

the spark

THE DIARIES #3

APRIL 2022

IIT KANPUR



CSE at IITK : The DEC-1090 Era
Remembering Rajeev Motwani
From IITK to IBM

The Spark

April 2022

Contents	Page
Editorial -- CSE at IITK: The DEC-1090 years Your Letters, In the Spotlight, Changing Times...	75
Establishment of the CSE Programmes Professor Rajaraman's recollections on the establishment of the MTech, Ph D, and BTech Programs	79
Old Friends Three faculty members who had helped steer the CSE BTech program catch up on old times	84
The Arrival of the DEC-1090 Anecdotes around the arrival of the DEC-10 and a last minute sale of the IBM-7044/1401	89
Remembering Mots From IITK to Google and Randomized Algorithms	92
Rajeev Motwani: In His Own Words On Shaping Influences, IITK, and the Inception of Google	99
From IITK to IBM A message from IBM CEO and IITK Alumnus, Arvind Krishna	104
Our Bits of That IITK: Three Bumps, Campus Residents, and other stories You are now in a wildlife sanctuary. Fasten seatbelts, keep your cameras ready and on no occasion roll down your windows!	106

* Pages 1-72 refer to the Spark Diaries #1 - 2, available at <https://iitk.ac.in/dora/spark/>

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Views and opinions expressed in The Spark are those of the Editors and Contributors and not those of the Indian Institute of Technology Kanpur, unless specified otherwise.

Editorial

To bridge the gaps between the various limbs of the community is the prime objective of The Spark, to let it grow into a vehicle of creative expression, its ideal.

-The Spark, Vol. 1 No. 1, Feb 15, 1965

While the rekindled Spark has been conceived and sponsored by the alumni, we would love to see it grow as a true community magazine with increasing content from current students and faculty.

Students and faculty are the lifeblood of IITK. While we, the alumni, can continue to talk ad-infinitum, our content, by definition, is history. History is good, but then you are always looking at the rear-view mirror. We therefore invite, with great enthusiasm, the current residents of the institute to take finger to keyboard and opinionate. You are the 'today' of IITK!

This issue is the third in a planned four-part series on CSE education in India, which started with the 1963 arrival of the IBM-1620. That story completed a full circle when IITK alumna Arvind Krishna took over as CEO of IBM in 2020. In this issue, Arvind shares a message with current students and alumni on his many learnings on the campus.

The arrival of the DEC-1090 in 1979 established a new level of interactive computing on campus, with the Computer-Card-driven batch processes finally replaced by Time-Sharing terminals. It also marked the start of the BTech CSE program which immediately became the destination of first choice for JEE entrants. They in turn, would follow up with global contributions, and the results continue to impact advances in computing, including how we surf the internet, even today. This issue of the Spark pays a special tribute to Rajeev Motwani and includes excerpts from an interview featuring his years at IITK, and his contributions to the creation of Google.

As always, we would love to have your feedback. Drop us a line, and share a memory or a reflection! We love to hear from you and will try to publish as many responses as possible. Write to us at: spark@iitk.ac.in, or post directly in our FaceBook group [This Bit of That IITK](#). If you are on FaceBook, check us out! We welcome new group members: students, alumni, faculty and staff, and all others with IITK connections, but ask that you respond to the three screening questions so that we can validate your membership.



The Summer Campus

We are into the beginnings of Summer. A time when the IITK campus starts to bloom with brilliant shades of yellow, pink, and orange from the Amaltas, Gulmohars, and Bougainvilleas.

Here is a view clicked by Somesh Patel (BT/MT, ME 2014-19). Looking from WL, that is the Library in front, and the walkway visible on the right. More such pictures have been shared in our Face Book group referred to above.

Letters to the Editors

What's In a Name (or a Description)?

Thank you for sharing this. This is really good. My only comment is with calling it an IITK Alumni Magazine.

The Spark was started in 1965 as a student newspaper. The new Avatar should be called an IITK Student/Alumni Magazine that is open to current students' contributions.

*Ram Misra
BT, ME, 1963-68
IITK Distinguished Services Award, 2019*

Thank you, Ram! Point noted. Editorial and Cover Letter have been modified accordingly! On a separate note, we now know that the Spark appeared through 1989, not 1986 as we had assumed earlier, making this at least the fourth reincarnation. Like the cat with many lives, more remain in the kitty.

We Didn't Start the Fire!

Thank you for the link. Thoroughly enjoyable!

I knew "The Spark". It was cyclostyled, hand-illustrated, hand-delivered to unspecified recipients, in general very rough-hewn. This new Avatar is perhaps better called "The Bonfire". The Spark has done its job. But whatever you call it, keep up the good work.

Now, regarding the photo on page 40. You are right about R N Basu and M N Mishra, but I believe the guy here is IBM engineer Hinduja. No idea who the guy facing the camera is.

*Hari Sahasrabuddhe
MT/PhD, EE, 1964-68
Faculty, EE/ CSE, 1967-86*



Thank you, Prof. Sahasrabuddhe, or as your friend Mr. Murthy, said complimentarily about you in the previous issue, 'Buddhe'.

Yes, the original Spark was indeed "cyclostyled, hand-illustrated, hand-delivered to unspecified recipients, in general very rough-hewn".

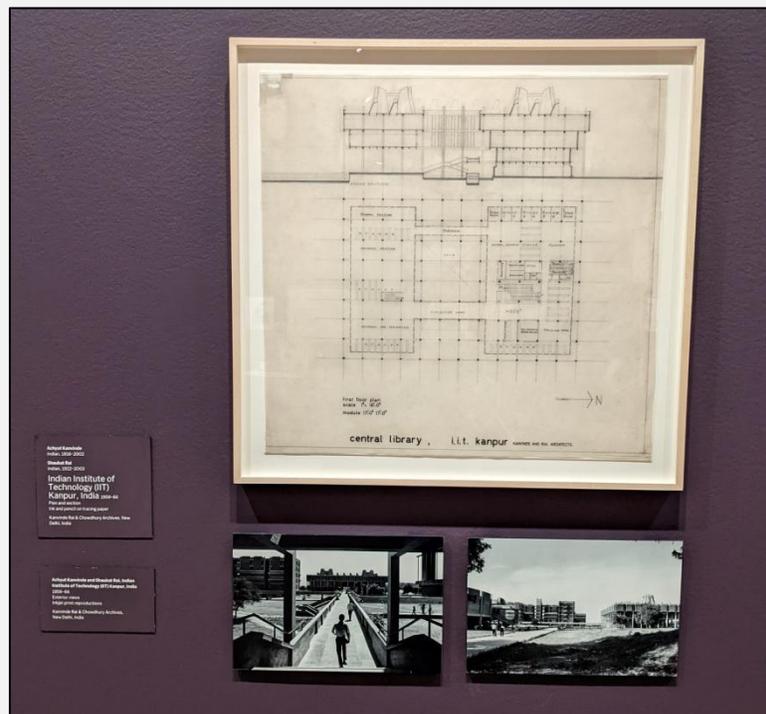
That style is now fashionably known as the 'French Country style'. Much like the Aalu Parathas, where finding the Aalu part of the Paratha was the 'Sunday Morning Treasure Hunt', consumed together with the warm fluid in those battered jugs, uncertain whether it was coffee or tea, or an eclectic blend of both. Now, with automation, everything is homogenous and standardized, but we are trying very hard to keep the 'country-style' alive, with a diverse blend of writers, photos, and irreverent comments like this one.

In the Spotlight

Folks living in the New York City area might want to check out a MoMA exhibition on Architecture of the Indian subcontinent post independence from British rule.



The featured exhibits include the works of Achyut Kanvinde and IITK, including detailed designs of the PK Kelkar Library. The exhibition runs through July 2, 2022.



Picture Credit: Keshaw Singh (BS, Math, 2013-17)

The Times They Are A-Changing

In December, one more icon of our era went away, with the launch of metro services from IITK. A change, iconic in its own way, this one distinctly for the better.



The metro service from IITK to Kanpur City was inaugurated by the Prime Minister, Mr. Narendra Modi, on Dec 28, 2021. The inauguration team included IITK alumnus DS Mishra (BT, EE, 1978-83), who during his tenure as the Housing and Urban Affairs Secretary, Govt of India, has contributed to the launch of the Kanpur Metro, as well as other Metros around the country.

The service is currently up to Moti Jheel, after which the underground portion of the track (to Kanpur Central Station and beyond) is under construction. The IITK station is a five minute walk from the Main Gate. The ride to Rawatpur takes 15 minutes, and costs 20 bucks, as of now.



Clockwise from Top Left: Metro and Driver at IITK; the IITK Platform; view from Moti Jheel, towards IITK. Credits: The 1977 photo of the Tempo was clicked by Shirish Joshi. Other pictures have been shared by Shakti Chaturvedi. Text contributed by Amit Shukla (BT, ChE, 1983-87) and Shakti Chaturvedi (MBA, IME, 2014-16, Research Scholar IME)

Establishment of the CSE Academic Programmes at IIT/Kanpur

V. Rajaraman (Professor EE/CSE, 1963-82)

Prologue

I joined IIT/Kanpur as an Assistant Professor in the Department of EE on March 23, 1963. I was an Assistant Professor of Statistics at the University of Wisconsin, Madison before I came to Kanpur. My Ph.D. was in EE (Adaptive Control Systems). When I joined IITK there was no campus. We were in a wing of HBTI in Agricultural Gardens (called Company Bagh by locals). We officially moved to the Kalyanpur campus at the end of March 1963. The only building which was ready was the workshop. First, the library moved to the workshop. About a month later, the departments moved to the workshop. I remember the May - June heat in the workshop where all faculty of EE sat together in one enclosure. The next buildings that were ready were the Southern and Western Labs. The IBM 1620 moved to the far end of the Western Laboratory in August 1963.

The (Late) Professor H.K. Kesavan joined as Professor and Head of the EE Department in early 1964. Before joining IITK he was the Head of the EE Department at the University of Waterloo in Canada. It was fortunate that he joined IITK as he was far-sighted and an excellent academic administrator. He was my mentor in my early days at IITK and I learnt a lot from him about academic administration. There was only a BTech programme when Kesavan joined. He was convinced that with a young research-oriented faculty joining the EE department it was necessary to start a post-graduate programme as soon as possible. IITK was a new institute and it was necessary to publicise its special facilities and the young talented faculty. On his suggestion, I went to IIT/Madras and IISc, Bangalore in March 1964 to talk to graduating students in EE and tried to convince them to join the MTech programme being started in IITK in August 1964. The first batch of ten students joined in August 1964. Among them was H.V. Sahasrabudhe who had earlier joined IITK as a research assistant after graduating from IIT/Bombay, S.C. Seth, C.V.S. Rao, and R.K. Ragade from IISc, Bangalore. (All three went on to get Phds.)

