# Research and Development

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## Introduction

Research at IIT Kanpur has always been given the pride of place, be it in the domain of teaching students or the professional goals of the faculty. Research, in this sense, has been intertwined with all curricular activities of students and the faculty alike. For students, the message that is conveyed is of research as a way of life. It is a strategy appropriate in all contexts – University, research laboratories, industry, or the corporate world. A research orientation that has permeated education at the Institute can be related to the adoption of engineering science as the basis of curriculum development. It is noteworthy that postgraduate programs at the Institute started at around the same time as the undergraduate, with graduate-level electives being offered to sophomore and junior level students. The culture of giving projects and term papers to supplement examinations can also be attributed to the research mindset of the faculty, almost since the inception of the Institute.

Truly speaking, research in the IIT system as a whole was envisaged by the Sarkar committee itself in 1944 when it said: *The teachers in these Institutes would be expected to do only so much teaching as would leave them sufficient leisure for research work for which they would be given reasonable facilities*. While creating IITs through an Act of Parliament, Prime Minister Jawaharlal Nehru stated his dreams in the following words: (IITs are established to) *provide scientists and technologists of the highest caliber who would engage in research, design, and development to help building the nation towards self-reliance in her technological needs*. IIT Kanpur learnt its lesson in true spirit from the founding fathers.

## Classification

How can research be initiated by an individual? The answer would probably run along the following lines: Identify a core theme, a question that needs to be resolved. The solution may provide intellectual satisfaction, may contribute fodder to an ongoing discussion, or may simply be of great utility. The process of finding answers to the question thus posed will require investment of time, effort, and resources. The fact that the individual needs to be suitably trained over a very long time frame and must possess sufficient motivation and excitement are not incidental to the discussion. Such a person enjoying the right ambience is ready to address unanswered questions. Most factors needed for research are internal to the individual. The most

visible external factor is financial support. It can be derived from the Institute budget; the expectation, however, is that research is conducted using external resources such as funding agencies, private companies, or philanthropic organizations. The advantage of external funding is that proposals are carefully reviewed and progress is closely monitored. Project monitoring gets increasingly stiffer as one moves from a government funding agency to a private charity organization. The former aims at manpower training and capacity building in areas where weaknesses exist. The latter delivers fruits of research to the society as quickly as possible. The term *sponsored research* has been applied to government funded projects while industry sponsored projects have been categorized as *consultancy*. A third category called *developmental* research was popular in the mid-eighties but has largely faded away.

The discussion on the real meaning of engineering research vis-à-vis scientific research has been held on occasion. IIT Kanpur, however, has not drawn boundaries between the two and engineering faculty publishing in science journals is considered appropriate. Yet, the IIT review committee of 1986 seeks to define engineering R&D as a guide with the quote of Lord Baker (1979) from the Working Party on Engineering Research in Britain:

> *Engineering research should be considered as the combination of new scientific discovery with the practical design and development of a real product or process of proven, or potentially likely, utility. Involvement of industry is essential at all stages of research, development, and design, whether it be done in the physics or materials laboratory as basic research or in an engineering laboratory or drawing office for product design and development.*

The absence of a clear purpose within engineering research has had its influence on the Institute profile. Achievements have been sporadic and divided over various domains. If a success story is to be told, it is closer to scholarly publications (as in Appendix IV) than innovations for the industry.

**Aspirations**

The Institute faculty conducts research with goals and objectives ranging from intellectual curiosity, addressing contemporary challenges, developing technology, or writing scholarly publications. The Institute gains immensely from these activities and in fact, thrives on faculty quest. The Institute standing in the world as one of repute and prestige rests squarely on its performance in the research domain. Consequently, the Institute has facilitated a healthy ambience for research – both in terms of infrastructure and scholastics.

IIT Kanpur has always had pride in the research contributions of its faculty and has said so, on many an occasion. The document entitled R&D Capabilities published in 1989 extols the outside world to approach its faculty in the following manner:

*If you have a project or a problem for which you would like another opinion, or would like to build a prototype, a device, we would be delighted to hear from you and put you in touch with the right person on the IITK faculty. ….. If you think that you need to sit down with someone who can help crystallize your idea, we will arrange for one of the faculty members to speak with you……. We are confident that, together, we shall be able to work out a solution to your problem which will be effective in terms of both cost and time.*

These words hold concisely the idea of our self as a research fraternity in tune with the expectations of the real world.

**Sponsored Research**

The first 25 years of the life of the Institute saw academic processes, namely courses, degrees, and teaching standards being established. These are now considered benchmarks around the world and contribute to the brand image of the Institute. The second 25 years can rightfully be considered the research phase wherein the process of seeking financial support outside the Institute has been set in motion.

The early years saw research funding stemming from Institute resources. The need for seeking external financial support was rarely felt, and if at all, for the purpose of getting set-ups fabricated or papers typed from external parties on a very short time-frame. Indeed, public funding agencies did not exist and private industry did not deem it necessary to consult academia for problem-solving or evolving vision for the future. However, exacting standards needed in science and technology drove up research costs, particularly instrument costs, and internal support was found to be inadequate. The era of sponsored research *via* extramural funding was thus introduced within the Institute. Historically, the science departments embarked on sponsored research in the 1970s with engineering departments following soon after. The attempt to create a bridge between scholarship and applications can be seen in the R&D booklet of 1984 created by the Dean, Dr. P. Dayaratnam where Professor S. Sampath, the then Director had the following comment to offer: *The urgent need is to strengthen the hands of academicians with the requisite motivation and to provide an arena in which interaction with the outside world of industry and society at large can be set in motion to find an answer to the question – "Is the work of the Institute so academic in character that its faculty members will be at a loss when*

*faced with the need to solve mundane problems?"* The importance of partnering the industry is now widely recognized and the above question would be answered quite to the satisfaction of the Director.

