CONNECT

Newsletter of the Indian Institute of Science

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The New Kids on the Block

Even though the Indian Institute of Science (IISc) prides itself on the importance it attaches to student learning, it only recently started an undergraduate (UG) programme. The Institute has traditionally offered Master's, PhD and Integrated PhD programmes in a variety of scientific disciplines, but the absence of a UG programme had been a glaring omission. This gap needed to be filled not merely to complete the Institute's bouquet of course offerings, but also to provide an opportunity for young minds interested in science to engage in scientific thinking and research.

The seeds of this initiative were sown back in 2008 in a position paper written jointly by all the three science academies in India titled "Restructuring Post-School Science Teaching Programmes". It received further impetus after a meeting chaired by Prof. CNR Rao in which the possibility of starting a UG programme in IISc based on the paper's recommendations was discussed. Following the meeting, a small group of motivated faculty carried out the planning required for this ambitious project. It was now gaining steam and was actively encouraged by the administration and the faculty community, as well as people from outside the institute including Dr. APJ Abdul Kalam and the Institute alumni. The Institute's effort also received the financial backing of the Ministry of Human Resource Development. In 2010, Prof. Chandan Dasgupta assumed the position of the Dean of the programme. He along with the Director, Prof. P. Balaram, helped transform this vision into a reality. In 2011, more than a century after the institute was established, its hallowed walls welcomed its newest and youngest members to the BS programme.

The programme in IISc is already very popular among students interested in pursuing science, not only because of

A classroom discussion evokes laughter

In this issue

From the Editorial Team

To those of you who wrote in, thank you for your encouragement and for your suggestions to improve CONNECT. We will certainly keep them in mind as we move forward. In this issue, Rhine Samajdar takes a closer look at the undergraduate programme, Megha Prakash introduces you to speakers who gave Centenary Lectures on campus in the past few weeks, Karthik Ramaswamy reveals the association between a German migrant architect and Institute, the faculty in charge of the electron microscopy facility highlight their advanced instruments and Manu Rajan showcases our researchers who have recently won awards. We also have pictures from a few events that took place on campus in the last few weeks.

Quick Link

apc.iisc.ernet.in/newsletter

"The students are performing very well and also pursuing various co-curricular activities. They have integrated quite well with the larger community of Master's and PhD students and are contributing substantially to the social, cultural and recreational activities on campus. All of us are favourably impressed by the curiosity, intellectual ability and enthusiasm of these young students. – Prof. Chandan Dasgupta, Dean of the Undergraduate Programme

A student demonstrates an experiment to school children at the UG Chemistry laboratory

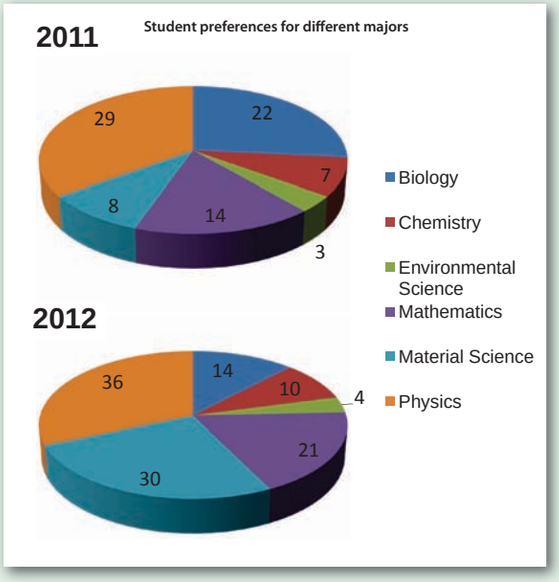
the reputation of the Institute, but also because the programme is unique in many ways. Instead of three years of undergraduate study which is the norm in India, students who come here embark on a four year journey. This gives them the opportunity to master the fundamentals of a subject and to take courses in all areas of science, not just their own area of specialization. It also ensures that students can pursue a PhD without a Master's degree, either in India or abroad. This programme has a strong interdisciplinary approach with students taking courses in the social sciences and humanities as well. These courses help them understand how different strands of human endeavour are related to each other. Another hallmark of the programme is the emphasis on active learning in laboratories equipped with world-class facilities. The hands-on learning approach allows them to understand that science is a process of discovering the unknown and not merely a set of facts.