In early 1965 H.N. Mahabala joined the EE Department from the University of Waterloo. He had worked with a Bendix computer at the University Of Saskatchewan in Canada where he obtained a Ph.D. In August 1964, Professor Kesavan was made the Head of the Computer Centre in addition to his responsibilities as Head of EE. He requested me to join him in the Computer Centre as his deputy and I gladly accepted. I had taken courses in digital computation and programmed the IBM 704 in the USA during my student days and had extensively worked with analog computers during my doctoral research. In 1965 Mahabala and I started teaching some courses in computers and requested Kesavan to allow us to introduce an option in MTech EE with specialisation in Computer Science. He was far-sighted and saw the future growth of computing and the unique position of IITK that had a computer. It was an informal arrangement as the MTech degree was awarded in EE.

Starting an M.Tech. (Computer Science) Option in the EE Department

The Computer Science option in EE became very popular and a majority of students admitted to MTech EE opted to take courses in Computer Science and do a project in that area creating some friction among

the EE Department faculty. The courses in Computer Science were limited. They were on Digital Logic Design, Software Engineering, Programming Languages, Artificial Intelligence, and Design of Information Systems. Approximately a dozen students were graduating with MTech with the Computer Science option in EE. Ph.D. students also joined EE in 1965/66. If I remember right H.V. Sahasrabudhe started working with Professor H.K. Kesavan as a Ph.D. student in 1966 in the area of power systems that involved considerable programming using the 1620. In 1966, P.C.P. Bhatt who was a lecturer and C.R. Muthukrishnan started working on their Ph.D. thesis with my guidance. Muthukrishnan submitted his thesis in 1969 working in the area of Decision Tables and joined the faculty of EE along with Sahasrabudhe. Another Ph.D. student was (Late) T. Radhakrishnan who worked with me in the area of parallel information retrieval. He also joined the EE faculty. P.C.P. Bhatt also obtained a Ph.D. degree in 1969. We now had six faculty members in the Computer Science area. In 1968, Professor Kesavan left IITK and returned to the University of Waterloo where he started a new Systems Engineering Department. I took over as the head of the Computer Centre.

Starting an Interdisciplinary Post-Graduate Programme in Computer Science

In 1971 the Senate of IITK approved starting separate MTech programmes in Computer Science, Materials Science, and Nuclear Engineering. The first admissions to a new MTech Computer Science Programme were started with an admission of around a dozen students. As an interdisciplinary programme the minimum qualification for admission was BTech in any discipline or an MSc degree in Mathematics or Physics.

The parting of ways from the EE Department was cordial. The EE faculty was happy that Computer Science got separated as the MTech students in EE, after the split, were taking EE courses and working on their MTech and Ph.D. theses in the traditional EE subjects such as Power Engineering, Electronics, Control Systems, Electromagnetics, and Circuit Theory.

I continued to be a faculty in EE in addition to being the Convenor of the Computer Science Programme. The first MTech (Computer Science) batch graduated in 1973 and most of the graduating students were employed by TCS. The course was in great demand and we continued to get good students. Admission was by a written test and an interview. GATE had not started.

The Computer Science faculty size increased slowly and steadily with Shyam Kumar, S.V. Rangaswami, S.K. Basu, Narsingh Deo, R.M.K. Sinha, V.K. Vaishnavi, S.N. Maheshwari, Arvind (Visiting), S.C. Seth (Visiting), R. Kodandapani, K.V. Nori, and R. Sankar joining over the years. IIT/Madras installed an IBM 370/155 system in 1973 and did not have any experienced faculty to manage the computer centre. Mahabala accepted an invitation from IIT/Madras to join its faculty, manage the Computer Centre, and also start an academic programme in Computer Science. He persuaded Muthukrishnan and Radhakrishnan to join him. P.C.P. Bhatt was invited by IIT/Delhi to start its Computer Science programme.

The MTech and Ph.D. programmes thrived. IITK was graduating around a dozen MTechs every year. The Ph.D. programme was also thriving. In my memory several students including A.S. Sethi, V.K. Vaishnavi, M.S. Krishnamoorthy, R.M.K. Sinha, V.Gupta, M. Ibramsha, Om Vikas, B.K. Gairola, Asha Goel, V.M.

Malhotra, R. Govindarajulu, S. Krishna, and S. Biswas obtained Ph.D. during the period 1970 – 1982. (This list is not exhaustive).



An early picture of the CSE Programme Faculty, in the early 1970s, received from Prof M.S. Krishnamoorthy. This photo was taken after a Quality Improvement Program Course - an intensive course aimed at improving the quality of faculty members in other Engineering Colleges. Seated (L to R) are a Program Attendee (QIPA), M.S. Krishnamoorthy, QIPA, V. Rajaraman, R.M.K. Sinha, QIPA, and H.V. Sahasrabuddhe. Standing in the back are additional QIP attendees along with V. M. Malhotra and V. K. Kaithal who were the Teaching Assistants for that course

Introducing the B.Tech. Programme in Computer Science

By the mid-1970s, the faculty of the Computer Science programme felt that CS was maturing as a discipline and the time was ripe to start an undergraduate programme. As the convenor of the CS programme, I prepared a proposal, after consulting the faculty, to start a BTech programme in Computer Science. I discussed this proposal with the Acting Director Dr. Jagdish Lal in 1975. He was convinced and as Chairman of the IITK senate introduced the proposal in a senate meeting. There was extensive discussion in the senate with many members opposing the resolution.

The arguments against its introduction included thoughts that: it was not a major discipline; had little content besides programming; was already being offered as programming diplomas by private companies; would not offer employment for BTech graduates; and was not an Engineering course. Finally, other departments would have had to give up some seats as the total BTech intake was fixed by the Government of India.

I and my Computer Science colleagues in the Senate pointed out that it was indeed a mature discipline; it was not just programming; there were professional societies on computers in India, the UK, the USA, Japan, and several countries in Europe; there was an International Federation of Information Processing Societies (IFIPS); it was growing rapidly, and would become essential knowledge for all engineers. Many countries in the world including the UK, the USA, and several countries in Europe already had Computer Science departments in their universities.

Despite our attempts to convince the senate members, no decision was taken. Dr. Jagdish Lal left IITK in 1976 and returned as the Principal of Motilal Nehru Regional Engineering College (MNREC), Allahabad, from where he had come to IITK. While the IITK senate was continuing the debate on the BTech programme in Computer Science, Dr. Lal convinced the Board of Governors of MNREC and started a BTech programme in Computer Science in 1976 two years before IITK did, thus becoming the first institute in the country to offer this.

In 1976, Dr. A. Bhattacharya took over as the new Director of IITK. I had a long discussion with him and he was convinced of the importance of starting a BTech programme in CSE. He re-introduced the proposal in the senate. The arguments for and against were repeated. Finally, Dr. Bhattacharya steered the discussion successfully and the senate approved a BTech programme in Computer Science with a student strength of 20 in 1977. He also steered the proposal through the Board of Governors. The programme was slated to begin in 1978. A few seats were taken from other departments and allocated to the BTech programme in Computer Science.



The IITK CSE Faculty with the MTech graduating class of 1978.

Seen here (L to R) are Row 1: Professors A.S. Sethi, Arvind (visiting from MIT), V. Rajaraman, R. Sankar, H.V. Sahasrabuddhe, M.S. Krishnamoorthy; Row 2: T. Sanyal, Agarwal, Murthy, Lt. Gyan Prakash, Ashok Modi, Flt. Lt. Routela, Gorthi, Madhav Prabhu; Row 3: Alok Khare, Satish Goyal, Satpal, Laxman Badiga, Mukkamala Ravi, M. Pramod Kumar Rao, R. R. Gargeya, Ambrish Mathur, Bhasker

Picture shared by Professors Hari Sahasrabuddhe and M S Krishnamoorthy

BTech Programme Begins

BTech in Computer Science was announced as a discipline in the Joint Entrance Examination (JEE) of 1978. Many parents came to me to discuss Computer Science and its prospects before choosing the department for their children. I distinctly remember Rajeev Motwani's father and Jaideep Srivastava's father who were anxious about the future of Computer Science and had long discussions with me. Both Rajeev and Jaideep joined the first batch of the BTech Computer Science programme.

To the surprise of the entire faculty of IITK and the other IITs, BTech Computer Science became the first choice of a large number of students who qualified in the JEE. By 1980, the last student admitted to the program had an All India Rank of 40! The students from the first (1978) batch were uniformly good and many of them distinguished themselves as world leaders in Computer Science.

Epilogue

A professor of IIT/Kharagpur collared me after a meeting in Delhi and asked how IITK could give a BTech degree in Computer Science when there was no department. I retorted that IITK was a pioneer that broke many existing norms. IITK was the first IIT to have a core curriculum, letter grades, grading "on a curve", a semester system, sizeable humanities courses in the BTech, etc.

When the other IITs saw the success of IITK's BTech programme in Computer Science, they unitedly requested the Ministry of Human Resources Development to allow them to start a Department of Computer Science and Engineering. The ministry agreed in 1983 and all IITs started a CSE Department. The Computer Science Programme at IITK became the CSE Department in 1984. I was not at IITK when the new department started as I had left IITK to join IISc in 1982.



IITK CSE faculty and students at the Golden Jubilee Reunion in 2010. Seated (L to R) are Professors: Pankaj Jalote, Rajiv Sangal, PCP Bhatt, R Sankar, V Rajaraman, HN Mahabala, KV Nori, VK Vaishnavi, and Gautam Barua. This picture has been shared by C. K. Mohan (standing sixth from Left in Row 2)

Catching Up With Old Friends!

Ananth Sankar (BT, EE, 1982-86)

Professors V. Rajaraman, H.V. Sahasrabudde and R. Sankar, three of the faculty that helped steer the Computer Science B.Tech. Program at IIT Kanpur, have stayed in touch with each other over the years. With their inputs, IITK defined the UG CSE curriculum, with the first batch joining in 1978, and graduating in 1983. Among them was the late Rajeev Motwani, who went on to complete his PhD at Berkeley, and have a very successful career as a faculty member at Stanford University and as an advisor to Silicon Valley startups, including Google and Paypal.



The IITK CSE Department circa 1982, with many of the faculty and members of the first batch present. Seated on chairs in the second row are Prof. Chandrasekhar, Prof. RMK Sinha, Prof. H.V. Sahasrabudde, Mrs. Veena Sahasrabudde, Mrs. Dharma Rajaraman, Prof. V. Rajaraman, Prof. R. Sankar, Mrs. Padmavathy Sankar, Prof. Somenath Biswas, and Mrs. Kiran Biswas.

This picture has been shared by CK Mohan (seen in the middle of the front row), and Prof. V Rajaraman

Prof. Rajaraman joined IITK in 1963 and taught Computer Science as part of the CS option for Electrical Engineering M Tech students. He wrote the original proposal for the creation of the B Tech CS program in 1975, which was approved by the Director, Dr. Jagdish Lal. Prof. Rajaraman recalls the many debates prior to the creation of the CSE Dept, and the efforts required to convince other departments to give up the 20 seats before the program was finally launched in 1978. Everyone was shocked when these were filled by students with All India ranks under 40 - the CS BTech program was clearly here to stay!

Prof. Rajaraman taught courses in Analog and Digital Computation, Logical Design of Computers, and Software Development. The many hugely popular textbooks on programming languages that he wrote evolved from his class notes at IITK. The books made programming languages accessible not only to IIT students but to students all over India. India's success in software engineering owes a huge debt to these early efforts. Prof. Rajaraman left IITK in 1982 to join the Indian Institute of Science, Bangalore. He is now retired and lives in Bangalore with his wife, Mrs. Dharma Rajaraman.



