined Twitter," she says.

It has become a common practice for scientists to routinely update their Twitter accounts with research progress and findings. Facebook groups are also great for meeting other like-minded people and staying up-to-date on trending topics in science. Anand has benefitted from posting pre-prints of their work on science-related Facebook groups and Twitter, and says that in his experience, such platforms can foster collaborations that might not have been possible before the rise of social media. Preprints also help him stay up-to-date with the field. "In biological sciences, it can take anywhere between 4-12 months or more to get the work out in a journal. By the time the preprints are published in the journal, the work is generally old news," he explains.

Mohit Kumar Jolly, Assistant Professor at the Centre for BioSystems Science and Engineering, has similar stories to share. "I posted about our recent bioRxiv preprint a few days ago. A colleague from the University of Ottawa came across it and shared one of their research articles with complementary experimental data to support our computational meta-analysis included in that preprint. We are now in talks, exploring common interests for potential collaboration." According to Anand, there are constructive ways to network despite the term "networking" having had a negative connotation in the past. Mohit, too, believes that academic Twitter is an ecosystem with a critical mass of colleagues and researchers who may be looking for postdocs, collaborations, new positions, and so on. "To expand my horizons, I want to connect to people from inside and outside the field, be it trainees, colleagues at similar career stages, seniors, or officials of different funding agencies," he states. Vishwesha Guttal, Associate Professor at the Centre for Ecological Sciences also says that his digital presence has facilitated several invitations for academic talks in India and abroad.

Fake news and phoney research

In addition to using social media for developing their network base and facilitating collaborations with scientists around the world, researchers use it to share the nitty-gritty of their work and research interests with the public. However, unlike peer-reviewed publications, social media content is not screened or vetted by anyone, allowing false or misleading information to spread just as easily as accurate information. This glut of easily accessible information at fingertips has generated intense competition for people's attention, consequently leading to loss of quality. In light of the current climate surrounding several hot-button issues, such as climate change and vaccines, many scientists feel obligated to use their platform to spread awareness and combat misinformation. "As a practising scientist, I sometimes feel studies have been made more trivial and watered down than they actually are. So one has to be careful about how science is communicated," says Anand. "Things are far more nuanced than black and white," he adds.

Social media outlets are also home to some of the most heated debates in science today. "Some topics can polarise people," states Vishwesha. "There is always a dichotomy of opinions. I take both and react the least until there is an apparent reason," adds Arindam Ghosh, Professor at the Department of Physics. He stresses that sometimes, the response goes in a direction entirely different from the original post's intention. "That gives me feedback that probably the post has not been written in the best possible manner."

The digital revolution has shifted the way science is practised and communicated, but social media is not a replacement for disseminating high-calibre research. Though there is the benefit of getting almost instantaneous feedback on preprints, it also brings the science under public scrutiny. Several instances of phoney research being called out by bloggers with keen eyes have been in the news. These serve as reminders that scientists are not infallible, are accountable to the public, and have a responsibility to provide authentic data and results.

Outreach

Social media is also proving to be a very useful tool for science outreach and communication. A single tweet can potentially reach millions of people instantly and is a strategy that many scientists, including those at IISc, have used to spread awareness about specific issues. Arindam, who has a significant Twitter following, states, "The advantage of having a large number of followers is that whatever I post becomes accessible to a larger pool, and students have reached out to me on what is a good research direction, what are good books to read, and about entrepreneurial activities." And it works both ways, he says, adding that he learns about students' problems such as not receiving scholarships on time through social media, which he might not have known otherwise.

Searching for topics of interest on any social media site is simple and can be done using hashtags, keywords, events, themes, usernames, and places. More and more science enthusiasts are hence gravitating towards such platforms. It helps students by providing them with a large amount of really concise information to choose from. Vishwesha, who is recognised for his scientific outreach in Kannada via his Twitter handle, elaborates that social media aids in reaching out to a larger student body and enabling student collaborations. He shares that social media has also contributed to his interactions and engagement with science journalists who find it easy to get in touch with him.

Screenshot of a tweet by Vishwesha Guttal, known for his Kannada posts about science

Mohit is also well-known among the Twitter scientific community for his meme posts concerning various aspects of academic life. "Over time, it [Twitter] has become a self-sustained, reasonably large, all-in-one platform," he says. He believes that online media is significantly changing the way in which research is disseminated both within and outside academic circles. He recently got an email from someone who just completed class 12, is about to begin his undergraduate studies, and wants to spend a few months in his lab. "He [the student] learned about our work, primarily through social media. The impression that one can connect with the stakeholders in the scientific circle is a significant change, especially for people in the earlier stages of their careers, such as this student," he says.

Screenshot of a meme post by Mohit Kumar Jolly

Striking the right balance

Through social media, science is now something that the average person can learn about and even get involved in, as opposed to being something that is only conducted behind closed lab doors. "The sense that social media has made scientists accessible has boosted the morale of many [young researchers and science aspirants]," states Mohit. He further highlights the influence of social networking outlets on multiple aspects of science. "Social media can be an excellent exercise in the democratisation of research, and can potentially translate to crowdsourcing funds and promoting research." However, more often than not, social media can also be a double-edged sword. It is unrestrained, but also unregulated. Hence, it is vital to be judicious and cautious on what to share and opine on, and what information to believe in. Achieving the right balance – staying connected to the science and not letting the negatives influence one's mental health is crucial. "One must be clear about the purpose of them using social media. It is an additional space that helps to reach beyond the immediate physical space but to believe it is the real, complete world is misleading," says Vishwesha.

Despite these pros and cons, social media is here to stay, and will continue to play an essential role in shaping the landscape of conducting and disseminating science. "Our constitution states that each citizen must inculcate scientific temper. I think social media is now playing a big role in that," states Anand.

Seemadri Subhadarshini is a PhD student at the Molecular Biophysics Unit, and a science writing intern at the Office of Communications, IISc

How do Students at IISc manage their money?

- Faizan Bhat

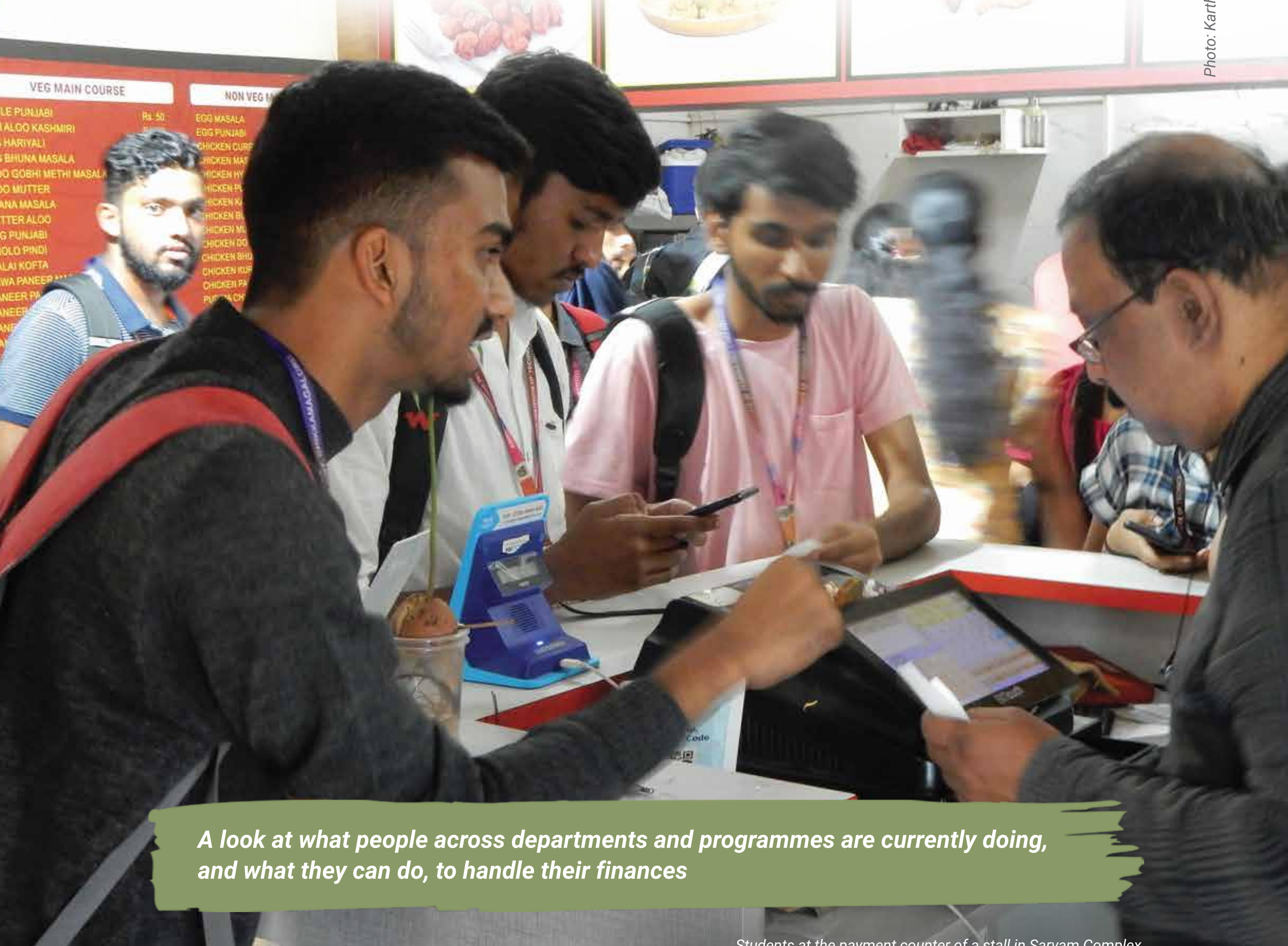


Photo: Karthik Ramaswamy

A look at what people across departments and programmes are currently doing, and what they can do, to handle their finances

Students at the payment counter of a stall in Sarvam Complex

Although India has a literacy rate of around 74%, it may surprise many that only 27% of the Indian population is considered financially literate. In fact, post graduates at 31% only do marginally better than the national average, while curiously, university students rank at the top at 43%. How do students at IISc fare in this regard? We interviewed several students across departments and programmes to find out.