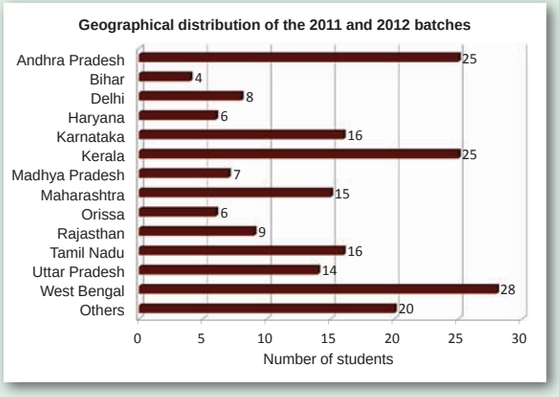
Hands-on learning is an integral part of student learning

"Mahatma Gandhi said 'The future depends on what you do now'. The UG students are doing a wonderful job now!" – Prof. Giridhar Madras, Department of Chemical Engineering

Students can major in any of the following branches of science: physics, chemistry, biology, mathematics, environmental science and material science.

"I have no hesitation in saying that they are the best students I have ever taught" – Prof. K. L. Sebastian, Amrut Modi Chair Professor in the Division of Chemical Sciences





In the first three semesters, students take core courses in all these subjects after which they choose their major field of study. They require at least 36 credits from their chosen major in order to graduate. This is besides the 15 credits of requirements from other electives. All courses are taught by the faculty of the Institute and in their final year, students work on a research project under the guidance of one of them.

The team behind *Pravega 2014*

The academic session 2014-15 will mark the fourth year of the programme. The Institute admits about 110 students every year and these students come from all over the country. Students are selected based on their performance in standardised exams including the Kishore Vaigyanik Protsahan Yojana (KVPY), IIT-JEE and the All India Pre-Medical/Pre-Dental Entrance Test.

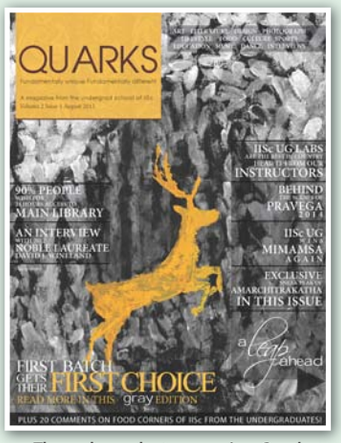
A dance performance from *Pravega 2014*

"They have done a wonderful job. It was terrific to see that they have so many different talents." – Prof. Diptiman Sen, Centre for High Energy Physics on *Quarks*

"I see this year's Pravega as the first step towards becoming a top scientific and cultural festival." – Prof. T. A. Abinandanan, Materials Engineering

It's not all about studies for these talented and enterprising young minds. In 2011, a group of them brought out the first issue of *Quarks*, the official undergraduate magazine of IISc. January 2014 saw the first edition of *Pravega*, the undergraduate science, technology and cultural festival. These students have also infused their infectious energy into other groups on campus like the *Rangmanch*, *Rhythmica* and *Notebook Drive*.

The UG programme, initiated three years ago, has ensured that the usually sombre campus of IISc has been invaded by a bunch of dynamic, talented and enthusiastic young men and women. And it is indeed a most welcome invasion.