Prof HV Sahasrabuddhe (on the Right) with Mrs. and Prof. Rajaraman, Bangalore, August, 2019

Prof. H. V. Sahasrabuddhe came to IITK as an Electrical Engineering Ph.D. student in 1964, after getting his B.Tech. degree in EE from IIT Bombay. At that time, Computing was taught as a specialization in the EE department, with the Computer Center under its care. A 10-day intensive course on computing was in progress, and Prof. HVS remembers it was so much fun that the Computer Center became his second home right away. He completed his Ph.D. in 1968, and joined IITK as a faculty member.

Since computing was then a specialization in the EE department, he got to teach many courses in this area. Simultaneously he was assigned a core EE lab (ESc341/ESc342 in alternate semesters) as the EE "pound of flesh!" This continued till 1976 when he was formally moved full time to the newly formed "Computer Science Program" in anticipation of the IITK Senate approving a full Department of Computer Science and Engineering.

Professor Sahasrabuddhe was an avid Bridge player during his IITK days. He recalls an interesting incident - once, in a lab, his students could not get an experimental circuit assembled on a breadboard to work properly; the oscilloscope connected to the breadboard was not impressed. He recalls doing what people used to do with radio and TV sets of those days - he gave the scope a hard slap, and voila, the circuit started working! Prof. Sahasrabuddhe left IITK in 1984 to join the University of Pune. He is now retired and lives in Pune.



Professors H.V. Sahasrabudde and R. Sankar, Bangalore, Aug 2019

Prof. R. Sankar joined IITK in 1975, on the initiative of Prof. Rajaraman, after previously being the head of the Computer Center at the National Aeronautical Laboratory in Bangalore. His education was in Mathematics, and he had received his Ph.D. from Oxford University. Interestingly, his older son, Sriram, was a student in the inaugural CS B Tech batch of 1978-83. Prof. Sankar co-taught the introductory core course in Computer Science to B Tech students, as well as Numerical Analysis and Discrete Mathematics. He also introduced the area of Computer Graphics and Computer Aided Design at IITK, teaching courses and conducting research in those areas.

He recalls a funny incident having to do with acronyms - there were several acronyms being used at IITK, and he could not keep up with them. He remembers his embarrassment, when, as the head of the Computer Center, he asked a student what CC stood for! Prof. Sankar left IITK in 1985 to join the University of Pune, which Prof. Sahasrabudde had joined a year earlier. Together, they built a strong CS program at Pune university as well. He is now retired, and lives in Bangalore with his wife, Mrs. Padmavathy Sankar.



Prof. and Mrs. Sankar, Mrs. and Prof. Rajaraman, Bangalore, August 2019

In August 2019, Professor HV Sahasrabudde visited Bangalore. He visited both Professors Rajaraman and Sankar, and took the pictures that we have shared here. Later in that same month, we achieved all C(3,2) combinations of the three professors when the Sankars visited the Rajaramans. We also learned that Prof. Sankar and Prof. Rajaraman had met for the first time in 1949, at the age of 16, in a bus on the way to Delhi University to collect their DU entrance scholarship examination form. Both got the Rs. 25 scholarship. Prof. Sankar completed a BA in Math, and Prof. Rajaraman a BSc in Physics, both from St. Stephens College. Prof Sankar graduated as the topper of Delhi University in 1952, receiving the President's Gold Medal from Dr. Rajendra Prasad, the first President of India. What a long connection between old friends!

About the contributors:



This story has been written by Ananth Sankar, the younger son of Professor R. Sankar, using the pictures shared by Prof. HV Sahasrabudde. Ananth, and his brother, Sriram, grew up on the IITK campus, and qualified for the BTech program, Sriram in 1978 (the first CSE batch) and Ananth in 1982 (EE). They were both very active members of the Gliding Center, and Ananth played the guitar for the IITK band. They both live in the Bay Area, with Ananth now a Principal Staff Engineer at LinkedIn, Sunnyvale, CA.

Music lovers on the campus will recall...

The Legendary Hindustani Classical Vocalist, Composer and Guru Vidushi Veena Sahasrabuddhe.



Vidushi Veena Sahasrabuddhe (14 September 1948 - 29 June 2016) was a prominent Indian Classical and Semi-Classical Vocalist and composer of Hindustani Classical Music. Though her singing style reflects Jaipur and Kirana Gharanas, it finds its roots in the Gwalior Gharana. Veena was known as an accomplished singer of Khyal and also of Bhajans.

Veena Sahasrabuddhe was born in a musical family to father Shankar Shripad Bodas, who was a disciple of famous vocalist and musicologist Pandit Vishnu Digambar Paluskar. She began her early musical education under her father, and then under her brother Kashinath Shankar Bodas. She also learned Kathak Classical dance form in her childhood. Veena's musical mentors include Padmashri Balwantrao Bhatt, Pandit Vasant Thakar, and Pandit Gajananrao Joshi.

She obtained a Bachelor's degree in Vocal Performance, Sanskrit Literature, and English Literature from Kanpur University (1968), a Master's degree (Sangeet Alankar) in Vocal Performance from Akhil Bharatiya Gandharva Mahavidyalaya Mandal (1969), as well as a Master's degree in Sanskrit from Kanpur University (1979). A.B.G.M.V. Mandal conferred on her a doctorate in Vocal Music (Sangeet Praveen) in 1988. She was the Head of the Department of Music at the SNTD Pune campus.

Veena had given musical performances in and across India and toured foreign countries including Australia, Europe, the Middle East, and North America. Her many awards included prizes in Vocal Classical category in a national competition for artists under age 25, conducted by All India Radio (1972), the Uttar Pradesh Sangeet Natak Akademi Award (1993) and the National Sangeet Natak Akademi Award (2013). Veena Sahasrabuddhe passed away on 29 June 2016 at her home in Aundh, Pune, after a prolonged illness. She is survived by her husband Dr. Hari Sahasrabuddhe, a son and a daughter.

From the Facebook group, Hindustani Classical Music and Everything, shared by Alok Kumar (BT, ChE, 1976-81)

CSE at IITK: The Arrival of the DEC-1090

V. Rajaraman (Professor EE/CSE, 1963-82)

Earlier, I had written the story of the purchase of IBM 7044/1401. These systems became fully operational in 1966 in the new Computer Centre building. From day one they were used 24 hours a day, 7 days a week. Besides this system, there was an IBM 1620 that continued to be used for undergraduate teaching and laboratories until it was sold to SAIL R&D. We also bought an IBM 1800, a small process control computer, for experiments in real-time control.

The (Late) Professor John McCarthy, head of the Artificial Intelligence Laboratory at Stanford University visited IITK in 1971. He saw that students were using a computer that had a batch processing operating system (OS) which did not allow interactive computing. He was a great believer in interactive time-sharing systems. He had written a famous memo to the Director of the MIT computer centre in 1959 pointing out the advantages of interactive time-shared use of computers for better human-computer symbiosis that would improve the productivity of computer users. That memo led to the development of the first time-sharing operating system in the world, called Compatible Time-Sharing Operating System (CTSS) in 1961, for the IBM 709 at MIT.

Professor McCarthy told me that his laboratory at Stanford had a DEC PDP 1 computer with a time-sharing OS which was in good working condition but was being replaced with a larger computer. He wanted to donate the PDP 1 to IITK. I was at first reluctant as it is normally difficult to maintain a used computer. On second thought, after consulting my colleagues in the computer centre, I decided that such a machine in the laboratory would allow students to have hands-on experience with both hardware and software of a computer that was not possible with IBM machines used by all departments and maintained by IBM engineers.



With the time-sharing operating system, the terminals of the DEC-1090 (right) replaced the punch card machines of the IBM-7044 (left). Visible on the right, in front of the camera, is Rajeev Motwani of the first UG CSE batch. Picture Credits: (L) Echoes In Memory, photo yearbook, 1982; (R) Growing Up, photo yearbook, 1983

The PDP 1 computer was shipped courtesy of KIAP and arrived at Kanpur in 1972. It was installed in the Computer Centre by our students who were assisted by Professor H.N. Mahabala and it started working. The computer came with only two terminals. One was a graphics terminal and the other a teletype. Several users could not use it simultaneously. Its greatest attraction for students was a large display terminal that came with it. It was used to play one of the early computer games called Star Wars. I gave

both hardware and software projects on PDP 1 to many undergraduate students of the EE department. I remember R.S. Nikhil and Bhasker, among others, who worked with it.

A 20 MB disk (one of the largest IBM disks in the 1960s) was added to IBM 7044/1401, but by 1976, it was saturated and IITK wanted to replace it. However, during the 1970s there was a serious balance of payments deficit in India and the import of computers was highly restricted. IITK's budget also was not adequate to buy a new machine that would have cost around Rs. 1 Crore.

I was a member of the Electronics Commission of the Government of India, chaired by the Secretary of the Department of Electronics (DoE), now called the Ministry of Electronics and Information Technology (MEITY), from 1978 to 1982. I was also a member of several committees of the DoE that approved buying computers for the Regional Computer Centres being set up by the DoE and computers requested by other organizations during the late 1970s. I was able to convince the Secretary of the DoE of the need to replace the aging IBM 7044/1401 system at IITK. The Secretary agreed to fund IITK up to Rs.50 Lakhs in 1978 provided IITK was able to contribute matching funds from its budget.

IITK was short of funds and it was difficult to allocate Rs. 50 Lakhs from its budget for a new computer. I felt that we could raise some money by selling the IBM 7044/1401 computers. As I pointed out earlier, there was a foreign exchange crunch during the latter part of the 1970s. When the Janata Government was in power after the defeat of the Congress party in 1977, George Fernandes was the Industries minister. A new government policy required foreign companies to dilute equity and take an Indian partner. IBM and Coca-Cola refused to comply and were asked to leave India in 1977.

The IBM 1401 was a highly popular computer in India with over 100 companies having 1401 installations. Many of these companies had saturated their 1401s and wanted to expand by renting/buying additional 1401s for their software packages. Their investment in 1401 software was enormous. The IBM plant in India was the only one in the world refurbishing used 1401s and renting/selling them for reuse. IBM had discontinued the sale of 1401 for the rest of the world in 1971. Many Indian companies were thus in a bind with IBM's exit and I knew that there would be a market for IITK's 1401. Besides this, IITK had a stockpile of critical spare parts for both 1401 and 7044.

I told the then Director of IITK, Dr. A. Bhattacharya, that we could raise some funds by selling the 1401 and 7044. He felt that it might be pittance but agreed. Consequently, a committee was appointed that included Srivastava, the then chief accounts officer, and some other professors besides myself. The committee discussed the procedure to conduct the sale. It was decided to advertise it in the papers and separate tenders were invited for the two computers with an earnest money deposit of Rs. 5 Lakhs each. Many prospective buyers visited IITK to inspect the machines to see whether they were in working condition and also to assess the availability of spare parts. On the day assigned to open the tenders, all the tenderers were present, and the committee met them and explained that their tenders were final and that there would be no negotiation. It was also pointed out that in case a tenderer renegeed, the earnest money they had deposited would be forfeited.