For most UG and MTech students, saving is tough because the monthly stipend is too low. "My monthly stipend is Rs 5,000. Just the mess bill comes out to be more than that. My other expenditure is mostly on midnight food at Sarvam. We have no time to take up a part-time job. I know many who have less than a three-digit amount in their accounts," says a second-year UG student. "The only way to earn extra is by volunteering for CNS [Centre for Neuroscience] experiments," he adds while laughing. Annu Niraj, a second-year MTech student at the Centre for Product Design and Manufacturing (CPDM) says, "More than half of my stipend of Rs 12,400 goes into paying off an education loan I took for my BTech, and the rest goes in the mess bills. There is barely anything left for my expenditures, leave alone saving."

Among PhD students, saving is also difficult for those who support their families with their fellowship. Brijesh Kanodia is a third-year PhD student in the Department of Physics. He says he spends around Rs 15,000 out of the Rs 35,000 he gets every month and sends the rest back home. Others don't focus on saving for the future because they have other priorities: Pingal Pratyush Nath, a third-year PhD student at the Centre for High Energy Physics (CHEP) says he'll think more about saving in the future when he has a higher-paying job. "Right now, most of my savings are spent on travelling. I plan a trip every two months or so. I'd go every month if I had the time and money." Almas Siddiqui, a second-year PhD student in Civil Engineering, also says she's trying to save in order to travel in the coming months: "I don't think too much about the long term. I want to make the most of the present. Money comes and goes."

Some PhD students say that they try to save in order to support themselves beyond the usual five years of a PhD in case they require longer to complete their work. Kiran Kolluru, a fifth-year PhD student in the Department of Physics, says, "The standard duration for students to complete their PhD requirements in my lab is six years. I've been saving 15,000 per month in an RD scheme for the past four years. I'll use it to support myself if required." Akshay C, another PhD student in his third year, says he knows many students in their sixth year who are struggling financially. "How is a student expected to do research with no financial stability?" he adds.

When we talk about savings, we usually mean putting our money in safe places that allow us access to our money any time, like a savings account, a fixed deposit (FD), or a recurring deposit (RD). But the tradeoff for the security and ready availability is that we earn low interest rates on the money we deposit. Investing money in real estate, stocks, mutual funds, cryptocurrencies, or commodities like gold and silver, for example, can lead to higher returns, but the stakes are higher: you could lose some or all of the original amount you invest. And not all students have an appetite for taking on that risk. Debapriyo Chowdhury, a second-year PhD student from CHEP, says he wants to focus only on academics right now. "I save around 21,000 out of the 31,000 I get each month, and it stays in my savings account. I've never thought about investing it. I like doing science, and if I am getting paid for it, everything else will sort itself out, I believe." Another common reason why students say they do not invest is the perception among many that investing is complicated and requires a lot of time and knowledge. "Investing is not my cup of tea. I don't think I will be a good investor. I had never even thought of it before this interview," adds Debapriyo. Almas says that she has colleagues who do invest, but she never considered it due to the risks involved. "I've heard that people can lose all their savings in the stock market. So I stayed away," she says.

On the other hand, we have a fifth-year PhD student (who asked not to be named) at the Divecha Centre for Climate Change who started his own successful business in 2015 which is now being run by his family. He invests his money back into his own business, but has an opinion on why many students at IISc don't invest. He says, "Unlike in a business or a job, PhD students have no profits to be earned or promotions to be rewarded based on their daily work. So they detach from the idea of growing their money and do not associate with the right people to get mentored in investing or starting a business."

Tanveen Kaur Randhawa is a fifth-year PhD student at the Centre for Ecological Sciences (CES). They were unsure of how to begin investing until a friend advised them to start investing in mutual funds. "I thought it would be a complicated process. But you can simply download a brokerage app and start investing in mutual funds, just as we order food on Swiggy. But just as we check for restaurant ratings before ordering, you have to look at things like rate of return and commission charges of the fund before you invest." They add that they put around 20% of all their savings in an FD, and the rest in mutual funds. "COVID-19 gave me a lot of time to think about my career trajectory. Even though I enjoy my work, I realised that this is perhaps not what I want to do all my life. I started saving in case my PhD runs over five years, which seems likely. I am also considering an alternate career path. Shifting towards another field or an industrial job is not always quick and smooth. I am saving so [that] I have some breathing space to assess my options and upgrade my skills as needed after my PhD," they say.

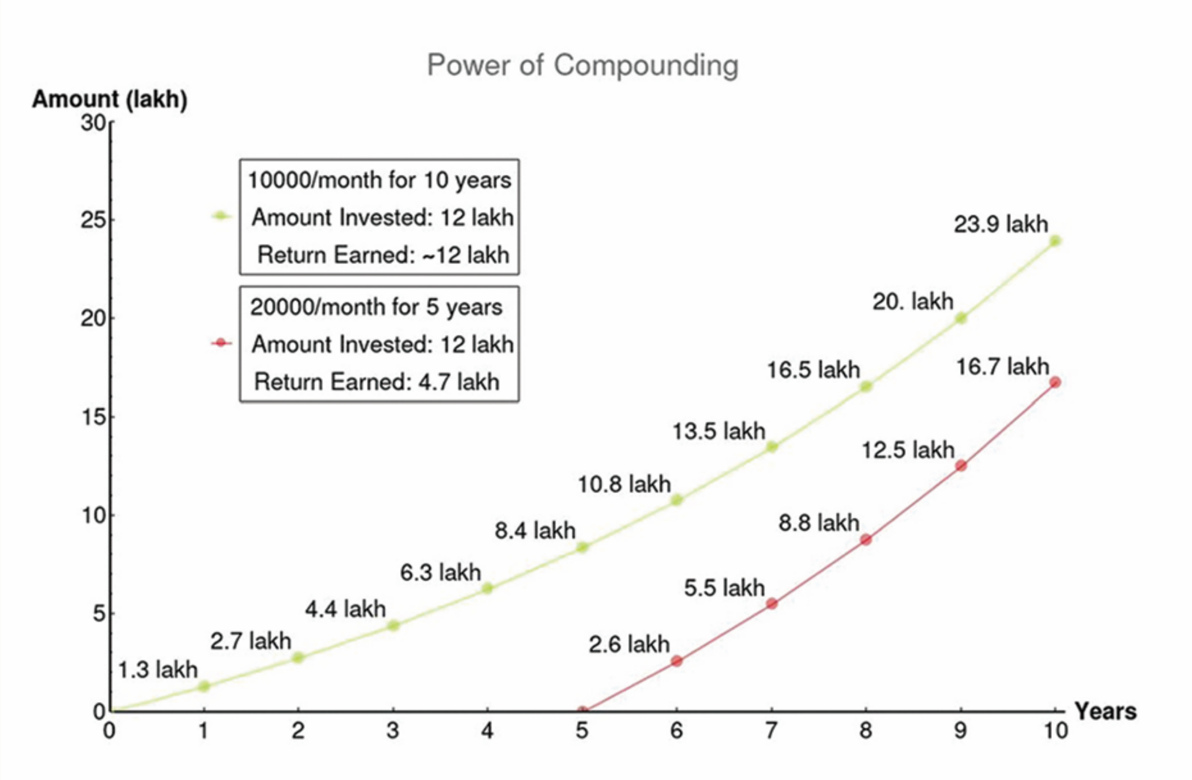


Image: Faizan Bhat

The graph shows the difference in earnings of two people who invest the same amount with an annual rate of return of 12.5%, but one starts five years later than the other. The early investor earns around 12 lakh, a 150% extra return compared to the 4.7 lakh earned by the late investor

Some students swear by investing, rather than only saving, as a strategy to prepare for the future. Swapnil Shukla, a third-year PhD student at the Solid State and Structural Chemistry Unit (SSCU), has been investing directly in the stock market for around two years. "I started investing in the stock market during the COVID-19 lockdown after learning that my money in bank accounts is losing its purchasing power with time due to inflation," he says. The fellowship amount of a Senior Research Fellow (SRF) in 2010 was Rs 18,000, which has increased over the years to Rs 35,000 presently. But if we consider inflation, Rs 18,000 in 2010 is the equivalent of about Rs 39,070 today. So leave alone any income growth, the fellowship hike over the years has not even kept up with the inflation rate. Swapnil adds, "I decided to invest in the stock market to get higher returns. It was scary in the beginning as I was a complete novice. I would listen to a bulletin on some business news channel in the morning and buy stocks according to the advice of their experts. Then if the stock price fell, I would panic and sell it immediately at a loss. With time, I realised that this is not the correct way to invest in the long term. Buying shares on your own can be risky, especially if one doesn't have a strong understanding of the stock market or the patience required to handle the market volatility. I've gotten more confident over time and invest more responsibly now," he says.