The undergraduate magazine, *Quarks*

UG programme website:
http://www.iisc.ernet.in/ug/

-- Rhine Samajdar

Campus Critters

A colony of **short-nosed fruit-bats** hanging from the roof of the old Physics building

Photograph: Natasha Mhatre (Reprinted with permission from *IIScPress*)

Campus Visitors

Jocelyn Bell Burnell

Jocelyn Bell Burnell is a radio astronomer who discovered pulsars in the late sixties. This discovery led to the first Nobel Prize in Astronomy in 1974. The award, however, was not given to Burnell; instead it went to her PhD supervisor Antony Hewish and to Sir Martin Ryle. Burnell recently visited the Indian Institute of Science where she delivered a Centenary Lecture titled 'Reflections on the discovery of the pulsars' on 9 January, 2014. The following is a brief account of how she discovered these neutron stars that blink on and off at a constant frequency.

It was rare for a woman to choose a career in astronomy in the sixties even in the west. Jocelyn Bell Burnell did exactly that when she joined Antony Hewish's lab at the University of Cambridge for her PhD in 1965. Hewish wanted her to study quasars. A quasar, like a pulsar, is also a source of radio waves, but unlike a pulsar, is the nucleus of a distant and energetic galaxy. It had only recently been discovered and exploring the sky for unknown quasars was then a hot research topic for astronomers.

Jocelyn spent the first two years of her PhD just building a radio telescope for her research. When it was completed in the summer of 1967, she started recording radio signals picked up by her telescope as she scanned the sky for quasars. These recordings were made on chart paper. In just six months Jocelyn had accumulated 5.3 kilometers of paper with recordings. Unfortunately for Jocelyn, they had to be analyzed manually because in those days computers were rare or inaccessible. The only computer at the University of Cambridge had limited memory and was mostly used by the well-known astronomer Sir Martin Ryle or his students.

In early August that year when Jocelyn was analyzing her data, a funny blip caught her attention, a blip she hadn't seen before. It appeared as a small spike on her paper chart. And then she saw it again. And again. She was stumped. Jocelyn pulled out some old paper records that she stored in shoe boxes and spread them all on the floor, scanning them carefully. Her eyes then caught identical spikes on the chart papers. She noticed that they came from the same part of the sky and at regular intervals.

Determined to understand the origin of these spikes, which she knew not to be from quasars, she made recordings at a higher speed in the hope of catching them again. For weeks, luck eluded her. And then all of a sudden, she saw the suggestion of a pulse much like the one she had seen earlier, and it was repeating itself every 1.33 seconds. She immediately called Tony, her PhD Advisor. Tony, who was in class then, didn't waste much time in dismissing it as an artifact of human activity.

A disappointed Jocelyn didn't give up. She continued her observations and saw the same signal and with the same pulse period. And it moved slowly across the sky over the next few months. But why was it moving? And then it struck her. It was moving across the sky because it was in the constellation Vulpecula.

Jocelyn, now more sure than ever that she had stumbled onto something new to science, invited Tony once again to the observatory. Tony too saw the pulse and after checking Jocelyn's records, was convinced that it was not due to human-made radio frequency interference. There was one other possible explanation – faulty equipment. This fear was alleviated when a radio telescope belonging to a colleague also picked up the same signals. Jocelyn and Tony now knew that they had discovered a celestial body. The celestial body was most likely a small, dense neutron

Crab nebula with the crab pulsar

star because it emitted short pulses maintained with regular periodicity. They named this pulsating star LGM-1, a playful acronym for "little green men".

On the bitterly cold night of 21 December, Jocelyn went to her observatory in Cambridge on a whim. She went there even though the following day she was to leave for her native Ireland to celebrate Christmas and also to be engaged to her then boyfriend. And that night, she discovered yet another pulsating star.

After the Christmas break, Tony convinced Jocelyn to look through her records all over again to look for pulsating stars she may have missed. Sure enough, she found more blips in her charts and more convincing evidence for the existence of pulsars, as they were later dubbed. But by then it was too late for Jocelyn to change the focus of her thesis from quasars to pulsars. Though the discovery was relegated to an appendix in her thesis, it occupies a prominent place in the annals of science.