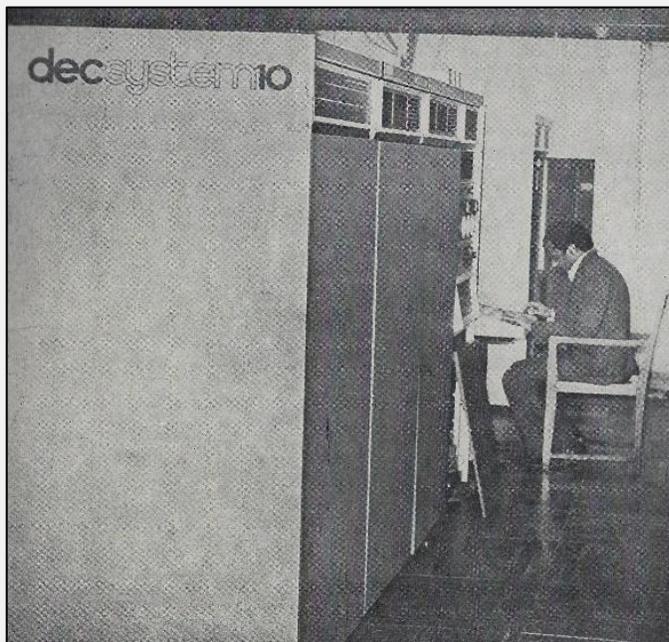
The tenders were opened one by one. There were around 10 bids for 1401 and only one for 7044. The committee was flabbergasted when one of the bids was Rs.30 Lakhs for 1401! The next highest bid was 15 Lakhs. There was only one bid of Rs. 15 Lakhs for 7044 – a much more powerful computer. The highest bid for 1401 and the lone bid for 7044 were from the same company. This company was owned by two entrepreneurs, Sadasivan and Raghunathan, and was based in Bangalore. Sadasivan was an ex-IBM customer service engineer with many years of experience in maintaining 1401s and Raghunathan was a financier. Sadasivan was confident of maintaining the computers and had assessed that the spare parts IITK was offering were adequate. I learnt that they had already lined up a customer who had

contracted to buy two shifts of IBM 1401 time to run their existing programs. They had second thoughts on 7044 and withdrew their offer. The committee explained that they would forfeit Rs. 5 Lakhs, the earnest money deposit.

After the formal tendering process was over, I invited Sadasivan and Raghunathan for a discussion. I asked them why they were withdrawing their bid for the 7044 which was at least 10 times faster than the 1401. Their trepidation was a lack of customers as most companies in India were not familiar with the 7044 and all their software was for the 1401. I then offered to depute programmers from IITK to write software for the 7044 to enable 1401 programs to be run on it much faster. I also assured them that if the software did not work, they could return the 7044. They agreed to take the 7044 and paid Rs. 15 Lakhs. The software was developed in Fortran by our programmers, Nirmal Roberts and K.S. Singh with the guidance of Professor H.V. Sahasrabudhe. It was good software and ran 1401 programs faster in 7044 than in 1401.

Dr. Bhattacharya was pleasantly surprised to learn of the sale of the computers for Rs. 45 Lakhs after they had been used for 13 years. We had bought the two machines for around Rs. 95 Lakhs in 1966. The circumstances during 1978-79 were fortuitous for the sale of used mainframe computers in India. Later mainframe computers were sold as junk.

With Rs. 45 Lakhs from the sale, IITK allocated Rs. 5 Lakhs from its own budget and we were able to match the grant of Rs. 50 Lakhs by the Department of Electronics (DoE). With Rs. 100 Lakhs in the kitty we started exploring the market for a new machine. An evaluation committee was appointed by DoE that invited quotations for a high-end time-sharing computer. Digital Equipment Corporation won the tender. DoE negotiated for two DEC 1090 computers, one for IITK and the other for IISc, Bangalore. IITK had a larger budget and got a bigger DEC 1090 computer. The DEC 1090 was installed in 1979 at the location vacated by IBM 7044/1401.



*The DEC-1090 at the IITK Computer Centre, early 1980s.
Picture Credit: Growing Up, photo yearbook, 1983*

Remembering Rajeev Motwani

Chilukuri K. Mohan (BT, CSE, 1978-83)



Among all of our numerous brilliant classmates, one name stands out, like a comet that traversed the adolescent sky of computer science research, accomplishing an incredible amount of work that continues to influence leading researchers in many areas of computing. His name now honours the IITK Computer Science building, made possible by a generous donation from his family.

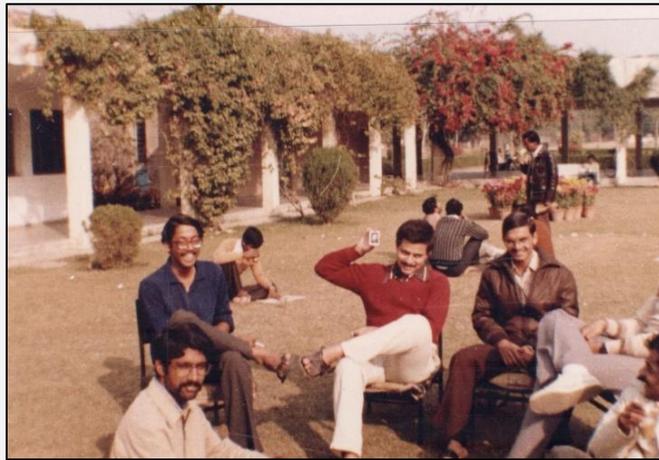
Rajeev Motwani (“Mots” to friends) was born in Jammu (1962), and grew up loving mathematics in New Delhi, where he studied at St. Columba’s school. He joined the first batch of 18 students* admitted to B.Tech. in Computer Science in 1978. During 1983-1988, he completed his Ph.D. dissertation research at the University of California, Berkeley, where he was supervised by Richard Karp, a 1985 winner of the Turing Award (something like a Nobel Prize for computer scientists). Rajeev then started teaching at Stanford University, where he mentored many graduate students (including the founders of Google) and conducted pioneering research in collaboration with colleagues and students who went on to become leaders of their research areas.

He served on many corporate boards, advising the founders of Google and numerous Silicon Valley startups; he was a soft-spoken deep thinker whose reasoned words were revered by many successful entrepreneurs. He passed away in June 2009, in a tragic accident that robbed his wife (Asha Jadeja) and children (Naitri and Anya) of his love and affection, and robbed the world of all the great potential contributions that would surely have sprung forth from his exceptionally creative brain.

** Of the 20 students accepted in the first batch, two chose to follow other interests and did not join the program.*

I first met Rajeev during our early days at IITK, as a fellow member of the cherished "first batch" of CS undergraduates, and in ragging sessions; later, we were both in the same classes and in nearby rooms in Hall V. Rajeev had always been a lofty thinker, and in the last two years at IITK he became intellectually excited and began exploring research ideas. A few of us were deeply interested in theoretical Computer Science, and three of us (Rajeev, Amitabh Shah, and I) wrote up a rather unusual B.Tech. project report under Prof. Somenath Biswas's guidance. That report, addressing communication protocol verification, using "Mailbox Automata" (an invention of Rajeev) and Petri Nets, still has a hallowed place in my shelves.

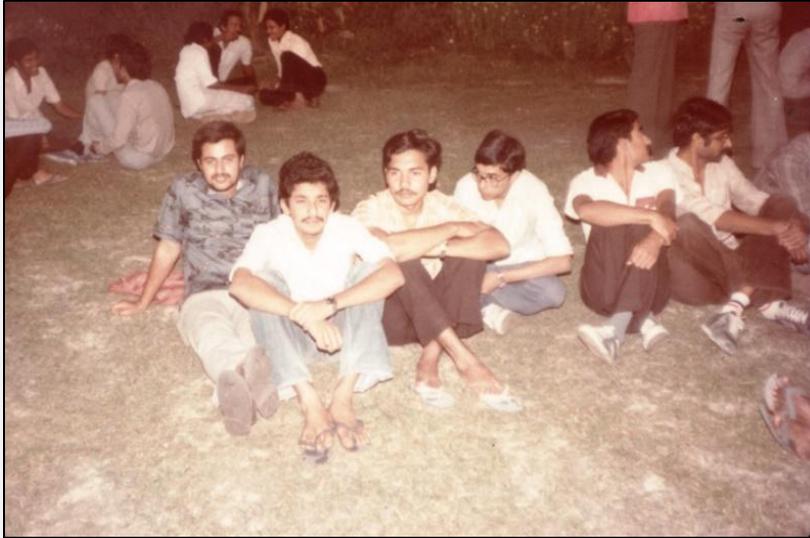
We had many mind-bending discussions in those days, focusing on mathematics and theoretical CS. We used to take graduate-level courses from the Math. Department, and Rajeev had most fun with the courses on Number Theory and Graph Theory. He was always very helpful and generous, sharing knowledge and explaining ideas to his classmates on the nights before mid/end-semester tests. It didn't seem to matter whether he had actually attended the lecture itself: a quick look at someone's class notes would suffice for him to rapidly grasp difficult concepts with which others vainly struggled.



In the Hall V Quad, 1982. Sivaraja Mohanram, Dipak Ghosal, Rajeev Motwani, and CK Mohan. Picture Credit: CK Mohan

Athleticism was not his forte, though we spent many hours patiently tossing the volleyball around on Hall V's court. Of the two old photographs of Rajeev that I have, one is of his posterior on the volleyball court, and the other is on the Hall V lawn, holding up his own photograph, an allusion to ideas of "self-reference" that we played with in those days. After coming to the USA, we communicated occasionally by email, but our paths rarely crossed. I met him only twice: once in 1985, on the Berkeley campus, where we were in a group of IITK alumni who fondly shared a fondue dinner, and once in 1994 at Stanford. Every time two friends separate, there's a possibility that they never meet again. That happened with us, though I've often celebrated his accomplishments with pride at having known him, though briefly.

Rajeev's room-mate in Hall 3 (Room 256) was Rakesh Kumar ("Teddy"), who reminisces that Rajeev was doing very well at academics without putting in too much effort. Rajeev would be out partying when Teddy fell asleep at 11PM, but could be seen studying for an hour or two in his bed at 2AM if Teddy happened to wake up. When Teddy was quarantined with chicken pox at the IITK Health Center, carefree Rajeev wanted to hug him despite warnings from Teddy to the contrary. Teddy remembers that Rajeev was not abstemious (to put it mildly), but could totally stop smoking and imbibing alcohol at will when he returned to his parents' home in Delhi during the summer, when he used to volunteer teaching kids at a neighborhood school.



This picture was probably clicked in March 1981, on the occasion of Director Sampath's inaugural address to the IITK students. The group is on the VH lawns (now part of the Outreach Centre).