For students looking to grow their savings, Balachandran Ramiah, a financial expert with a PhD in Marketing, Business, and Public Policy from the University of Pennsylvania, has some tips. "The safest and most practical way for a student to invest is through the Systematic Investment Planning (SIP) schemes offered by mutual funds. Through an SIP, you can deposit a certain amount at regular intervals, and the mutual fund manager will invest it in the stock market for you," he says. According to him, it is advisable to invest at least 20% of one's salary, and students with no additional responsibilities can try to save around 30%. He also suggests investing in a health insurance policy: "The premium charged by insurance companies increases as you age, and you can also get broader coverage if you've no existing ailments. So, it is more economical to buy when you're young and healthy."

Now is as good a time as any to invest, he says, so that your money compounds with time. "In the long run, it's not the amount you invest but the time you invest it for that matters a lot more. So the earlier you start, the better," he says.

Faizan Bhat is a PhD student at the Centre for High Energy Physics and a science writing intern at the Office of Communications, IISc

MY JOURNEY

From Field Assistant to Information Scientist

- *Yashwant Kanade*

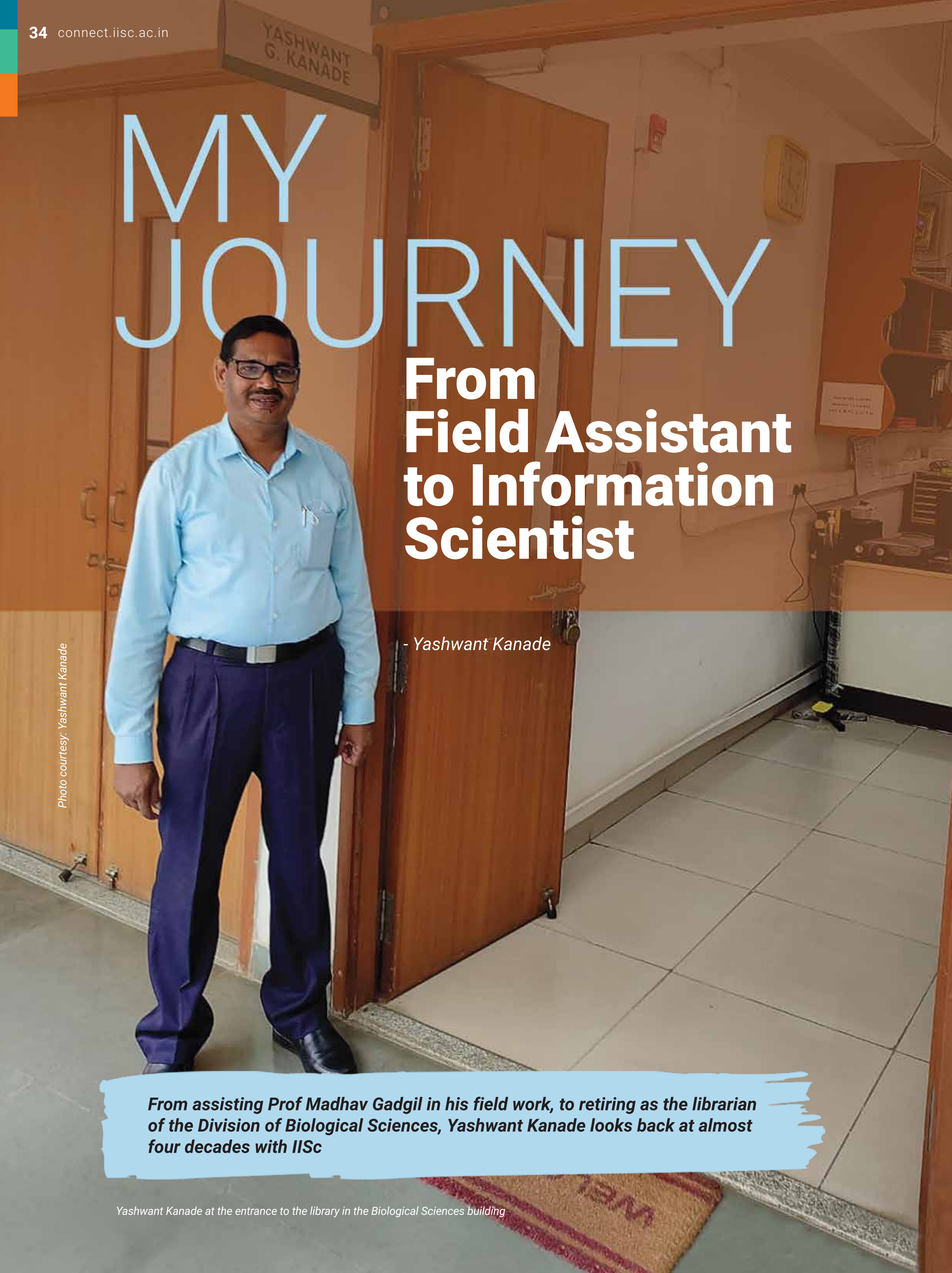


Photo courtesy: Yashwant Kanade

From assisting Prof Madhav Gadgil in his field work, to retiring as the librarian of the Division of Biological Sciences, Yashwant Kanade looks back at almost four decades with IISc

Yashwant Kanade at the entrance to the library in the Biological Sciences building

I was born on 16 January, 1962 in Sirsi, Uttara Kannada. After finishing primary school, even though there was a private school near my house, I joined a government school as I was interested in the NCC. I cycled a lot during my school days. When I was in the 8th standard, I cycled from Sirsi to Honnavar, almost 100 km, just to see the sea!

I took up PCMG (Physics Chemistry Math Geology) for my PUC, but didn't get very high marks, and joined a diploma course in electrical engineering in 1982. One day, a notice on our college board mentioned that Prof Madhav Gadgil, Padma Shri awardee, was giving a talk on environmental sciences, and that anyone interested could attend. His talk was very interesting, but we were scared to go and talk to such an eminent person.

At that time, employment opportunities in Sirsi were very few. After finishing the diploma in 1983, I went to Bombay to try to get a job in Crompton and Greaves. But I didn't like the pace of life there. It was always rushed and there was a lot of stress. I came back to Sirsi and joined a BA programme in sociology, history and economics.

While I was in Bombay, Prof Gadgil came back to our college to recruit field staff for a research station that he was planning to set up in Sirsi. My father was an attender in the college at that time, and he told Gadgil, "I have a son who has a diploma in electrical engineering."

Around the same time, one of my cousins met Prof MS Hedge from the Solid State and Structural Chemistry Unit at IISc on a bus from Bangalore to Sirsi, who mentioned a "Tata Institute." Until then, we had no idea that it was a science institute – we used to think that it was a tyre company connected to Tata Motors!

A couple of months after I came back from Bombay, I went to a village called Yadahalli to attend an NSS camp. There was a Technology and Development Centre (TDC) nearby where Prof MS Hedge was attending a workshop, and I went to meet him. Prof Madhav Gadgil, Prof CJ Saldanha, Prof DK Subramaniam and Prof Govindaraju had also come there to conduct workshops. There was a workshop on electrical wiring which I joined. I had a lot of curiosity, and this time, I asked some questions and they noticed me. I approached Prof Gadgil and asked him if there were any opportunities at the Tata Institute. He enquired about my background, and asked me to put in an application.

There were 10-12 people on the interview panel, including Prof LT Sharma, Principal of MM Arts and Science College; Prof RS Hegde, Yadahalli College principal; Prof Madhav Gadgil; Prof DK Subramaniam; Prof Narendra Prasad; Prof Govindaraju and Prof R Gadagkar, who had just joined. They asked me if I could ride a bicycle and what salary I expected if I got selected. I had been earning Rs 500 per month in Bombay, but did not have the courage to ask for the same amount. So, I told them that I will work for Rs 400 per month. They agreed, and told me to wait for the offer letter from Bangalore, and contact Narendra Prasad at the Sirsi field station.

Photo courtesy: Yashwant Kanade

On the way to Kigga falls near Sringeri, 1983

My house was on the lane between Samrat Hotel where all the field staff took their meals, and the field station, which was in a rented building in Sahyadri colony. Ten to fifteen days passed and there was no letter. It became a ritual for me to stand outside my gate and ask Prasad when he passed by: "Namaste sir, why hasn't the letter come yet?" And for him to reply: "Wait maadi, it will come." And indeed, it did come, at the end of October. I was 21 years old at that time.

On the 2nd of November 1983, I reported to the field station. Some of the staff there discouraged me from joining. They said it was too much work. "You'll have to go to the forest, the salary is poor, you'll have to cycle all around," and so on. But none of this was a deterrent for me, and so I joined as a field assistant on a project with Prof CJ Saldanha, renowned botanist and author of the *Flora of Karnataka*.