James Fraser Stoddart

James Fraser Stoddart (JFS) is an organic chemist and Director of the Center for the Chemistry of Integrated Systems (CCIS) at North Western University. Stoddart grew up on a Scottish farm with no electricity. He left his village in 1960 to study Chemistry in Edinburgh. He is credited with the development of a new type of bond in chemistry, the mechanical bond.

Richard Neil Zare (RNZ) is a renowned physical chemist at Stanford University. Zare is a pioneer in the field of laser chemistry and spectroscopy.

Richard Neil Zare

Both Stoddart and Zare gave Centenary Lectures at the Indian Institute of Science (IISc) on 15 January and 5 February 2014 respectively. Besides being illustrious researchers, they are widely recognized for their excellence in teaching and commitment to undergraduate education. In a brief conversation with CONNECT, Stoddart and Zare talk about science, creativity and coming to IISc.

On teaching and mentorship

JFS: In high school, I had magical teachers who taught me Chemistry. I can say that they fired up my imagination for the subject and I chose Chemistry over Engineering. Similarly, I always make a conscious effort to get to know my students and I strongly believe that a student-mentor relationship should be based on mutual respect.

RNZ: I consider teaching as a secret weapon of the researcher. I think that teaching and research go together. Teaching should not be seen as a process of information exchange. Instead the goal of teaching should be to inspire young minds and excite them to learn something.

On the origins of creativity in science

JFS: My own research has been informed by my interest in the Celtic tradition from which I come. It is full of knots, rings and intermeshing of strands and that has spilled into my thinking in stereochemistry. I also like to think of scientific problems as pieces of a lego set or a jigsaw puzzle that need to be assembled.

RNZ: With advent of technology and efficient search engines there is already an information overload. So, I think it is important to find novel ways to foster a temper of problem-solving in students to bring out creativity.

What is the best way to do science?

JFS: My life's experiences tell me that we can have much higher productivity from research that is not highly targeted. I think one should pursue research for the sheer love of doing it.

RNZ: The key driving force to do research is to believe in something and doubting it at the same time. I call it schizophrenic contentment. To do science one should have a playful attitude and an ability to learn from failures. To an extent, a researcher should be a dreamer.

What did you enjoy on your visit to IISc?

JFS: I am overwhelmed to come to IISc, especially to see N. Jayaraman, one of my former students who spent five years with me and see him organize the International Conference on Carbohydrates. To see him run a conference with 700 people single handedly is incredible.

RNZ: I am pleased to see that IISc has introduced an undergraduate programme and I enjoyed interacting with the undergraduates after my talk on 'problem-solving'.

Harold Varmus

Harold Eliot Varmus took an unconventional route to science. He graduated in English Literature from Amherst College before embarking on a career in medical research. After serving as the Director of the National Institutes of Health (NIH) in the US for many years, he joined the National Cancer Institute (NCI) as its Director. On 21 January 2014, the Nobel laureate gave a Centenary talk titled 'Directions in Cancer Research' at the Indian Institute of Science. In his talk, Varmus discussed the history of cancer and how to deal with this growing global epidemic. He argued that we need to better understand how different cancers differ from each other and the genetic aberrations underlying them. He also made the case for increased spending in cancer research. NCI, he said, had already committed US $ 5 billion towards this effort and urged research institutes in India and around the world to join hands in a united fight against cancer.