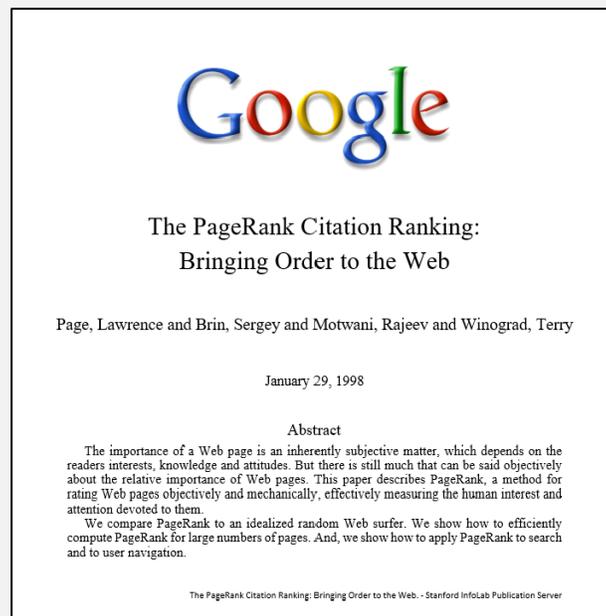
L to R: Rajeev Motwani, Saman Kelegama, Sunil Jha, a 78-83 batchmate, Ramadurai Ramesh and Sivaraja Mohanram.

This picture had been shared by the late Saman Kelegama (MSc, Math, 1978-83) who went on to serve as Executive Director of the Institute of Policy Studies and

Chief Economic Advisor to the Government of Sri Lanka.

Rajeev was very successful at solving the brain-teasers with which Teddy used to challenge him. Puzzle-solver he was, breaking crossword puzzles with ease. He had told me, in 1982, of the easiest way to crack passwords on the IITK's DEC10 system. I promptly changed my password. Three years later, in the US, when someone else briefly shared his password with me while he was traveling, I found that even that password was predictable by the Rajeev heuristic.

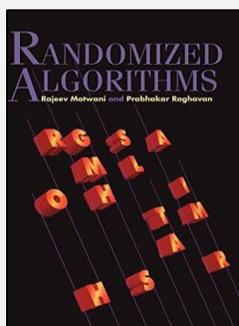
I will try to discuss his research contributions, and why we consider Rajeev to be a great computer scientist, at the risk of being too simplistic (for computer scientists) as well as abstruse (for the rest of us).



Rajeev is most famous for being the co-author of a 1998 technical report (published in 1999) describing the "PageRank" algorithm for citation ranking. Two of his co-authors, Larry Page and Sergey Brin, were graduate students at that time, whom he mentored and encouraged in their successful efforts to start a new company which swiftly became a household word. The brilliance of that algorithm was in showing

how objects in a connected network could be evaluated and compared, effectively using the evaluations associated with other objects with which they are connected.

The basic idea of the algorithm, updating a web-page's importance using the importance attributed to connected web-pages, appears straightforward (as is the case with many brilliant ideas); the importance of the work is in showing that the iterative process converges to a meaningful quantity, *i.e.*, the probability of arriving at a web-page (when you start from almost anywhere in the web) after a large number of clicks. This provides the basis for making recommendations: if thousands of pages could be retrieved after a query, in what order should they be presented to an impatient user, assuming that a human user would prefer to reach their most likely destination very quickly? Such a question is answered by identifying the most important ones, using PageRank and its successor algorithms that have emerged over the years, and are used extensively every time we pose a query to a search engine. Many of our batchmates remember Rajeev, in the early 2000s, excitedly telling us "look at this; it will change how people surf the web". Needless to say, it did!



Rajeev is also famous for being a pioneering researcher and the co-author (with Prabhakar Raghavan) of the first book on "Randomized Algorithms" which has been used as a textbook in many universities. A large class of problems is known to be practically impossible to solve in a reasonable amount of time—this is not just an abstract mathematical concern, a huge number of challenging problems encountered by real-world companies falls into this category, e.g., scheduling or route-planning. Randomized algorithms address such problems, obtaining very good solutions with high probability by carefully exploiting randomness, often using numbers generated randomly using a known probability distribution.

Rajeev's most cited work is the classic textbook he co-authored (with John Hopcroft and Jeffrey Ullman), the second and third editions of "Introduction to Automata Theory, Languages, Computation". We had touched its first edition (called the "Cinderella Book" due to its original book cover) as B.Tech. students, and Rajeev's work as co-author appears to have been focused on Automata Theory and its applications, making the book more accessible to undergraduate students than its predecessor. The mark of a great teacher is his ability to explain a difficult subject at a level understandable to a student, and Rajeev personified this attribute.

Rajeev's next most cited work is a 1998 paper co-authored with a graduate student (Piotr Indyk), on algorithms for finding "Approximate Nearest Neighbors"; they followed this in 1999 by writing another highly cited paper on approximate similarity search, which focused on addressing problems of high dimensionality. Finding exact nearest neighbors for a point involves excessively high computational effort. Rajeev's work shows that we can efficiently find solutions that are acceptable for most practical problems, *i.e.*, points that are almost as near as the nearest neighbors (within a specifiable tolerance level), for an important class of problems. A key idea developed in this work is that of "locality-sensitive hashing"; these results have applications in many areas, including information retrieval, clustering, and pattern recognition. Rajeev's work has practical applications and is also mathematically well-developed—unlike many other publications in related fields, his work is not restricted to proposing algorithms which have been demonstrated to work well only empirically.

Rajeev co-authored numerous other highly cited publications; the impact of researchers' work is often evaluated in terms of citations, and his record in this respect is amazing: as per the Google Scholar citation index on Feb. 11, 2022, his "h-index" was 95 and the number of citations was almost 100,000; last year alone, he had 3,935 citations. His impact as a professor can also be assessed in terms of the

remarkable success of his former students, some of whom continue to conduct excellent work at top-ranked academic institutions in the USA. IITK recognized Rajeev as a Distinguished Alumnus in 2006.

I conclude with a few verses that I had written when Rajeev had passed away in 2009.

MOTS

The gods struggled, the gods gave up;
A theorem found, no proof in sight;
They thought of Mots, they needed Mots!
Alas, he's gone, mid-day is night.

When reckoning day comes
And sins are weighed,
Accuse, indict, arrest these Lords
For desolate hope, betrayed.

Not yet his prime,
It was too soon.
Just forty seven,
Oh randomized June.

Sometimes a lotus,
from water grows;
Sometimes a pool
drowns hope's rose.

Fermat, Turing,
Brightest flames gone,
And now, young Mots,
Too early, we're alone.

But he smiles
from the other side,
Einstein's proved wrong
A roll of dice, is life denied.



Rajeev with IITK friends at his home in Atherton, CA, 2001.

Standing: Sunil Singh, Rajeev Motwani, Ramesh Warriar, Ashok Singhal, Sanjeev Madan, Arun Chandra, Sivaraja Mohanram. Kneeling: Nitash Balsara, Gautam Bhargava.

All are from the batch of 1978-83, except Nitash Balsara and Sanjeev Madan who are from 1977-82.

Picture shared by Ramesh Warriar (BT, EE, 1978-83). More pictures of Rajeev with his IITK friends are in the 1978-83 Batch Memorial Book, which is accessible in the FaceBook group 'This Bit of That IITK'.

Gödel Prize - 2001

Sanjeev Arora, Uriel Feige, Shafi Goldwasser, Carsten Lund, Laszlo Lovász, Rajeev Motwani, Shmuel Safra, Madhu Sudan, Mario Szegedy

In three pathbreaking papers, the nine authors have developed a completely new understanding of when an algorithmic problem is "intrinsically hard". To clarify this is a central task of theoretical computer science. The basic idea of describing hard problems goes back to Kurt Gödel and is captured today in a problem class named NP. The first fundamental contribution of the prize winners is a description of NP by a new model of computation which integrates the idea of interacting computing agents and randomized computation. The authors obtained the remarkable and far-reaching result that the correctness of a solution can be checked by inspecting only very few bits of it when these bits are chosen by random. The second and equally strong contribution is concerned with a standard approach to solve hard problems, namely by allowing approximative solutions which would be easier to compute. The prize winners established the surprising fact that certain problems in NP remain hard even when only an approximative solution is required. With their deep insights and powerful results, they have opened new perspectives for many problems in computer science, for example in optimization and cryptography.

<https://eatcs.org/index.php/component/content/article/507>

Quotes: (extracted from <https://voxiitk.com/rajeev-motwani-there-wasnt-a-startup-he-didnt-love/> and <https://mathshistory.st-andrews.ac.uk/Biographies/Motwani/>)

- Gaurav Garg: *Rajeev was one of those rare people who operated at the highest level of excellence in multiple disciplines. He was exceptionally observant, practical, thoughtful, yet decisive, with an unerring instinct for the right questions or issues around any topic, be it the game of cricket or a startup. I was always impressed by his kindness, fondness, and open door policy with young entrepreneurs.*
- Sergey Brin: *In addition to being a brilliant computer scientist, Rajeev was a very kind and amicable person and his door was always open. No matter what was going on with my life or work, I could always stop by his office for an interesting conversation and a friendly smile.*
- Larry Page: *Rajeev was a wise theoretician that had the rare knack and desire to turn theory into practical applications.*
- Seffi Naur: *Rajeev struck me from the beginning as brilliant, very knowledgeable, and having broad interests. Working with him, he was always full of new ideas, prolific, but also very calm and mature.*
- Aleksandra Korolova: *His lectures were so perfectly crafted, from the progression of describing a simple approach providing the intuition to generalizing it, to doing an impeccable formal analysis, to the perfect board technique, that I left every lecture excited about a new powerful topic that I have just learned and understood.*
- Neha Kumar: *As a teacher, he was awe-inspiring - carrying with him an equanimity and cheerfulness that remained undisturbed through every lecture. As a student advisor, he was kind and supportive - never impatient or proud (though he may have had every reason to be so). As a supervisor, he was trusting and understanding.*

About the author: *Chilukuri Krishna (CK) Mohan (BT, CSE, 1978-83) was a member of the first CSE batch at IITK along with Rajeev; they had collaborated in their first research effort (B.Tech. Project Report), and they lived in the same wing in Hall 5 during 1981-83. CK received a PhD from the State University of New York at Stony Brook in 1988, and has been teaching at Syracuse University (NY) since then. He has co-authored books on Neural Networks, Expert Systems, and Anomaly Detection, and his current research interests include Bioinformatics, Evolutionary Algorithms, and Machine Learning.*

A Bit of IITK, Twelve Thousand Kilometers Away



LOCALITY

In honor of Rajeev Motwani,
and a gift to his family

This painting contains elements inspired by Rajeev's career and personality, especially Locality Sensitive Hashing, which maps disparate objects into a geometric space, such that similar objects have a tendency to be adjacent to each other. This painting also alludes to Rajeev's pioneering work in data streams; his foundational role in Google; his affection for Indian festivals; his affiliation with IIT Kanpur, Berkeley, and Stanford; and the view from his Stanford office.

By Ruchi Goyal, with input from Ashish Goel and Rajeev's students.

9/25/2009

This painting by Ruchi Goyal, done as a tribute to Rajeev, with images of the places he associated with, hangs in the Computer Science Department at Stanford University. IITK students and alumni will recognize the image of the Library in the centre of this painting.