Field assistant days

DK Subramaniam and Govindaraju were part of the research team working on a proposed microhydel project on the Bedthi river. My job was to measure the water flow using a current meter. I had to collect readings at fixed times throughout the year, even in the heavy monsoon rains, and they gave me an umbrella. I had to cycle 30-35 km every day. Ultimately, the project was shelved as there was a lot of pushback from the local community, since some areas could get submerged by the project, including farms and plantations.

discussed the data I had collected and also showed me the analysis he did. He even mentioned my contribution in the journal publication.

Then I worked on a plant phenology project with Prof DM Bhat. I was a co-author on that paper. I had no idea about any of these papers at that time; they were giving me a salary and I was working.

Photo courtesy: Yashwant Kanade

From L to R: Yashwant Kanade, GT Hegde and GN Hegde collecting samples for a plant diversity project at Ashisar village in Sirsi, 1983

After that, I was put on a team collecting data on plant diversity. This involved taking measurements of the annual growth of trees, canopy cover and so on. Ranjit Daniels was working on birds at that time, and I was really interested in birds. I would spend a lot of time talking to him. Soon after, Putta Marullaiah, a botanist from Bangalore University had joined as a lab assistant. He was an expert at identifying species, and with his guidance, I learnt to identify some 50-60 species using the *Flora of Karnataka* identification key.

After working on the project on plant diversity, I assisted Prof BK Mishra as a translator and helped him conduct interviews in Kannada for an eco-development project. Prof Gadgil observed that I was good at translating, using technology and convincing people. One day, he asked me, “Kanade, would you be interested in handling an individual project?” I wasn’t very confident, but he gave me a project titled ‘The Economic Uses of Plant Materials’, and we created a format for data collection. At that time, I was helping out Silanjan Bhattacharya, a student working on a human ecology project. After conducting interviews for his project, I would ask the same people my own set of questions on the uses of plant materials. Prof Gadgil

The shift to Bangalore

In the meantime, I finished my BA and started an MA in sociology through a distance learning course from the Karnataka University, Dharwad. Field work took up a lot of my time and was tiring, especially the travel, and it was getting a bit difficult to manage it along with my studies. They told me to obtain a two-wheeler driving license. I gave up the bicycle and started riding a motorbike to the field. I remember one incident vividly. The year was 1989 or 1990. I had to collect data from Bangane Morse, a remote village in Uttara Kannada. I had to park the bike and cross a large stream on foot to reach there. This stream was in spate by the time I finished my work, and the villagers advised me to stay back. I was able to cross over the next day. But the bike refused to start, and I realised that someone had cut the accelerator cable, possibly while trying to steal it. It was getting dark and the main road was 4-5 km away. By the time I reached it, I was very tired and lay down for a bit. When I woke up, it was pitch dark, and I had no clue which direction to go. After walking for 2-3 km, I saw a light from a house. I could not walk up to their door as they had dug a trench all around to protect their land from wild animals. So I shouted for help. Fortunately, they heard me and came to get me. They gave me food and shelter for the night, and the next day I went to Kumta in a bus, and came back with a mechanic who repaired the bike.

I often had to spend some days in Bangalore, bringing specimens and other samples from the projects, and I requested them to let me stay back there, so that I could focus on my studies. Prof Gadgil agreed immediately. In November 1990, Prof Gadgil and Dr TV Ramachandra introduced me to Vijaylakshmi, who was in charge of the library at the new Centre for Ecological Sciences (CES). They said, “He is Mr Kanade from Sirsi. Please give him the charge of the library, he will run it in the future.” I said, “Sir, I don’t know anything about libraries, except when I would sign up for books from my college library." "You can do it, I know your capacity," Gadgil replied. I joined CES on 8 January 1985 as a permanent staff member.

Vijayalakshmi gave me an orientation, but nothing was going into my head. I started taking notes in my own language in a small notebook. I studied all the files about budget, purchase orders and so on, and continued to take notes. In six months, I became well-versed with the system and my notes became a technical report about the Library and Information Centre at CES!

One day, Gadgil asked me, "Kanade, why don't you study library science?" I quit my MA degree, and entered the world of information sciences. I completed a Bachelor's in Library Science from IGNOU by attending weekend classes, and also went on to obtain an MLibSc. However, my official designation remained 'Gestetner operator' (Cyclostyle machine operator).

Photo courtesy: Yashwant Kanade

From L to R: Nagaraj K (field trainee), Yashwant Kanade and Anitha Hebbetu (project trainee) at the CES library, 2010

I registered for a PhD at Bangalore University with Prof TD Kemparaju, but was not sure that it was the right pursuit for me. I had to submit a synopsis (thesis proposal) and started writing one on 'The Information Seeking Behaviour of Ecologists'. Around the same time, Prof Gadgil wrote a letter to the main library seeking to send me for training there. NM Malwad, the Chief Librarian, agreed. This was 1992-93. Every day, I spent an hour in the main library, observing all the activities in all the different sections so that we could implement them in the CES library. I learnt how to place orders, got international contacts for books and journals, subscriptions, got introduced to international publishers, and more. My communication skills and knowledge both increased greatly. Dr KS Chudamani, Deputy Librarian, taught me about administration, and BC Sandhya about classification of library resources. There was also Dr Shyam Prasad Pujari, who was the librarian at the Karnataka State Council for Science and Technology. He would come to the CES library on Saturdays and guide me in classification. It was not too different from the plant classification I had learnt during my days as a field assistant!

In 1999-2000, someone from the Institute told us employees that there were plots of land available in Nelamangala, so I booked one. Kaalappa, the secretary of the Employees Association at that time, also visited the site, saw that the documentation was sound, and spread the word. After that, 200 sites were purchased by people from IISc. Soon after that, when Ratan Tata visited IISc, Kaalappa requested him for financial assistance for the employees. He donated 50 lakh, and each of us got Rs 35,000. I took a loan of 3.5 lakh from Allahabad Bank to build a house there. This was a huge amount, and I was under a lot of pressure. In the meantime, Bangalore University sent several reminders about submitting the PhD synopsis, but I had to focus on the land and the construction. Even though I had prepared the proposal, I could not submit it on time, and I had to drop the idea of pursuing a PhD. Later, I published it as a conference paper with Chudamani.

New technologies and trainings

In 1996, I attended a conference of the Society for Information Science organised by Malwad. By that time I had written a couple of papers and technical reports in this field, but I learnt a lot at the conference. I was also one of three people from

Karnataka selected for a training programme at the Documentation Research and Training Centre (DRTC) of the Indian Statistical Institute. This Centre was highly reputed and had been established by Prof SR Ranganathan, a mathematician who came to be known as the father of library science in India. Prof Gadagkar, who was the Chair at that time, was very supportive, and paid my fee. There, I learnt programming languages for libraries, including C and FoxPro. Kumuda, who had a Bachelor's degree in Computer Applications, had joined CES, and she was very good at programming. Dr TV Ramachandra, Kumuda, NN Janardhan Pillai and I wrote a program on FoxPro for the CES Library website. But the world of programming moves at a very fast pace, and languages become outdated. Document issue, renewal, recall, reservation – all of this had to be programmed, and I couldn't find a software that covered the range of requirements of the library. The main library had purchased LibSys for around Rs 5 lakh, but we could not afford that.

The librarian at Aranya Bhavan, Usha Kumari, told me about a software called e-Granthalaya, and I wrote to Delhi to ask for it. They said they gave it only after the applicants had completed a training session. Reva Rani, a computer applications graduate who had joined the library, and I were selected for the training session. We dived deep into understanding how the software worked, installed e-Granthalaya version 3 and started an online system for issuing books. Until then people would issue books using their library cards and we would enter the details into a ledger. Word had gotten around that Yashwant Kanade from IISc knows how to use e-Granthalaya, and we were invited to train others. Reva and I went to the Bharat Heavy Electricals Limited library, the Tata Memorial Club library, Aerospace Engineering, and several other places to teach them how to install and customise the software.

Visit to the USA

Chudamani and I had written a paper titled, 'A discourse on the promotion of reading habits in India' and submitted it to an international conference organised by the Association for Information Science & Technology (ASIS&T, formerly the American Society for Information Science and Technology) in the USA. Six months passed, and we didn't hear back from them. One day when I went to the main library, she scolded me, "What is this, Kanade? You have become famous, won an international award and didn't even tell us?" I got upset and said, "Ma'am, please don't joke with me. How can someone like me get an international award?" and came back to CES. She was angry and called me on the phone, "Why did you get upset and leave in the middle of the conversation?" and asked me to come back to the main library. There she told me about an email informing us that our paper had been selected as one of the winners of the International Paper Contest for library and information science professionals in developing countries. I had also received it as the first author, but had (unintentionally) deleted it. I apologised to Chudamani.

Sharath Ahuja, technical officer at the Department of Organic Chemistry and a friend, told me, "Such opportunities are rare, don't miss this chance. Let me know if you need any help." I replied that I was not familiar with the procedure involved in going to America. He pointed me towards sources of funding that could sponsor my trip. Sir Ratan Tata Trust gave Rs 50,000 and the Dorabji Tata Trust helped with the airfare. I got a 12-year multi-entry visa to the USA, and went to Texas for the conference in 2006.