-- Megha Prakash

Campus Flora

A flower of the **Shaving Brush Tree**. A native of Mexico, it blooms from February to March.
Photograph: K. Sankara Rao (Reprinted with permission from *IIScPress*)

Advanced Facility for Microscopy and Microanalysis

The need for electron microscopy characterization at the Indian Institute of Science (IISc) was increasing over the years and was being felt by researchers from several departments across many divisions. There had been significant improvements in the technique itself and the Institute did not have access to the newer instruments and their capabilities. Hence, it decided to set up a central facility with state-of-the-art electron microscopes that caters to the needs of the entire research community on campus, both for routine characterization and for their specialized needs. The centre, called the Advanced Facility for Microscopy and Microanalysis (AFMM), was formally established in 2005. More details about the instruments as well as information about how to reserve a slot to use the facility can be found at http://afmm.iisc.ernet.in/

Transmission Electron Microscopes

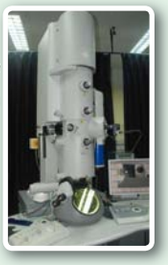
FEI Tecnai G2 T20 U-Twin TEM
Location: AFMM, IISc

- Working voltage: 200 kV
- Thermionic emission LaB6 electron source
- FEI ultra-twin objective lens
- EDS(Energy dispersive spectroscopy) detector for compositional analysis
- 1Kx1K Gatan multiscan camera for imaging

FEI Tecnai G2 T20 S-Twin TEM
Location: AFMM, IISc

- Working voltage: 200 kV
- Thermionic emission LaB6 electron source
- FEI Super-twin objective lens
- 2Kx2K Gatan ORIUS camera
- Goniometer tilt: 40° (Alpha)

FEI Tecnai G2 F30 S-TWIN TEM
Location: AFMM, IISc



- Working voltage: 300 kV
- FEG (Field emission gun) electron source
- EELS (Electron energy loss spectroscopy) spectrometers and energy filters
- NanoMEGAS PED (Precession electron diffraction) setup which enables automatic reconstruction of reciprocal cell of any material and solve any nanocrystalline structure
- EDS(Energy dispersive spectroscopy) detector for compositional analysis
- STEM-HAADF: Scanning transmission electron microscopy-High-Angle Annular Dark-Field detector
- Cryo holder (FEI) (room temperature to -170°c)
- Heating stage holder (Gatan) (< 900 °C)
- CCD camera
- Optional application softwares such as TEM tomography package and TrueImage™ focal series reconstruction.

JEOL 2000 FX-II TEM
Location: Department of Materials Engineering, IISc

- Thermionic electron gun with a tungsten filament
- 200 KeV operating electron energy
- Energy dispersive spectroscopy detector
- CCD camera
- Double tilt holder equipped with 60° along a-tilt and 30° b-tilt
- Gatan-made Single tilt holder equipped with heating stage that can achieve temperatures up to 900°c
- 10 Å imaging resolution

JEOL 200 kV JEM-2100F FETEM
Location: Department of Inorganic and Physical Chemistry, IISc

- Working voltage: 200 kV
- Equipped with Field Emission Gun
- Equipped with CM Lens Unit
- Equipped with BF and HAADF Detectors
- Equipped with EDS (Energy dispersive spectroscopy) detector for compositional analysis
- Equipped with a 1Kx1K Olympus KeenView CCD camera for imaging

Scanning Electron Microscopes

FEI SIRION XL30 FEG SEM

Location: AFMM, IISc

- Emitter: field emission source
- EDS Detector EDAX Genesis
- Electron Back Scattering Diffraction (EBSD,TSL) detector used to examine the crystallographic orientation of many materials, which can be used to elucidate texture or preferred orientation of any crystalline or polycrystalline material
- In-situ straining stage (Gatan)
- Ultra high resolution imaging with in-lens SE detector
- Resolution: 1.5 nm at > 10kV, 2.5 nm at 1 kV, 3.5 nm at 500V
- Accelerating Voltage: 0.2 – 30 kV
- Image Processing: Resolution: Up to 3800 x 2800 pixels, Dwell: 100 ns – 1 ms per pixel