Another similar painting by Ruchi now hangs in the Rajeev Motwani Building on campus. Those on campus are encouraged to walk over and take a look at that one; the two paintings are not the same.

Pictures shared by Akshat Jindal (BT, CSE, 2015-19)

Rajeev Motwani: In His Own Words

From an Interview with Shivanand Kanavi

Shivanand Kanavi interviewed Rajeev Motwani in July 2002, while researching for his book "Sand to Silicon: The amazing story of digital technology". Below are some excerpts that focus on IITK and on how Google got started, in Rajeev's own words (as transcribed by Shivanand, and compressed by the editors of this issue). The full interview can be accessed here:

<http://reflections-shivanand.blogspot.com/2009/08/rajeev-motwani-interview-2002.html>

On Childhood Interests and Shaping Influences

One of the shaping influences was that my father was in the Army and that meant not being in one place for too long, not more than two years. My parents were great believers in education so where ever we were they sent me to the best possible school available. All of them were missionary schools and had many inspiring teachers. I also always wanted to be a mathematician or a scientist at any rate.

Then I decided that I did not want to be an Einstein but wanted to be a Gauss. That was because I was an avid reader and I used to read a lot of books. My parents had given me a lot of ten great scientists, five great mathematicians, kind of popular science books and biographies which were very inspiring. I was not reading about other kinds of heroes. That is what I wanted to become. Fortunately I was good at Maths.

I also did not graduate from school. I used to study in St Columba's, Delhi, where they had just switched from 11 to 10+2 and IITs gave us permission to join them after 11th without completing 10+2. I did have problems when getting permanent residence here in the US because I had a PhD but did not have a school certificate.

IIT Kanpur at that time had for the first time an undergraduate program in Computer Science B.Tech. I really wanted to be a mathematician and I did not have any idea what a computer was. My parents were hesitant because they did not know how a mathematician would make money and support a family. Basically I was forced to do Computer Science. I then realized that Computer Science was very closely related to mathematics.

Some of the faculty in IIT Kanpur were also a shaping influence for me. One of the people who really influenced me was Kesav Nori. At that time there was Prof Rajaraman, R. Sankar, H.V. Sahasrabudhe, Somenath Biswas, Kesav Nori, Harish Karnik to name a few. I could not have constructed a better environment for doing Computer Science in India. It was an amazing confluence of people.



Nori had just come back from Europe. He stayed for a year or so and taught us the first course in programming. He was a wonderful teacher and used to tell great stories. We started out programming on computer cards, which you probably remember but most other people don't. That time we used to work on DEC machines and VAX machines with a terminal. We then had to use a login and a password. Nori could have made up random passwords, or given names of flowers but instead he gave names of famous computer scientists as passwords. Somebody had Don Knuth as password (who is down the hall).

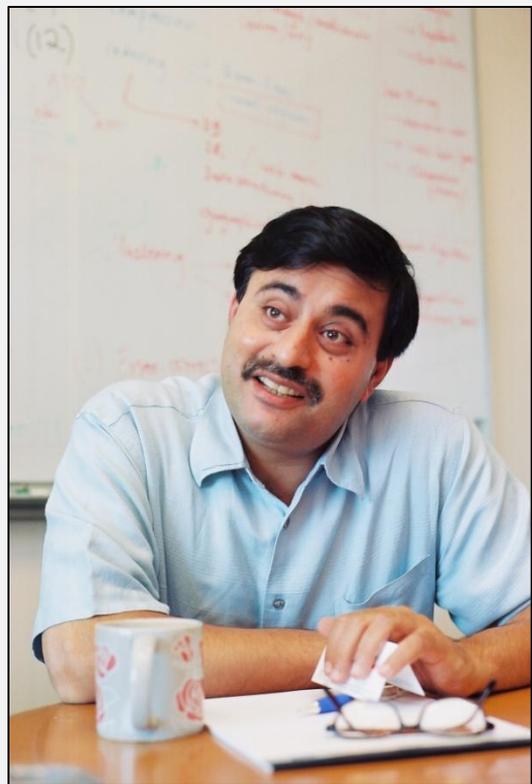
I went and did research to see who these guys were. Bob Floyd was my password. He was also at Stanford and passed away recently. He was one of the mentors of this field called analysis of algorithms. He also did the early work on randomized algorithms. I ended up eventually doing some work on randomized algorithms. The very first chapter of my book on randomized algorithms was on Floyd's algorithm. It is hard to believe that because he was my password this happened. But there must have been some connection! That was the wonderful thing about Nori who was a very inspiring person. He did more than just teaching. He created such a wonderful ecosystem and developed a personal connection with his students.

There are a lot of very good schools not only in the US but elsewhere. Going by what I have seen in this country and going by what I have learnt out there, definitely IIT Kanpur was one of the top five schools in Computer Science education.

On the Inception of Google

There was this guy Jeff Ullman, another one of the grand old men of Computer Science, who retired this year. He was in the office next to me and was into databases. I was talking to him and a new student – Sergey Brin, and I remember at that time we were using Mosaic, and we were looking at the web and I was sitting there and thinking that we could randomize the web in some way because that was going to grow and become big and randomness was going to be important; though I did not know how and why. So I thought about doing random walks on the web and there was this problem of crawling on the web. At that time a search engine called Inktomi had just come out of Berkeley. Excite and Yahoo had come out from Stanford so we had seen the first signs of all of this.

We then formed this research group called Midas which stood for "Mining Data at Stanford". We did a lot of good work on data mining. Then there was this guy called Larry Page who wasn't really a part of the Midas group but was a friend of Sergey and would show up for these meetings. He was working on this very cool idea of doing random walks on the web.



When I understood what the World Wide Web would look like, I knew I had to somehow force randomness into it. When Larry showed us what he was doing, it was like a complete epiphany, we thought it was absolutely the right thing to do. Soon Sergey got involved and it became a sub group inside Midas. I was really a good sounding board for Sergey and Larry and I could relate to what they were doing through randomness. They then created a search engine called Backrub. It was running as a search engine from Stanford just like Yahoo ran till the traffic got big and the IT guys sent it off the campus.

For me it was a fun research project. We had a lot of ideas which we shared. At some point this thing started getting very serious and we wanted a better name for this than Backrub. So somebody came up with the name Google. Google means 10 raised to the power of 100. It is actually spelt as GOOGOL but somebody misspelt it and that's how the search engine got its name. Of course the official story is we deliberately spelt it that way but my guess is we misspelt it.



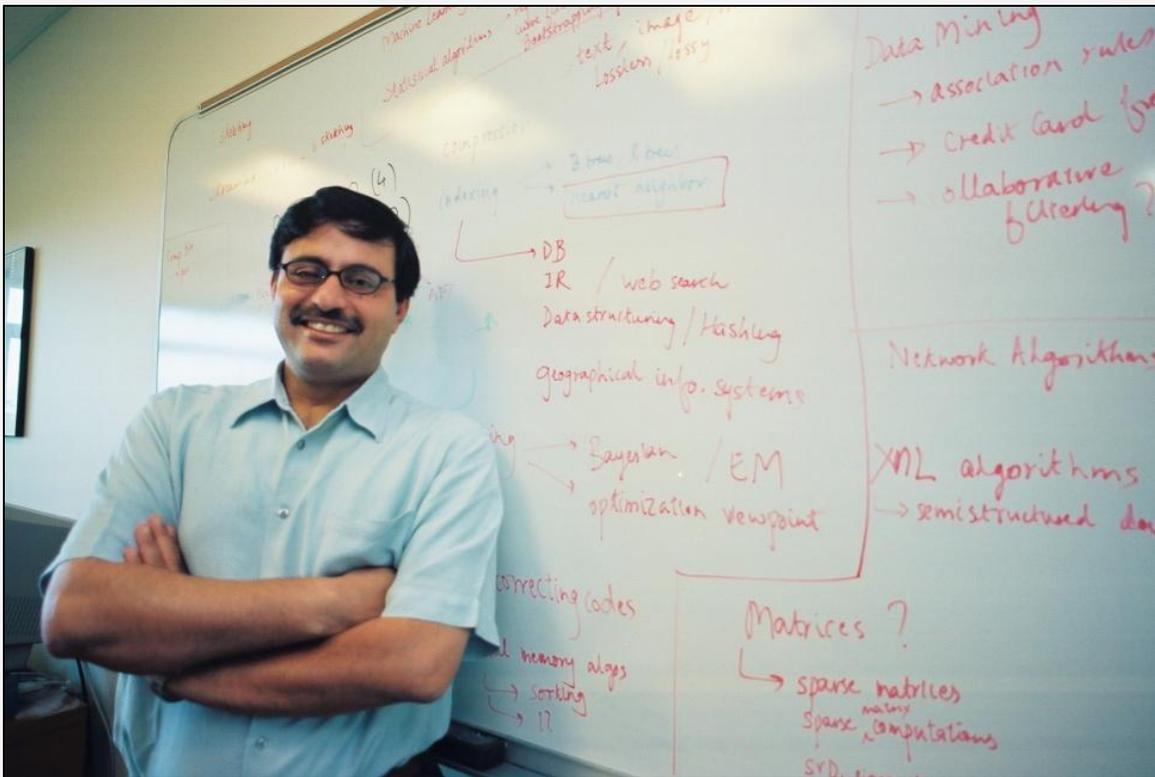
So Google started and pretty soon everybody in the world was using Google. The results were much better than all the other search engines going around.

At some point these guys said we want to start a company. Everybody said it was not worth it. There were 37 search engines already out there. How would you raise money? How would you form the company? But they decided to do it and they did it. There were some big names which supported the company. Andy Bechtolsheim, an ex-Stanford guy who along with Vinod Khosla had founded Sun Microsystems, put in a little bit of money. They managed to raise a million dollars. They started the company and it was right here in the university avenue. It used to be on my drive home so I used to go and hang out with these guys. It used to be wonderful.

Then they took over the world!

The old search engines like Alta Vista and Inktomi were able to harness a lot of memory and solve problems on a large scale. So instead of building indexes of thousands of words they could build indexes of trillions of words and search through them very quickly. They just put a lot of horsepower behind it but not any science.

What Google changed was the following: It actually started looking at the structure of the web. The basic structure we noticed was that it's a collection of documents. These documents talk to each other. The reason is the hyperlink. Without the hyperlink, the web would have been useless. When you click on it, it takes you to another document. It is like this document saying "hey, look at that other document". Now if I create a web page and make the effort to point to your webpage, there is some meaning and connection between my webpage and your webpage. The content here and there should be related in some form. This was the basic insight in Google. Instead of looking inside the webpage or the words inside it, look at how the web pages talk to each other, how they talk about each other and how they point to each other. So that was the basic insight and everything else was built around that insight.



So the question was how to find the most authoritative page on a certain topic?