Photo courtesy: Yashwant Kanade

Prize winner at the ASIS&T International Conference at Texas, USA in 2006

After that, I became recognised as a library scientist and was invited to give talks all over India. I am also a member of the Library and Information Science Forum of India.

Providing the best services

My job is service oriented. The right information to the right person in the right manner, that is the thumb rule of library sciences. And this service should be given with a smile. As part of the training, I would give an assignment: Say I receive a phone call at my desk. At the same time, a professor comes to ask for a book, another comes for a report, and a third person comes for an urgent xerox at the same time. How do I deal with this situation? The idea is to keep calm and talk to them one by one. And to prioritise.

I teach the trainees about maintaining discipline and I have made a manual that includes a library workflow chart of basic and advanced information techniques.

Maintaining a physical library in this digital age is challenging. Even though we have a large and important collection that is not available online, we hardly have any visitors. Over the last five years, funds have been low and we haven't purchased any new books. I have tried to create awareness, and made a big banner that says 'Library and information services' and put it up on the first floor. I also gave presentations about these services during students' orientation programmes.

Almost four decades at IISc

In the 39 years since I have been here, the campus and the Institute have changed a lot. We had planted many saplings from the Western Ghats forests in IISc – that is now the mini forest. Dr TV Ramachandra created a channel to divert water from Sankey tank to this section of the campus. There are so many species of birds and trees here, you won't find them outside. As you enter the main gate, you can feel the drop in temperature. I feel that it is really good for health, this environment.

However, what is missing nowadays is teamwork, or the feeling of community. Previously we would all meet and discuss our different projects in the seminar rooms. I feel that one can learn a lot through such sharing. Now people work individually and concentrate only on their own fields. Unless you read their papers, you won't know what they are working on.

Photo courtesy: Yashwant Kanade

From L to R: Prof Madhav Gadgil, Yashwant Kanade and Dr MD Subash Chandran at the CES Silver Jubilee celebrations

Take my own example – I had the opportunity to work on, and interact with people from many different projects. From electrical engineering to water and current flow, plant diversity, human ecology, economic use of plants, to library science. I learnt so many things along the way. To date, I have published several scientific papers and technical reports. I am very thankful to Prof Madhav Gadgil — he is the reason I am here and have reached this level. On every Teacher's Day I wish him.

Photo courtesy: Yashwant Kanade

Yashwant Kanade with family, and C Bharanaiah (field assistant) at Ooty, 2000

From the field to the farm

I really miss field work, that was a fantastic time. It was physically and mentally stimulating. I was born and brought up near a forest area and we were surrounded by singing birds, blooming flowers and flowing streams. We could jump into any pond, pluck any fruit. That was a different time altogether. But in the later years, I have been on some memorable treks with my close friends Ajith Kumar Maiya, a radiologist at the Health Centre and G Sudarshan, a Technical Officer from the Department of Electronic Systems Engineering.

I was a poor man when I came to IISc from my village. I never forgot that, and have helped many people from my village find their feet in this city. They were welcome to stay at my home, and I would help them with their education, and find a job. That has been my service to society. Maybe because of this, someone nominated me, and I was awarded the BDSA Dr Ambedkar National Fellowship Award for social work in 2012.

I have retired from IISc, but have started a new occupation – farming. I have bought 4.5 acres of land in Dongri village near Ankola. We have already planted coconut, arecanut and banana. After my son's marriage in December, my wife and I will settle in Sirsi to look after our aged parents and to focus on the plantation.

As told to Samira Agnihotri

An Uphill Battle

- *Deepika S and Ranjini Raghunath*

Researchers, doctors and communities work together to manage a neglected disease

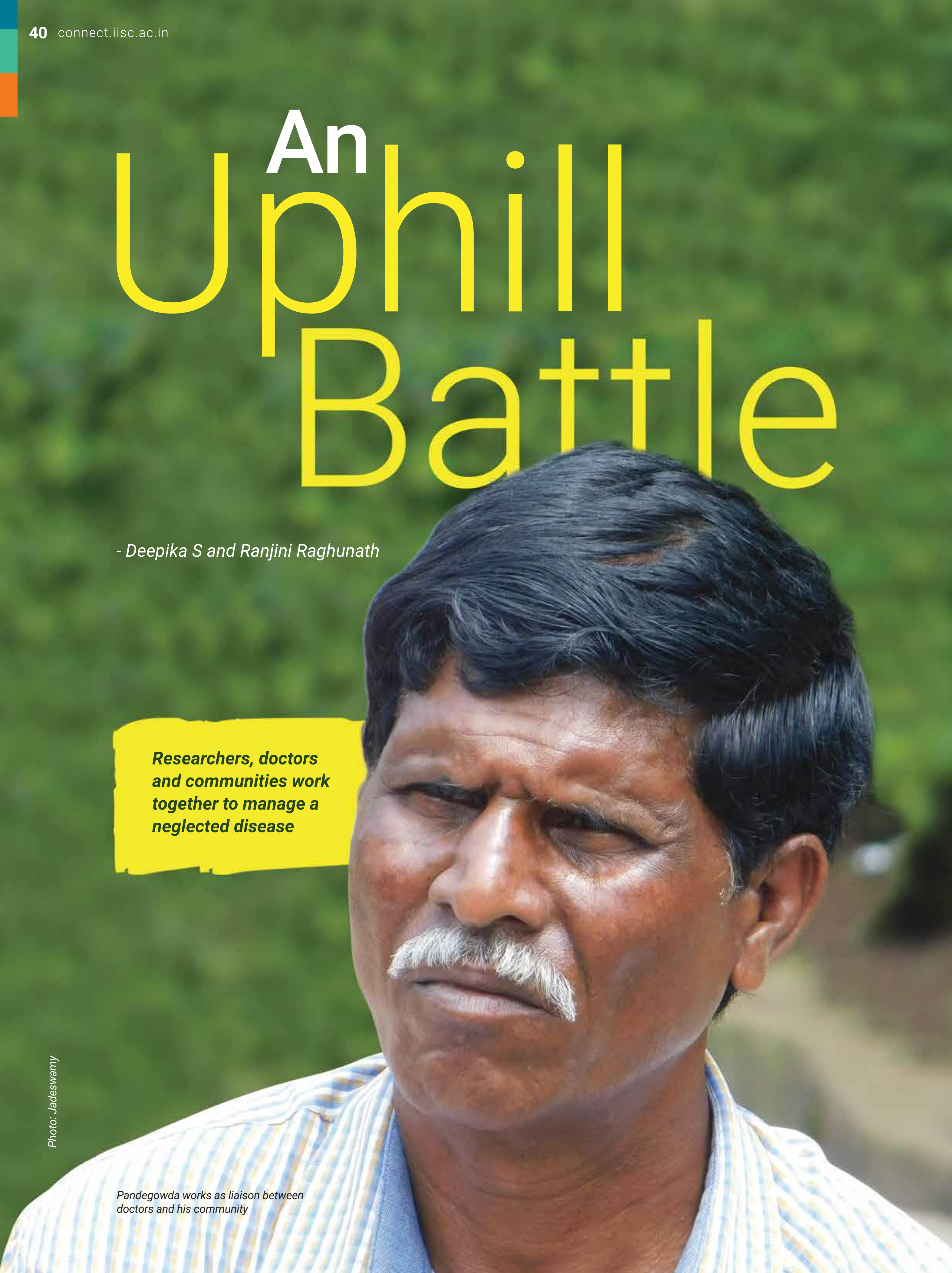


Photo: Jadeswamy

Pandegowda works as liaison between doctors and his community

The first time Nagendra Kumar P started experiencing extreme pain was when he was a toddler.

"He had severe headaches," says his father, B Pandegowda. "We showed him to small hospitals nearby. He would become better for a few days, but the headaches and joint pain kept coming back."

Pandegowda is a community health worker at the Vivekananda Tribal Health Centre (VTHC) in the Biligirirangana Swamy Temple Tiger Reserve (better known as BR Hills) in Karnataka's Chamarajanagar district. Like Pandegowda, most people in BR Hills are from the Soliga tribe. In 2006, when Nagendra was around nine years old, he was taken to a hospital in Mysore, where a doctor made an entry in a ruled notebook covered with a jacket made of brown paper, the kind a school child would use. It listed Nagendra's symptoms and case history, scrawled in the doctor's handwriting: "Headache – 4 days. Pain abd. – 4 days. Multiple jt. pains – 4 days. Fever – 3 days." It was the start of a record of a child's suffering.

The doctor in Mysore diagnosed Nagendra with sickle cell anaemia, a condition that in hindsight, Pandegowda believes had probably affected others in his family too. Pandegowda had a younger brother who used to have frequent pain and was bedridden for months at a stretch; at times he needed someone to carry him to answer nature's call. The family took the brother to several hospitals, brought him traditional medicine, and prayed to their gods, Pandegowda says, but his brother didn't survive. Pandegowda's mother also lived through extreme pain, and in 2012, in her 70s, was so sick that she couldn't move – her body had curled up into a ball. Doctors in BR Hills had referred her to hospitals in Mysore and Bangalore, but the family couldn't afford the travel or treatment, and going to Mysore around 90 km away seemed terrifying. "We didn't have the courage or the money," says Pandegowda.