FEI ESEM Quanta 200

Location: AFMM, IISc

- Suitable for low vacuum and low kV imaging
- Simultaneous secondary electron (SE) and backscattered electron (BSE) imaging in low vacuum
- Equipped with analytical system, such as energy dispersive spectrometer with an ultra thin window detector (EDAX)
- True surface (SE) imaging in all vacuum modes and voltages
- Easy-to-use, four quadrant/single quadrant user interface

FIB (Focused Ion Beam) System-Strata FIB 201Xp

Location: AFMM, IISc

- Single Ga Ion Beam System
- Detectors for imaging – CDME
- Accelerating Energy Range: 1 – 30 keV
- Beam current range: 1 pA – 11.5nA
- Less than 50 nm minimum resolution in milling and patterning
- Two complimentary gas injection systems (GIS) for Pt deposition and Iodine enhanced etch

JEOL JXA 8530F Electron Probe Micro Analyzer

Location: Department of Materials Engineering, IISc

- Field emission electron source
- Accelerating voltage: 0.1 - 30 kV (0.1 kV step)
- Probe current: 1 x 10-12 to 5 x 10-7 Amp; Minimum probe size: 40 nm
- Detectable Z range: 4 (Be) – 92 (U)
- Equipped with 6 Wavelength Dispersive Spectroscopy and 1 Energy Dispersive Spectroscopy detector
- Secondary electron image resolution: 3 nm@30 kV, 11 mm WD
- Backscatter electron detector for compositional contrast imaging

ESEM Quanta 200, FEI

Location: Department of Materials Engineering, IISc

- Thermionic, W-filament source
- 3 operating modes: high vacuum mode (electrically conducting metallic samples); Low vacuum mode (electrically non-conducting samples like polymers, ceramics etc); Environmental SEM mode (samples in their "natural state")
- Everthart Thornley detectors (ETD) for both secondary and backscattered electron
- Imaging @ high vacuum
- Large Field detector (LFD) for secondary electron imaging @ low vacuum
- EDS detector for compositional analysis
- Resolution: a) 3.0 nm @ 20kV SE @ HV
  b) 3.0 nm @ 30kV SE @ LV; c) 3.0 nm @ 30kV SE @ ESEM
- Solid state backscattered electron detector SSD-BSD for backscatter image @ HV, LV
- Gaseous secondary electron detector, GSED for ESEM
- 5-axes partially motorized Eucentric specimen stage for X, Y, Z, R and T

-- AFMM Faculty

Events on Campus

Pravega 2014, the first edition of the undergraduate science, tech and cultural fest, was held during 31 January and 2 February. The emphasis was on events based on science and attracted students from all over the country. It also featured lectures by eminent scientists and witnessed a spectacular cultural extravaganza.

A special postage stamp was released on 30 January to commemorate 2014 as the **International Year of Crystallography (IYCr).** It was released by the Chief Postmaster General, Karnataka, Mr. MS Ramanujan. The significance of IYCr and the events being held to celebrate it around the world were highlighted by Prof. G Desiraju , the President of IYCr. Another well-known crystallographer, Prof. TN Guru Row, discussed the history of crystallography in India.

The Flora of Karnataka, an online plant database and the first of its kind in India, was launched by Mr. N Sivasailam, Principal Secretary, Forests, Ecology and Environment Department, Government of Karnataka on January 30. The database, a result of years of field and lab work by Prof. Sankara Rao and his group at the Centre for Ecological Sciences, offers a detailed insight into nearly 5000 species of plants from the state and is equipped with an advanced search engine.