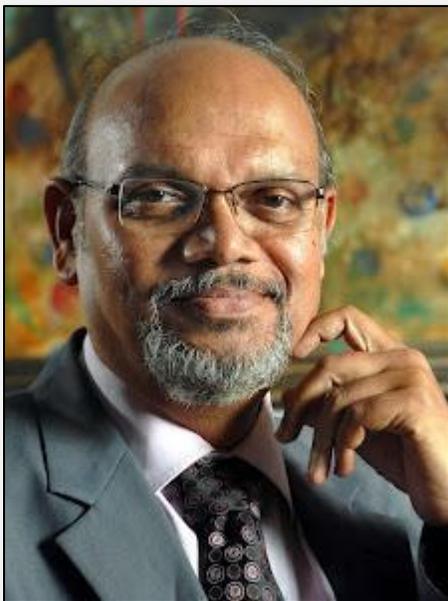
Suppose you are surfing at random. Let us say my page has seven links. You randomly clicked on one of those seven links. You reached the next page which had three links and clicked on one of those at random and it took you somewhere and so forth. After a while you will be on a random page on the web. Suppose you surf long enough, you do it a million or billion times, you will be distributed somewhere on the web. You could be on any page. The question is what is the probability that you are sitting on a particular webpage?

This is called doing your random walk on the graph which excited me about all these things. Turns out the probability distribution is not unique. There is a different probability being on different pages. Quite obviously if every page in the world points out to my webpage then the chances of ending up on my page are very high because wherever you are there is some probability that you will come here. If nobody points to me or if only one guy points to me then it is very unlikely. On the other hand, if the important pages in the world point to me, then you are likely to end up at my page. But what are important pages? Those are the pages to which other important pages point. So this logic of circularity or flow is what led to the notion of Page-rank. Ranking of pages is Google's secret sauce.

Now on a query on yeast and bread, what we do is look at all pages that contain yeast and bread, find the page with the highest rank or score which has the word yeast and bread and we say that must be your answer and it is usually right. Google got so cocky on this, that it has a 'I'm feeling lucky' button. So if you give a query and hit that button, it takes you to a page. That page has the right answer.

Editorial Note: A simple PowerPoint presentation explaining the Google PageRank Algorithm has been put together by Professor Eric Roberts for his CS class at Stanford University. Those not familiar with the algorithm and wishing to understand its step by step methodology can access this presentation here: <https://web.stanford.edu/class/cs54n/handouts/24-GooglePageRankAlgorithm.pdf>

About Shivanand Kanavi:



Shivanand Kanavi is former Vice President, TCS and is currently Adjunct Faculty at National Institute of Advanced Studies (NIAS), Bengaluru. He writes on business, science & technology, Indian history, political economy and philosophy. He is a popular speaker in IITs, Universities and higher educational institutions, as well as on Radio and TV. Shivanand studied Theoretical Physics at IIT Kanpur (MSc 1974); Northeastern University, Boston and IIT Bombay. Before working in TCS (2004-2013) as Vice President, he was the Executive Editor of Business India magazine, a pioneer in Business Journalism in India. He has written extensively on Business and Technology and was awarded the Madhu Valluri Award for IT Journalism for the year 2004. Shivanand has authored the highly acclaimed "Sand to Silicon: The amazing story of digital technology" (Tata-McGraw Hill 2004, Rupa 2006). He has also edited "Research by Design: Innovation & TCS" (Rupa 2007). Contact: skanavi@gmail.com

Picture Credits: the pictures of Rajeev in his Stanford office were clicked by Palashranjan Bhaumick

Portions of this interview previously appeared in the US weekly newsmagazine, India Abroad (2009), and in the IITK alumni publication, Voices (2013).

From IITK to IBM

Arvind Krishna (BT, EE, 1980-85)

I fundamentally believe that to make the world better, you must first understand how it works.

From engineering, to computer programming, to economics, to psychology, the knowledge I gained at IITK gave me a deep, rich understanding of how the world works. My studies at IITK instilled in me a deep sense of curiosity and taught me the fundamentals of both analytical and creative thinking.



The lessons I learned at IITK have stayed with me until this very day. My career at IBM would have been impossible without the formative years I spent there. For instance, classes on ‘digital’ influenced and guided me in graduate school. The valuable teachings of Professors Srivatsan, Bose, Biswas, Das, Rao, Sarma – just to name a very few – are as vivid in my mind today as they were decades ago. I also remember the wonderful faculty, who were so generous and patient with their time. I have a profound sense of gratitude for this great institution, which has played such a seminal role in shaping my life, my thinking, my work, and my worldview.

I must emphasize that it wasn’t just about the coursework. What IITK gave me were a set of intellectual tools or a unique way of looking at the world. Some of these are habits of mind that are specific to the world of engineering. This includes the ability to break a complex problem into its components, to apply general principles to specific cases, to discern cause and effect, to reason logically and statistically, and to vet fact from rumors and unexamined conventional wisdoms. And, of course, there was also the crucible of debating with classmates, which played a particular role in honing my critical thinking.

These experiences became the foundation upon which many of my career achievements at IBM have been built. Now, whenever I’m asked to offer advice to young people who are about to embark on their own professional journeys, I draw on three lessons I learned from these experiences.

First, be insatiably curious. Curiosity is sacred. Curious minds see efforts as a path to mastery. They learn from criticism. And they find lessons and inspirations in the success of others.

Second, be persistent. Many people believe that innovation is about eureka moments. The truth is that innovation is incremental, but also serendipitous. It’s a gradual and often painful process. Be aware, take the unusual path, and look for opportunities that are hidden in plain sight.

Third, find meaning in what you do. After working at IBM for more than 30 years, I still think that I have the best job in the world. The main thing that got me from there to here, other than sheer luck, was a deep passion for technology and an ability to approach and solve problems with an open mind.

To succeed in whatever path you choose, it's crucial to understand what motivates you – of what makes you tick, at a fundamental level. Also, try to figure out what motivates those around you. As you become a leader in your chosen field, you will excel by tapping into those motivations.

I also believe it's important to retain a sense of optimism, even in these challenging times. The global public health crisis has created a lot of uncertainty and brought into focus problems that have been brewing for quite some time. But no matter how hard we fall, we always bounce back. This speaks to the resilience of the human spirit.

At IITK I learned the importance of grit in achieving your goals. I saw first-hand how driven my classmates, advisors, and professors were, and how instrumental that drive was in their success. They had plenty of talent, but what made them truly special was their work ethic, and this is something I've carried with me throughout my career.

I have immense confidence in this generation's ability to take on the challenges of our day and use this moment as an opportunity to build back better. And it's because of institutions like IITK that I know we will surprise the pessimists. This is your world to shape. I'm eager to see the problems IITians will solve and the progress you'll make for all of us.

About Dr. Arvind Krishna

Arvind Krishna (BT, EE, 1980-85) got his B.Tech from IITK and then went on to get a PhD from the University of Illinois at Urbana-Champaign in 1991. He began his career at IBM in 1990, at the Thomas J. Watson Research Center, and was promoted to Senior Vice President in 2015, managing the IBM Cloud & Cognitive Software and IBM Research divisions. He was a principal architect of the acquisition of Red Hat, the largest acquisition in the Company's history. He took over as CEO in April 2020, and now serves as Chairman and CEO of the company. He was recognized as a Distinguished Alumnus of IITK in 2019.



Picture shared by Sanjay Khare (BT, EE, 1982-86).

At IITK, Arvind had been actively involved with the Cultural Council and in the management of the Festivals. He managed the Control Room, making sure that the events proceeded smoothly and on schedule. This picture of the IITK team setting up the Prize Distribution ceremony for Festival '83 has Coordinators Sanjay Khare (Publicity) on the left and Arvind Krishna (Control Room) on the right. The girl in the centre of the picture is one of the participants from JMC.

Arvind and his wife Sonia have two children and live in Connecticut, north of New York City.

Our Bits of That IITK

Three Bumps (And Many Children) Ahead!



Giving a birthday boy 'bumps' was a time-honored tradition on campus.

It involved four people (the bumpers) grabbing the birthday boy (the bumpee) by one limb each, so that he was suspended spread-eagled, facing up.

Vigorous upward launches propelled him several feet in the air, only to succumb to gravity and either a hard or a soft landing, depending on how well the launch party was holding on. The number of bumps was approximately equal to the age of the bumpee, although a half-dozen launches were generally enough to run the bumpers out of steam. Over time, the experience was enriched to include PawArti (Foot Blessings) on the bumpee's posterior on the way down. This was a challenging upgrade, because it meant that the bumpers had to perform the service while standing on the one non-kicking leg.

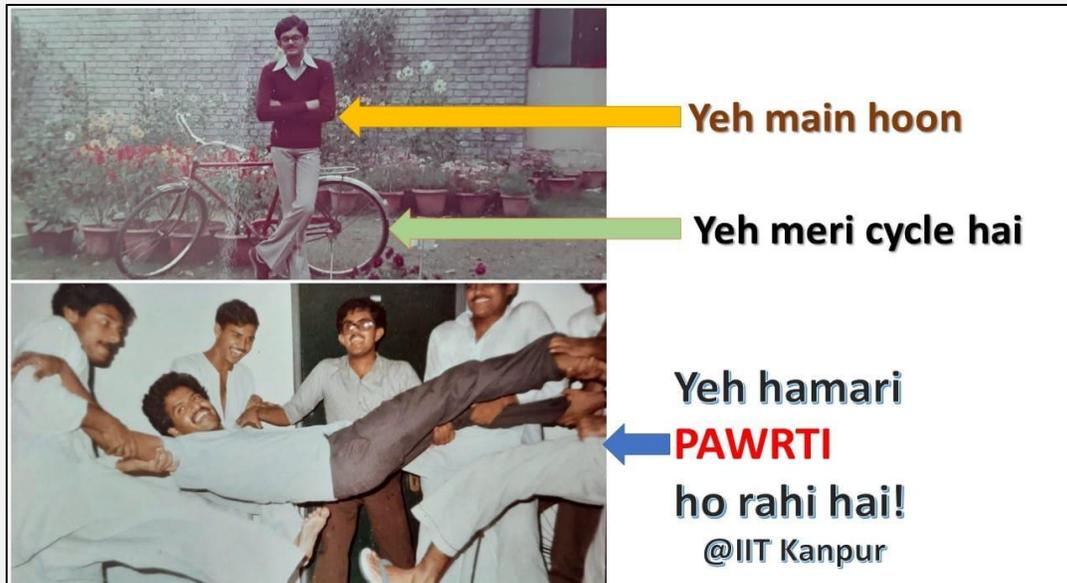
Only rarely, the bumpee put up an extremely vigorous defense to being bumped, so that even four strong bumpers were unable to start the bump launches. The only one in our batch who managed to put up such a defense was Neeraj Jain (who went on to be the Sports Secy in 1978). He never once enjoyed the thrills of being flung up into the ether, or the rush of plummeting earthwards.

In the photo above, Neeraj Jain has grabbed both lower limbs (he was very strong), and Bong (aka Sandeep Ghosh) is grabbing the right arm, prior to starting the festivities. The gent looking on indulgently on the left is Sanjay Bhargava.

The identity of the bumpee is unknown.

- Shirish Joshi (BT, ChE, 1973-78)

Bumping can be fun but proper safety precautions should always be followed to make sure no one gets hurt.