In 2006, a month or so after Nagendra's diagnosis at the Mysore hospital, he fell ill again. His family began the usual rounds of local hospitals and traditional healers. Some people told them that Nagendra would get better as he got older. But even after he started Pre-University College, the headaches and joint pain continued, says Pandegowda. "We were beginning to lose hope … what did we do to deserve this karma?"

The same year that Nagendra was diagnosed, APJ Abdul Kalam, the former President of India, visited BR Hills. He met Prashanth N Srinivas, a doctor and public health researcher who was the medical officer at VTHC at the time, and asked him what diseases were prevalent in the area. Prashanth told the former President about the problem of sickle cell anaemia, to which Kalam replied, "Don't worry, doctor. Molecular biology, in a couple of years, will solve it."

Prashanth, who leads the health equity cluster at the Institute of Public Health, adds, "In 2022, the only small tablet we have [as a remedy], hydroxyurea, is still not securely supplied through the government channels. And molecular biology is far away from solving the problem."

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Although the first official cases of sickle cell anaemia were reported in the USA only in 1910, the genetic mutation that gave rise to the disease is much older. Scientists have traced the disease's origin to the Sahara desert about 7,300 years ago. In a region as much devastated then as it is now by endemic malaria, the disease may have begun when a mutation turned a child's red blood cells more rigid and sickle-like, making them a hostile environment for the malaria parasite, and therefore protecting the child from severe disease. This mutation then may have offered protection to generations of Africans from the most severe forms of malaria.

The flip side, however, was that anyone who inherited the genetic mutation from both parents ended up at higher risk for another debilitating condition that came to be known as sickle cell anaemia, also called sickle cell disorder or sickle cell disease (SCD). Today this disease is seen in people whose ancestors come from sub-Saharan Africa, Saudi Arabia, the Mediterranean, and some parts of India.

People with SCD have an unusual form of haemoglobin, the iron-containing protein in our red blood cells that carries oxygen from the lungs to tissues and organs, and brings back carbon dioxide from these sites back to the lungs for disposal. While haemoglobin molecules are typically globular in shape, the sickle haemoglobin (HbS) molecules stick to each other, forming long rigid structures inside a cell, giving them the characteristic sickle shape. People who inherit the gene mutation from one of the parents are said to have a condition called sickle cell trait (SCT), while those with genes inherited from both parents will have a 25% chance of being born with SCD. In communities that practise endogamy – marrying within their own community – the likelihood of having two parents who are carriers is higher.

The reason why SCD is of concern from an individual as well as a public health perspective is that its symptoms can be severe. Under certain conditions, when blood flows through tiny blood vessels in the body called capillaries, the sickle-shaped red blood cells end up clumping together and blocking the blood vessels. Blocked blood vessels cut off oxygen supply to vital organs, leading to organ damage. In many patients, particularly children, these blocks occur in the spleen, causing the kind of severe abdominal pain that Nagendra frequently experienced. Many children with a severe form of the disease do not survive beyond the age of five. Sometimes, patients feel such extreme pain that they have said they feel like killing themselves, says Deepa Bhat, a doctor, genetic counsellor and Associate Professor at JSS Medical College in Mysore.

In addition to extreme pain crises, which can severely impact the sufferer's ability to lead a normal life, SCD can cause the death of tissues like bone or joints, recurring infections, strokes, severe anaemia, acute chest syndrome, and meningitis. People across the country experience different symptoms based on their geographical location and the community to which they belong (the prevalence of the sickle cell trait varies from 1% to 40% among tribal groups in India). Because symptoms such as jaundice, severe joint pain or recurring infections are not unique to SCD, doctors sometimes erroneously write them off as arthritis or put routine infections down to lack of hygiene, according to Deepa.

This is not just an Indian problem. Even though SCD is one of the most prevalent genetic disorders in the world, according to the WHO, most countries do not have national-level control or systematic screening programmes, or even basic facilities to treat patients. In the USA, where SCD affects BIPOC (Black, Indigenous, or People of Colour) communities, mostly Black Americans, systematic marginalisation and a resulting lack of trust in the country's healthcare system has meant that many have slipped through the cracks. Gene therapy or bone marrow transplants – the only possible cures – are extremely expensive, can only be performed on some patients, are relatively new, and at the moment unavailable in many countries including India. The long-term effects of gene therapy for SCD are also unknown. There is no cure, therefore, for many SCD patients – the only way is to manage the symptoms.

> ***SCD is one of the most prevalent genetic disorders in the world***

But even managing symptoms is not easy. SCD is an overlooked disease in India, largely because of social and institutional neglect. Until recently, it was considered a disease that only affects tribal populations because of its high prevalence among them. According to the Ministry of Tribal Affairs (MoTA), one in 86 children in Scheduled Tribe communities is born with SCD. Accurate numbers are hard to come by as data on tribal health remains insufficient. Poor access to doctors also means that just maintaining general health is hard for these vulnerable populations. Due to a severe lack of awareness about the disease, even among doctors, patients are rarely advised about even simple strategies to manage the symptoms, such as avoiding dehydration, overexertion or high altitudes, all of which can trigger a pain crisis.

Like some other diseases in India, the actual number of people suffering from SCD is likely to be much higher than official figures – researchers have repeatedly flagged the glaring absence of data. And the problem lies in the way screening for the disease is done currently. For one, the tests have many practical and logistical challenges. Secondly, screening is largely only in tribal communities. But doctors and medical researchers have pointed out that they have seen patients from non-tribal populations with extremely severe presentations of disease – a phenomenon that is relatively less known and accounted for in public health programmes.

"What we are seeing," says Deepa, "is only the tip of the iceberg."

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Expanding screening might be a social problem, but developing tests that are more effective at picking up the disease falls squarely within a scientist's domain. And some like Sai Siva Gorthi have been working to address this issue.

An Associate Professor and Gore Subraya Bhat Chair in Digital Health at the Department of Instrumentation and Applied Physics, IISc, Sai first heard about the challenges related to screening for SCD a few years ago when he was contacted by Nisanth Nambison, an associate professor and nodal officer for a tribal sickle cell project at the Government Homoeopathic Medical College and Hospital at Bhopal. By then, Sai and his team had already been working on developing point-of-care diagnostic devices, and he had founded a startup called ShanMukha Innovations to take these devices to the market.

When Sai met Nisanth, the latter explained that he had just started working on a project funded by MoTA to test the effectiveness of homoeopathic treatments for sickle cell anaemia in particularly vulnerable tribal groups – the Baiga and Bharia tribes – in Madhya Pradesh. For the project, he first needed to collect blood samples from thousands of people in the Dindori, Mandla and Chhindwara districts, and identify those who had the disease using the solubility test.

The solubility test, the most common screening test for the disease today, is also the least expensive. A doctor or nurse takes a tiny volume of blood from a needle prick and dissolves it in a test tube containing sodium hydrosulphite, which specifically precipitates the abnormal form of haemoglobin (HbS) found in sickle cell carriers, making the solution turbid. Turbidity is an indication that the person has sickle cell abnormality, but the doctor can't decide that a patient is a carrier or has the disease from just looking at these murky samples. The next step is to send the patients' blood samples to a lab that has the facility to carry out High Performance Liquid Chromatography (HPLC) – the current standard for diagnosis – which identifies the presence of HbS more accurately.

"Both in terms of sensitivity and specificity, the solubility test is not great, and it doesn't provide information about whether the patient is positive for sickle cell trait or disease," says Sai. The HPLC test is more expensive and requires a greater amount of blood (about 3-5 ml), which can scare off some patients, because it needs to be drawn from the vein by an experienced technician or nurse. And blood samples collected at remote locations in tribal areas need to be shipped to labs or district hospitals which can sometimes be hundreds of kilometres away. "After we painstakingly collect the blood and take it to the district hospital, the person doing the HPLC will not be available, or will be on leave, or the machine will be broken down. Our effort of getting that 3 ml of blood from the patient would have gone to waste," explains Nisanth.

> ***Blood samples collected at remote locations in tribal areas need to be shipped to labs or district hospitals which can sometimes be hundreds of kilometres away***

Such delays can cost lives. Nisanth recalls an instance when his team had taken a blood sample from a child living in a remote location for further testing to a faraway district hospital. But rains played havoc in the following weeks and the child's report also became misplaced due to a clerical error. By the time they recovered the report – which showed her as positive for the disease – and returned to the same village, a month had passed and the child had died.

Given these challenges, Nisanth asked Sai if he could come up with a device that would immediately and accurately spell out the test result at the point of blood collection itself, using just a tiny volume of blood.

Spurred by Nisanth's appeal, and using the blood samples he shipped to IISc, Sai's team at ShanMukha Innovations began developing a diagnostic test. During their explorations they made an important discovery. When blood samples from both normal and sickle cell patients are stripped of oxygen using a buffer solution, the abnormal haemoglobin molecules undergo unique conformational changes. This causes the diseased samples to absorb light differently compared to healthy samples, a change that can easily be detected using a simple, portable spectrophotometer.

Although some scientists had noticed earlier that normal and diseased blood show differences in light transmission, no one else had reported specific, measurable differences in light absorption properties before, explains Sai. "That was the starting point."