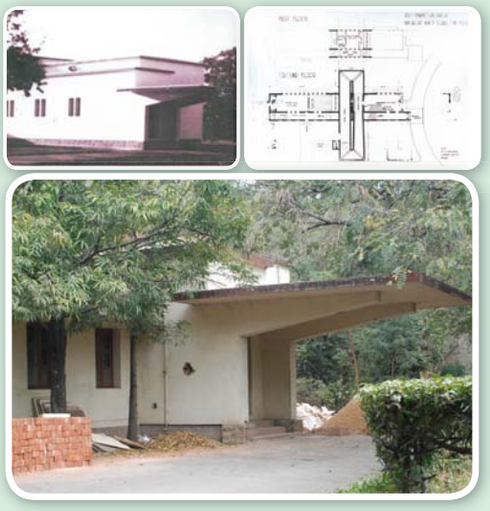
From the Archives: Otto Koenigsberger

On a warm summer day in 2012, the tower above the entrance canopy of the *Prakruthi* building in the Indian Institute of Science (IISc) caught the attention of Rachel Lee. Lee, a Scottish researcher studying the architectural legacy of Otto Koenigsberger at

Koenigsberger at his desk in Delhi (c. 1950)
Reprinted with permission from Rachel Lee

Koenigsberger's buildings in IISc - Then and Now

Aeronautical Engineering department



Hydrogen Plant

Dining Hall and Auditorium

Metallurgy Department

Berlin's Technical University, was visiting IISc because Koenigsberger worked here many decades ago. To her, the tower seemed familiar and so did the small windows and pronounced *chajjas* on the back wall.

Back in Berlin, she looked through the collection of photographs from the architect's archive and found images that confirmed her suspicion that this building too was a "Koenigsberger". She subjected one of the images to a shadow correction tool and noticed hydrogen cylinders stacked in front of it. But what were they doing here? She dug deep into her memory and remembered a hydrogen plant listed in Koenigsberger's CV. She then referred to a book on IISc's history by BV Subbarayappa. It mentioned a hydrogen plant in IISc, but not its location. At its peak the plant produced 20,000 cft of hydrogen gas per month to be shipped to Hindustan Aircraft (now Hindustan Aeronautics Ltd) where American World War II planes headed to southeast Asia were serviced. Lee then realized that the building which now sells airline tickets, books and idlis once made hydrogen gas for the American war effort.

Koenigsberger was an architect for the German Government who, like many other Jews in the thirties, fled the country, even though he had just won the prestigious Schinkel Prize for the Olympic Stadium in Berlin. He first went to Egypt where he excavated temples in the ancient city of Thebes. After a few years there, he received two job offers. One was to teach Egyptology at the University of Michigan in the US and the other, curiously enough, was a job as the Chief Architect of Mysore State. The Diwan of Mysore, Mirza Ismail was looking for a non-English architect, when the quantum physicist Max Born, then a Visiting Professor at IISc, recommended his nephew Koenigsberger for the job. Koenigsberger accepted the India offer and finally came to India in 1939. The decision impacted not just his career, but also urban planning and housing in India. And it may also have influenced the *green architecture* movement.

While working for princely Mysore, he built many buildings in Bangalore, including the TB Sanatorium, the Krishna Rao Pavilion, the Kalasipalayam Bus Terminus and the Boys High School in Malleswaram, buildings that display a tension between two divergent architectural philosophies. Koenigsberger, a modernist, prioritized functionality, but Mirza Ismail wanted ostentatious buildings with domes and towers.

During this time, Koenigsberger met the physicist Homi Bhabha, who was on a holiday in Bangalore from Cambridge. But war broke out in Europe and Bhabha could not return. So he started lecturing at IISc. Bhabha and Koenigsberger hit it off immediately, partly because of their common connection -- Max Born.

Bhabha introduced Koenigsberger to his good friends, the Tatas. Because of the Tatas' close association with the Institute, Koenigsberger was commissioned to build new Departments at the now rapidly expanding IISc. His tryst with IISc was long and fruitful. Here he was able to express himself more freely as an architect. Besides the hydrogen gas plant, he also designed and built the Dining Hall and Auditorium in 1944 (currently the Hostel office behind *Nesara*), the old Aerospace Engineering building in 1946 (including India's first closed-circuit wind tunnel), and the Metallurgy building (now Materials Engineering) in 1948.