Bottom: A birthday celebration for Vikas Prakash (BT, ME, 1980-85). Creating memories are batchmates Sudipto Mukherjee, Makarand Chaurey, and Atul Behari Bhatnagar, along with Anurag Agrawal (1982-86, face partially hidden). Shared by Atul Behari Bhatnagar (BT, ME, 1980-85)

And the tradition continues...



Sandeep Shinde receiving Pawarti, Aug 2005. Performing the rituals are Pankaj Singh Tanwar, Abhishek Srivastava, Amogh Dixit, Chandra Shekhar Tiwari, and Tanmay Sachan. Abhishek Verma and Arun Jain are visible in the background. Shared by Ravi Mishra (BT, MME, 2003-07)

Of Campus Residents (And Other Living Things)

Kaustav Das Gupta (M Design, 2007-2009)



Along the GT Road, on the way to IITK, 1963

Picture Credit: Dave Montenegro, from the KIAP collection of Prof. Gio Wiederhold

On my first day I went walking around the campus and I saw a herd of deer cross the street. It was quite dark and the vision had the quality of a dream. I could have easily disbelieved what I had seen but I soon realized that animals, big and small, were living all around the campus. Peacocks and squirrels were so abundant that you quickly got desensitized to their presence and treated them like dogs and cats scavenging for tit-bits outside the canteens. They even ate out of your hand. A particularly large monkey finally getting lured into a wooden trap and getting escorted out of the academic area was news. A few kilometers down the GT Road, away from Kanpur, I had seen a camel in a cattle auction. And domesticated elephants and horses drawing carriages could sometimes be seen on the highway and they seemed to belong to the scene as much as the Vikram tempos did.



Ek Bandar, LHC ke Andar... Is it time for class yet?

Picture Credit: Ravi Mishra, (BT, MME, 2003-07)



I am the Emperor of all I survey. Spotted on the roof of Hall II by Pranay Mehta (BT/MT ChE 2009-14)

The water in the Library fountain was full of tiny frogs which climbed onto your fingernail if you dipped your finger into it. There were tadpoles too and they were more than twice the size of the adults. The frogs would float around and the tadpoles swam beneath them, which seemed a little funny. I saw a squirrel outside the Hall-3 canteen that looked like Santa Claus because a piece of cotton wool was stuck to its face. Perhaps, it was trying to eat it.

One hot summer day I was walking towards the air-strip. It was so hot that as I came closer to a tree I wanted to get under its shade and rest a little. As I was getting close to it, I saw the matrix of a shadow quiver a little but I could not be sure. Once under the tree, I realized I was face to face with a Nilgai.



I got the fright of my life! It was a beautiful animal, at least as tall as I was. It registered for only a second before I turned tail and ran back to safety. It occurred to me later that it must have been as scared of me as I was of it.

*The Nilgai roaming free near the airstrip
Picture Credit: Jai Verma (BT/MT, EE,
2003-08)*

I once got a tip that a family of owls was nesting inside a particular tree. I went to check it out. Sure enough there was a baby owl. It was so well camouflaged that it was near impossible to make out. But the eyes give it away.

Peek-a-boo I see you! On a tree opposite the temple, both of us keeping an eye on each other.

Picture Credit: Bishwajit Sharma, (MT, EE, 2008-10)



Animals were as much a part of the campus as any of us were and maybe they had their own stories about lanky tee-shirted students that took some passing interest in their community.

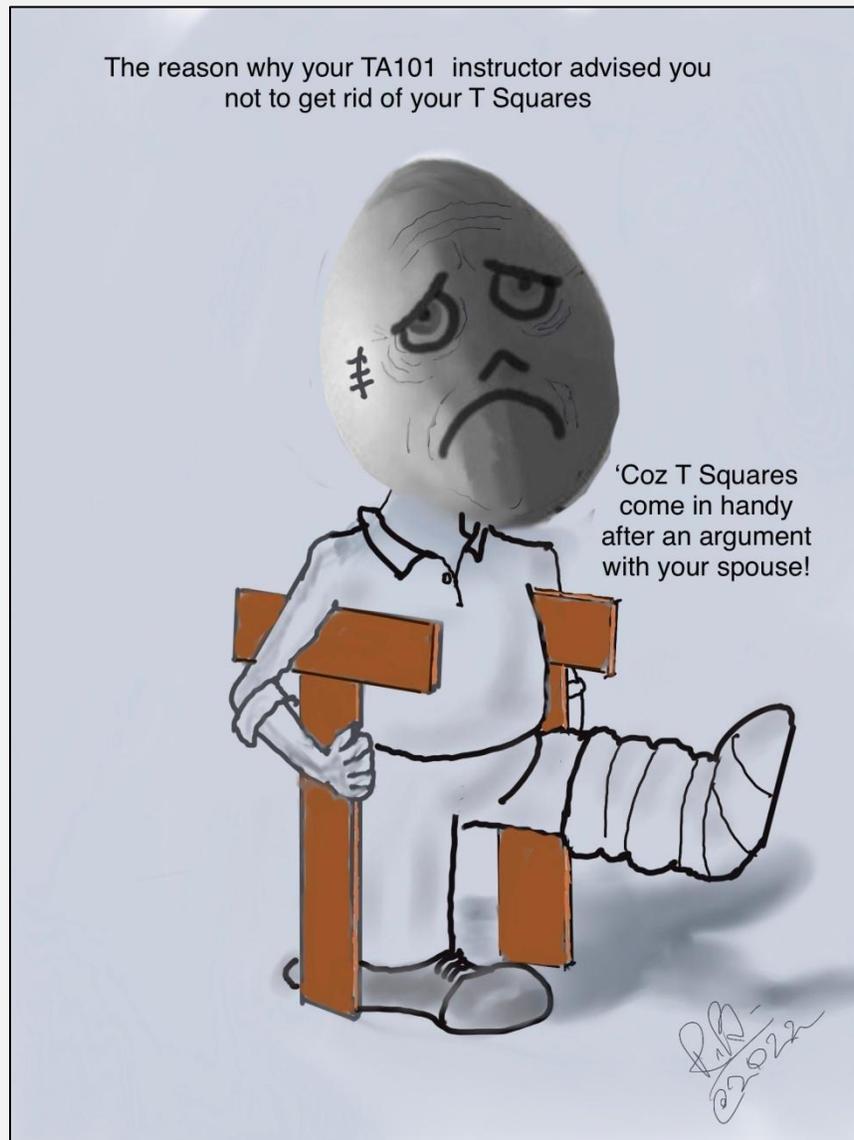


At the LHC... a well earned break between classes.

Picture Credit: Jiya Yadav (BT, EE, 2019-23)

The pictures for this story have been contributed by members of the FaceBook group 'This Bit of That IITK'.

Ageing IITK Eggheads



Shared by Raman Bhatia (BT, ME, 1977-82)

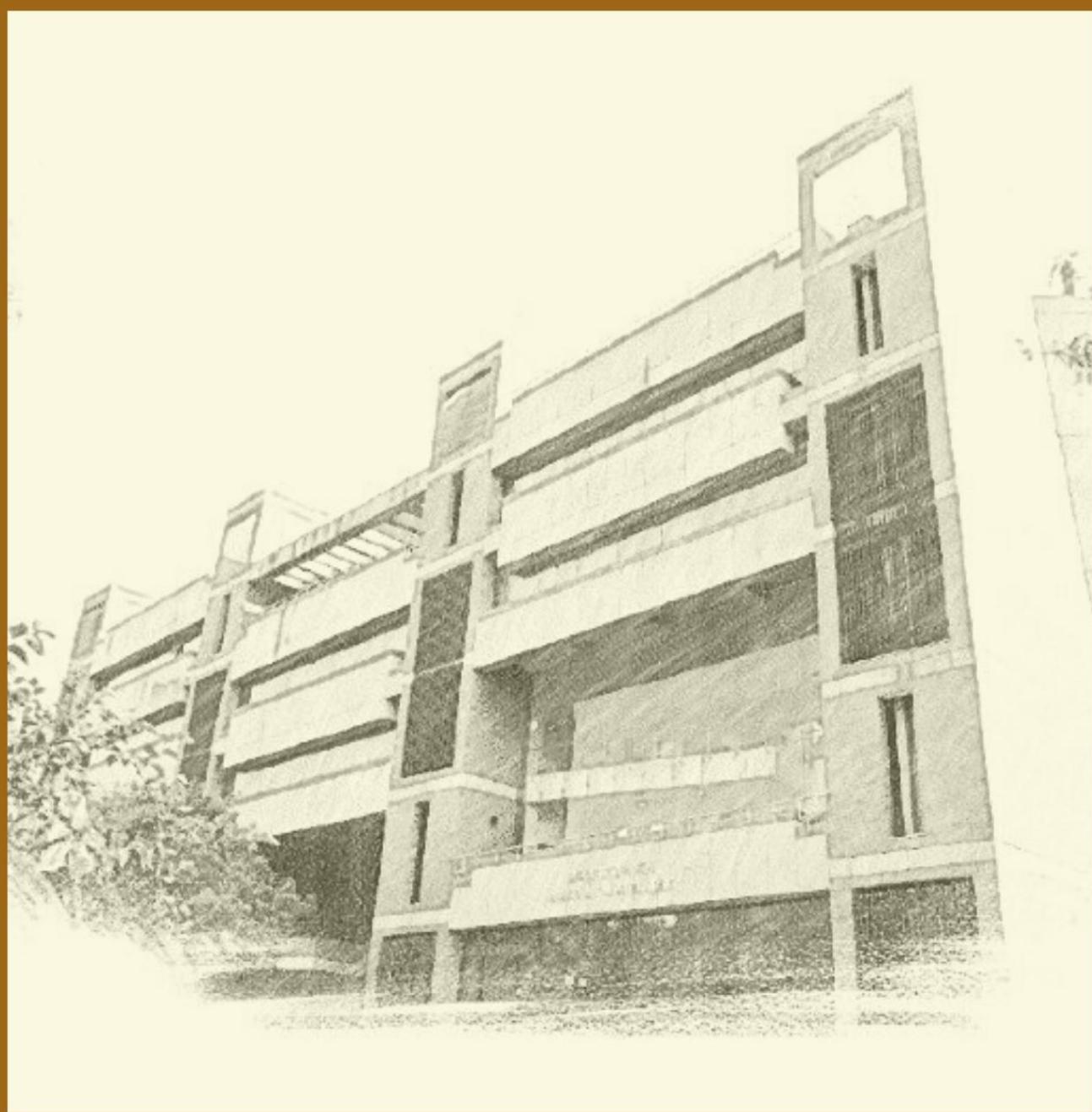
Cover Pictures

Front Cover: Over 250 species of birds can be spotted on the IITK campus. As Kanpur continues its urban sprawl, IITK has become a solitary green oasis in the midst of a concrete jungle, and a bird watchers paradise.

Top – Sarus Cranes romancing along the Panki Canal, clicked by Peeusa Mitra (Research Scholar, BSBE).

Bottom – A Peacock spotted near the Faculty Residences on 36th Street. Shared by Navpreet Singh (Chief Engineer, IITK Computer Centre).

Back Cover: The Rajeev Motwani Building, home of the CSE Department, sketched by the Outreach Cell, IITK, using an image shared by Girish Pant (Information Cell, IITK)



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