Excited by this discovery, the team developed two versions of the new technology they named as HPOS (High Performance Optical Spectroscopy) which uses a combination of a small hand-held, portable digital reader and reagent kit to treat the tiny drop of blood; SickleFind, which would help screen for individuals who might have either sickle cell disease or trait, and SickleCert, which can help distinguish between sickle cell disease and sickle cell trait.

Photo courtesy: Rajesh Srinivasan

The research team (L-R): Arun Balasubramanian, Nisanth Nambison, Sai Siva Gorthi, Rajesh Srinivasan, Prateek Katare, Bhaskar Varanasi

Once they had the process nailed down, they had to work on getting approval for marketing and selling the kit. They were keen on getting approval first from Indian regulators – a longer and more arduous process than getting a USA FDA or EU approval, which most other competitors were doing. "We wanted to make sure we launch the product in India first," says Arun Balasubramanian, Director of ShanMukha Innovations. They first obtained a test licence, which would allow them to carry out a clinical study in a lab accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL). The next step was to get a manufacturing licence from the Central Drugs Standards and Control Organisation (CDSCO).

But just as their efforts were gathering steam, COVID-19 hit. "All the field workers who were collecting blood samples were redirected to COVID-19 efforts. There was nothing happening for sickle cell, or malaria or any other disease," says Arun. "We could not get samples, and there was no technical support available to perform any kind of study." They finally managed to get about 120 blood samples for the clinical study, test their kit and submit the data to CDSCO in November 2021. But the CDSCO rejected the grant of manufacturing licence in the first round after a lengthy audit, and asked them to carry out additional accelerated studies to strengthen the case for their claim that the product had a six-month shelf-life.

In November 2022, after they resubmitted their data to CDSCO, their sickle cell kits were finally approved, clearing the way for them to market and sell the product. They have also been advised by the Indian Council of Medical Research (ICMR) to carry out a multi-centre study with samples from different regions of the country. "They would like us to test samples with all variants," Arun says.

> ***The new technology uses a combination of a small hand-held, portable digital reader and reagent kit for diagnosis***

However, acceptance of such products by doctors and healthcare authorities, and incorporation into their screening programmes – "mindshare", as Arun puts it – will take time and effort. Tanya Seshadri, Chief Medical Officer at VTHC and Programme Head at the Centre for Training, Research and Innovation in Tribal Health (CTRITH) in Karnataka, says that a device like this would certainly be useful for the purpose of screening for sickle cell trait, but she would rather use the current gold standard test to make a definitive diagnosis of something as serious as SCD. "It's labelling someone for life without being absolutely certain first. We are not yet at a stage where staff at the periphery – at the primary health centre (PHC) level – are equipped to handle confirmatory testing, patient counselling and follow-up," she says, adding that she would prefer to wait until a product like this is proven to have a low rate of error.

While Deepa believes it is important to have confirmation at the point of care, she also feels that SickleCert has some way to go to eliminate the likelihood of false negatives, and that the process could be made simpler. Currently, she says, it involves many steps – a technician mixing the blood sample with a reagent, waiting 20 minutes, inserting it into a spectrophotometer, and interpreting the results – and this requires training and careful handling. "At the PHC, realistically, you cannot control these things," she says. She currently prefers the two user-friendly rapid test kits that operate like pregnancy test kits – SickleScan, which is used extensively in Africa, and Hemotype SC, which is made in Canada and now distributed in India. "We took feedback even from ASHAs and ANMs [Accredited Social Health Activists and Auxiliary Nurse and Midwives] – they like these because it involves just a finger prick and gives instant results." But both Deepa and Tanya are supportive of the concept of an indigenously developed low-cost, simple testing kit, given the extent of the problem in India.

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"At first I thought, 'I'm gonna come in here and *fix this*,'" says Tanya, recounting her initial naivety about SCD as a doctor hoping to intervene in a public health problem. However, good intentions, she points out, aren't enough to grapple with the complicated reality of providing healthcare to vulnerable populations.

In 2018, when Nagendra was studying for a degree in commerce, the pain was becoming unbearable. His family began another round of visits to doctors in the hope of finding a solution. Nagendra spent time in Malavalli, Maddur and Gundlupet meeting doctors and trying every treatment possible, including Ayurvedic ones. At various points, he was given protein powder, calcium tablets, and folic acid tablets – none of which served as a solution.

At the moment, patients with pain crises are given painkillers and blood transfusions to reduce the complications caused by the blocking of vessels and increase the oxygen-carrying capacity of the patient's blood. In order to reduce the frequency of such crises, patients are prescribed hydroxyurea, a cancer drug that increases the level of foetal haemoglobin, which is thought to lessen the severity of the disease. Hydroxyurea, which costs around Rs 15 per capsule, has to be taken every day, for life. A new treatment is currently being developed by researchers in the USA – a drug to stimulate production of an enzyme called pyruvate kinase in red blood cells, which might help alleviate pain crises.

Beyond just treating the symptoms, scientists are looking at the possibility of curing SCD. In 1949, the biochemist Linus Pauling and his collaborators identified anomalies in haemoglobin as being the cause for SCD, showing for the first time that an abnormal protein could be linked to a disease, and that genes determined the structure of proteins. New developments in the field of gene editing, particularly the development of CRISPR-Cas9 in 2012, have accelerated the possibility of gene therapy as a cure – a patient's genes can be modified to 'correct' the sickle cell mutation or increase the levels of foetal haemoglobin, also known as gamma haemoglobin. Until a baby is born, it depends on gamma, which is suppressed a few months after birth and then beta haemoglobin takes over. Editing the stem cells of a patient with SCD to avoid the suppression of foetal haemoglobin might give them a fighting chance against the disease.

Vasanth Thamodaran, Senior Scientist at the Tata Institute for Genetics and Society (TIGS) in Bangalore, explains that foetal haemoglobin levels of 20-40% can protect against severe disease. In order to achieve these levels, haematopoietic stem cells (HSCs, the precursors of all blood cells) are 'mobilised' from the bone marrow of a patient (brought into circulating blood), extracted, and edited – using CRISPR-Cas9 to target the repressor binding region in the cells, which limits the suppression of foetal haemoglobin – before being reintroduced into the patient's body. "Clinical trials of this method have already been done in the USA, and they are transfusion-independent, so we know the concept works," he says. Researchers at Christian Medical College (CMC), Vellore have also shown that it can be done in pre-clinical studies using mouse models, he adds.

"What we are trying to do [at TIGS] is to reduce the cost of the procedure, which is estimated to be around 900,000 to 2.1 million USD." Many of the components involved in gene editing currently have to be imported, which drives up the cost. The TIGS team's focus is on the culture medium in which the isolated stem cells are placed during the process of editing, which requires five 'growth factors' – protein molecules that they use to prevent stem cells from differentiating into other kinds of cells, such as red blood cells, which will render the treatment ineffective. "Our goal is to make those growth factors in-house at a lower cost," Vasanth says, adding that they are also focusing on using smaller CRISPR-Cas9 systems to bring down costs.

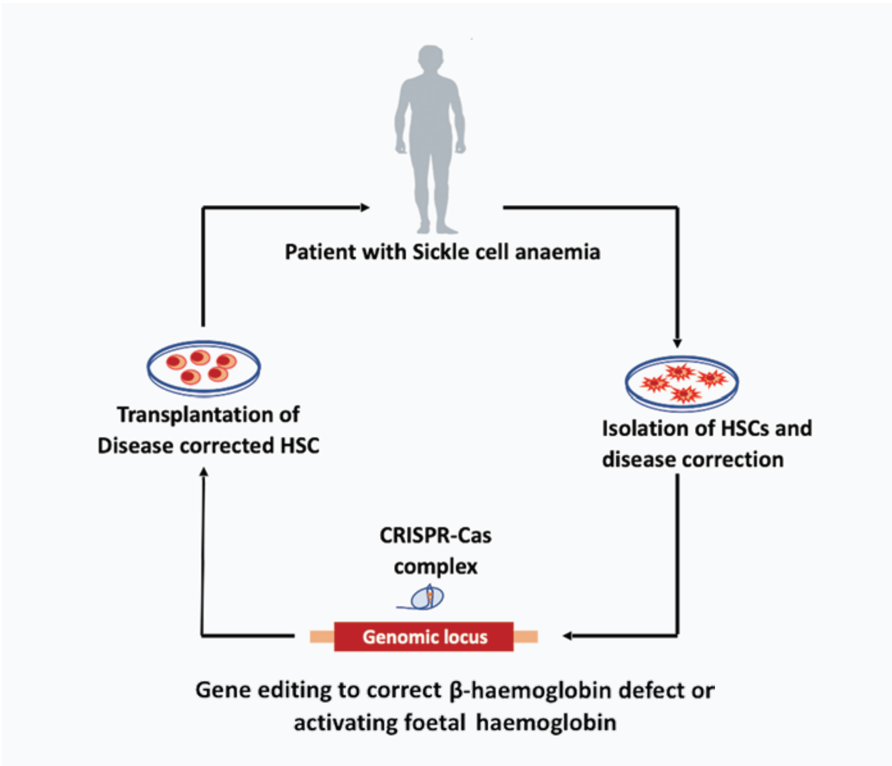

Image courtesy: Vasanth Thamodaran

The process of gene therapy to treat SCD involves isolating Haematopoietic Stem Cells (HSCs), editing them, and reintroducing them into the patient's body

"But technology is only one part of medicine," writes physician Dhruv Khullar in his *New Yorker* piece on gene therapies for SCD. "[M]any of the people who need them the most are on the fringes of a medical system that has marginalized them. Sickle-cell disease traces the deep, long-standing inequities of American society. Defeating it will require confronting them."