When Indian became independent, Koenigsberger was appointed as its first Housing Director by Prime Minister Jawaharlal Nehru. He designed low-cost houses for refugees fleeing from the other side of the new border. He also planned many towns including Bhubaneswar, Faridabad, Sindri, and Gandhidham.

It was in India that Koenigsberger's idea of tropical architecture evolved -- low-cost, place-specific architecture that used existing building materials and was responsive to local needs and environmental conditions. It remained on the margins of mainstream architecture for many decades before it was reinvented as *green architecture*.

In 1951, he left India for London where he established the Department of Tropical Architecture at the Architectural Association School. He also worked with the UN on town planning in the developing world. Koenigsberger died in 1999, leaving behind his buildings and a rich legacy.

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-- Karthik Ramaswamy

Awards and Honours

Padma Shri 2014

E.D.Jemmis *(Inorganic and Physical Chemistry)* works in the area of applied theoretical chemistry, studying structural reactions and properties of molecules, clusters and solids. He is also interested in the common threads in organic and organo-metallic chemistry, in the polymorphs of elements and their compounds and in the chemistry of various main group elements. His students have become leaders in computational drug design and molecular materials, transition metal catalysis and design of unusual molecules.

Prof. Jai Krishna Memorial Award 2013

M. L. Munjal *(Mechanical Engineering)* is a pioneer in the field of the acoustics of ducts and mufflers. He has been a faculty in the Institute for over four decades and is a veteran of numerous awards and recognitions. In his long and illustrious career, he has guided 16 doctoral students, published over 190 research papers in reputed journals and written 4 books. He has also carried out more than 100 consultancy projects on different aspects of noise control.

INSA Medal for Young Scientists 2013

Abha Misra *(Instrumentation and Applied Physics)* has been studying the fundamental properties of carbon-based structures at multiple length scales, structures including carbon nanotubes (CNT) and CNT bulk structures, synthetic diamond films and graphene. She also explores the advanced engineering applications of these structures as well as the development of tangible technologies such as novel CNT-based nano- and micro-electrical-mechanical systems (NEMS and MEMS), besides investigating sensors and actuators.

IISc Alumni Award for Excellence in Research 2013 (Science)

Akhil R Chakravarty (Inorganic and Physical Chemistry) has made significant and original contributions in medicinal inorganic chemistry. He has developed new metal-based targeted photo-chemotherapeutic agents that show selective anticancer activity only on exposure to visible light, preferably in red light, while being non-toxic in the dark. He has shown that curcumin, an active ingredient of turmeric, could be stabilized from hydrolytic degradation in a biological medium on binding to the transition metal ion in its enolic form. The curcumin complexes show novel photo-induced apoptotic cell death on mitochondrial localization, a promising avenue for cancer management and cure.

IISc Alumni Award for Excellence in Research 2013 (Science)

D Narasimha Rao *(Biochemistry)* studies DNA-protein interactions using Restriction-Modification enzymes and DNA Mismatch Repair proteins as model systems. The long term goal of his research is to understand how DNA Mismatch Repair proteins and Restriction-Modification enzymes achieve their specificity.

IISc Alumni Award for Excellence in Research 2013 (Engineering)

S. Gopalakrishnan *(Aerospace Engineering)* is interested in wave propogation in complex media, structural health monitoring, modelling of nanostructures and computational mechanics. He has authored 7 books, 9 book chapters and 163 research papers.

Mysore University Golden Jubilee Award 2013

K. Muniyappa *(Biochemistry)* investigates the molecular mechanisms underlying chromosome synapsis, homologous recombination, double stranded break repair and Fanconi anemia – the hereditary chromosomal instability disorder. Different experimental approaches are being used in the laboratory, which include genetics and functional and structural genomics using model systems that range from bacteria to yeast to human cells.

-- Manu Rajan

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