Part of the reason that many Soligas like Nagendra receive inadequate treatment is an enormous fear and hesitation to approach doctors until they reach the point of desperation – like it happened with his grandmother – because they do not trust that they will be treated with dignity. Even for those who overcome their fear and approach doctors, the likelihood of getting the right diagnosis and advice isn't guaranteed. Some doctors at the PHC level or district hospital level – the first point of contact for people who live in remote rural areas – seem to be unaware of SCD and how to effectively treat or manage it, according to Deepa and others.

C Madegowda, a Soliga researcher and community leader, says that when his nephew suffered severe joint pain at the age of 10, he took him to a government hospital in Mysore. Madegowda, who has a PhD in social work focused on his community, is a postdoctoral fellow at the Ashoka Trust for Research in Ecology and the Environment (ATREE), and is the current secretary of the community organisation Zilla Budkattu Girijana Abhivruddhi Sangha, says, "They didn't connect his problems to sickle cell anaemia. Because I knew about the disease and the fact that it affects Adivasis, I asked the doctors to test him for sickle cell anaemia. They didn't have a facility to test for it, so they took a blood sample and sent it to Bangalore. Then he received a diagnosis, and was able to get treatment."

The Soligas are just one community among the 50 or so tribes in Karnataka, which make up nearly 7% (numbering around 42.5 lakh people, according to the last Census in 2011) of the state's population. And Soliga patients are only some of the many people affected by sickle cell disease that Deepa sees on a regular basis. Since 2019, Deepa has been a

Principal Investigator for the National Task Force under which six states have worked together to develop a comprehensive model applicable at the level of PHCs, to screen for and manage SCD.

Photo: Deepika S

C Madegowda, a scholar and Soliga community leader in the BR Hills

Research by Deepa's team was largely conducted in HD Kote and other tribal belts in the Mysore district that are home to a range of people from tribal backgrounds, including Jenu Kurubas, Betta Kurubas, Yeravas, Paniyas, and others. The team learned that the hospitals where communities could avail care were usually far from their settlements, and the expectation that patients would travel these long distances was unrealistic. Screening in Karnataka, if at all it was carried out, only targeted those between six and 21 years old instead of all ages, including newborns. Decisions on the healthcare model were made by the authorities without seeking the participation of the affected communities. People who did participate in the screening did not hear back about their results. Even after being diagnosed, patients were not receiving a regular and free supply of hydroxyurea tablets to manage their pain, and many of them struggled to get a disability card, which would qualify them for pension, free blood transfusions and other benefits. The work they'd begun continues under CTRITH, where, among other areas of focus, they aim to build a registry of people with SCD who can be targeted for treatment and follow-ups.

Deepa believes that screening is futile without efforts to create awareness about the disease and provide follow-up treatment after diagnosis. Her team identified local leaders trusted by their respective communities (such as Ratnamma, who has a PhD in sociology focused on the Soliga community), and worked with them to spread the word about the disease and how to manage it, as well as to identify people in crisis so that they can receive timely treatment. "We created awareness, screened people, and supplied hydroxyurea," says Deepa. "We also helped build a referral system: we trained medical officers to identify mild, moderate and severe symptoms, and the courses of action necessary in each case, including sending people with severe cases requiring painkillers that cannot be administered at PHCs, to hospital by ambulance."

Still, overcoming decades of mistrust in the public health system can be hard for the communities. Deepa says, "People would ask us, 'Why are you taking our blood? Are you drinking it? Selling it?' They have even chased us away."

Photo: Deepika S

Members of the CTRITH team in JSS Medical College, Mysore. From left: Praveen Rao S, public and policy engagement officer; Pooja Aggarwal, senior resident at JSS Medical College, and Deepa Bhat, Co-Principal Investigator for the programme

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In 1986, when doctors Abhay Bang and Rani Bang moved to the district of Gadchiroli in Maharashtra, they diagnosed a 10-year-old girl with suspected heart disease as having SCD – the first identified case of SCD in the entire district. They then began a district sample survey and found 1 lakh carriers of the sickle cell gene and nearly 6,000 people with SCD. As a result of their much-lauded efforts, a centre for tribal medical research was set up – but in Pune, not in Gadchiroli, as they had requested. Recounting the matter, Abhay, who received a Padma Shri in 2018, writes in *Ideas for India*:

"Disappointed, we approached the tribal leaders in the villages and requested them to put some pressure on the government to bring the centre to Gadchiroli. Their response took us unawares: 'Doctor, this is your disease, not ours,' they said. 'Did we ever tell you that we need help for this?'"

Madegowda, who is a carrier of the sickle cell gene, adds that if it had turned out that he did have the disease, he wouldn't have wanted to know. "Telling me I have the disease will create automatic stress, it will create stigma. If someone tells me, 'Oh, you have sickle cell anaemia,' I would feel guilty, like it is my fault," he says. Deepa says she has seen people hide the fact that they have children with SCD or fail to disclose their carrier status in matrimonial alliances because of the stigma. She adds that counselling people to not marry other carriers can have adverse socio-cultural impacts, and doesn't believe in doing so herself. "There is life beyond carrier status," she emphasises.


Photo: Jadeswamy and Sathyapramodh HB

Madamma, a Soliga community leader from BR Hills, experienced severe pain since childhood because of sickle cell disease

Madamma, a Soliga community leader from Muthagada Gadde Podu in BR Hills, and a member of the same community organisation as Madegowda, believes she shouldn't allow the disease to hold her back. Having suffered chronic pain since childhood and experienced pain so severe during her pregnancies that she feared she wouldn't survive, she tries to ensure the disease doesn't affect her daily life. "I don't think much about having a disease. I should scare this disease a bit, I feel."

The tendency to see tribal people as data points – or "guinea pigs" for scientific curiosity as Abhay writes – has left many of them wary of sickle cell programmes conducted by researchers and the government. Madegowda says with an air of fatigue, "Doctors have a project, they have funding for it, they need to show progress reports. They present papers at conferences and receive recognition. But the community receives no treatment. Everybody comes to take blood samples from our community. But nobody wants to share the results." NGOs in the area have projects for one or two years, and then when the funding dries up, the projects are rolled back, he says. "Ultimately, who is facing the problem? We are facing the problem," he says, highlighting the need for members of the community to volunteer to spread awareness about the disease and its treatment as well as the difficulties of doing so. For tribal community leaders like him, advocating for better healthcare is yet another battle they have to fight for their people.

> ***I don't think much about having a disease. I should scare this disease a bit, I feel***

For others without Madamma's grit, doctors can play a big role in providing positive reassurance, according to Madegowda. "Doctors have to … reassure them that their condition can be treated or managed and that they may be able to lead a normal life, and build their confidence rather than tell them there is no hope for them," he says. "That is why we prefer to go to our oracles and traditional healers, or to temples. They give us hope."

Hope finally came to Nagendra when he was started on hydroxyurea by Deepa in January 2022. After two decades and nearly 30 different doctors, it was a turning point – the pain had lessened and Nagendra was finally experiencing some relief from the disease that had plagued his childhood and adolescence. “Only because I’m taking the tablet now, the pain is under control. Otherwise, the suffering is intense,” he says. In the past, Nagendra was never diligent about taking daily medications like folic acid tablets. “Now, he takes the medicine regularly on his own,” says his father Pandegowda.

It’s not just the patients who are persevering. For scientists like Sai and Arun, developing a diagnostic device for a “neglected” disease like sickle cell anaemia is a hard sell. “Not just in diagnostics, in pharma too, people only make drugs for which they know there is a big market. There are a lot of neglected conditions, or small pockets of challenges or issues which nobody cares about,” says Arun. But what keeps them going, he says, is the promise such technologies offer to save lives and the commitment they see among the clinicians and researchers they have interacted with so far.

Photo: Deepika S

A Kannada pamphlet about SCD distributed by the CTRITH. The sentence at the bottom reads, “Chintisabedi, Nimma Aarogya Nimma Kaiyallide!” – Don’t worry, your health is in your hands!

“We researchers are dedicated,” says Deepa. “But we cannot do much without government policy, which needs more streamlining.” She has seen funds for the SCD programmes bounce around in various departments or return because of technicalities, and a lack of focus as multiple sickle cell groups operate simultaneously without adequate coordination. But she hasn’t given up. “We are here to work.”

Prashanth also emphasises the role of the government in fighting the disease alongside scientists. “Innovation that IISc produces may have meaning in patients’ lives, but without state support, it is tough.” The number of people who might need a product like a low-cost screening test for SCD may be high, he says, but they are also less likely to be able to pay for it. “In the interests of equity and justice, someone has to pay, and it has to be the state.”

With input from Samira Agnihotri

Abstracts, IISc Photography Club