In contrast, the situation today is quite stark where faculty spends a majority of its time in writing and defending proposals, hiring staff, conducting time-bound research, and preparing reports and publications. Simultaneously, we see a concomitant growth in funding agencies willing to support cutting edge research. Participation of national organizations such as HAL, ISRO, and BARC in our research activity is on the rise. The private industry (national and international) seek faculty support in the form of consultancy services and testing.

Research as a theme has always been the center of attention at IIT Kanpur. Accordingly, positions of Deans first constituted were for faculty recruitment and research. The first Dean of Research & Development, Prof. H. K. Kesavan, was appointed in 1964. In fact, this was the first ever appointment of a Dean for Research anywhere in the IIT system. This was a time when external funding was practically non-existent and much of the necessary infrastructure was established from the mainstream funding of the Ministry equivalent of Human Resource Development (MHRD) and to some extent, from the Kanpur Indo-American Program (KIAP). During the mid-seventies, Government of India established the Department of Science and Technology (DST) as well as the Aeronautical Research & Development Board (AR&DB) and the Council of Scientific and Industrial Research (CSIR). This period heralded the era of sponsored projects at IIT Kanpur. By the late seventies, several government-based sponsoring agencies such as Board of Research in Nuclear Sciences (BRNS) and Department of Electronics (DOE) had been established. Umbrella organizations such as Defense Research and Development Organization (DRDO) introduced programs to provide financial support to the academia. In addition, funding was also possible from international agencies, in particular, the United Nations. For example, major funding was received from United Nations Development Program (UNDP) in 1985 to set up the Computer-Aided Design (CAD) laboratory at IIT Kanpur. The project pioneered the use of the CAD approach and tools in the Indian industry. The CAD project is primarily responsible for the spread of CAD awareness in Universities and engineering colleges around the country.

To develop a historical perspective on research itself on one hand and sponsored research on the other, it is important to understand the following development. In the early years after

independence, Universities and Institutes were the sole custodians of research. Industry put research in the back-burner while sustaining small development units within its organization. As an after effect of the liberalization policy of 1992, research has gripped research laboratories (since the year 2000 and beyond) and many new privately owned establishments have sprung up. The industry appreciates the need for research since it contributes to lower manufacturing and material costs, and possibly superior specifications. Thus, the situation in the year 2009 is that research is a widely distributed across the spectrum and academic organizations are no more than one of the players in the field. Now, more than ever, academicians have to innovate to make their presence felt and compete against a truly mighty competition that is blessed with better resources – money, manpower, as well as time.

The list of faculty who held the position of Dean: Research and Development over the years at IIT Kanpur is given in Appendix I. The list of sponsored projects received from funding agencies is given in Appendix II. The data is classified agency-wise and a separate column has been introduced for international projects. The list of consultancy projects received is given in Appendix III. A comparison of the quantum of funding per year shows that research grants and the number of projects have both increased significantly with time.

It should be mentioned here that a large number of students work on projects as well, thus contributing to a considerable project-related work force. The increase in the volume of project related activities is clearly visible in the form of increased publications, particularly in high quality journals. The list of publications emanating from IIT Kanpur is given in Appendix IV. Appendix V analyzes the publication trends across the Departments and reviews the quality of journals chosen by the faculty to show-case their research.

An encouraging development during the present decade is the significant increase in the number of industry sponsored projects. These include private companies, multinationals, and public sector organizations. Thus, projects have been sponsored by private companies such as TELCO and MicroSoft, multinationals such as Chevron, IBM, GE, and GM, and public sector undertakings such as BHEL and NTPC. Many of these projects are in the nature of consultancy with a budget that fetches financial rewards for the investigator but with an acutely confined time frame.

Till the end of the 1990s, most projects were narrow in scope with a modest budget. This picture has changed from 2000 onwards. During the period 2000-2008, several large projects

have been granted to the Institute. Examples are Media Lab Asia, Railway Technology Mission, and CFD software development from BARC. Short summaries of these major projects are presented in Appendix VI.

Another development in the last decade has been the creation of several Cells (example, Space Technology Cell, Railway Research Cell, HAL Research Cell) to coordinate and facilitate research from a broad cross-section of the faculty (Appendix VII). Equally noteworthy is the setting up of Centers that are inter-disciplinary units with faculty participation from across departments. Examples to be cited here are Samtel Centre for Display Technologies, Prabhu and Poonam Goel Centre for Computer and Internet Security, Center for Environmental Science and Engineering, and National Information Centre for Earthquake Engineering. The Institute boasts of over 20 centers at present; these are individually described in Appendix VIII.

No man is an island! The Institute is exposed to international trends in science and technology and the choice of research subjects is influenced by peer groups world-wide. Dominant winds to have swept the campus include information technology, bioengineering, and nanotechnology. Consequently, strong research programs and faculty formations have emerged in these topical areas.

**Consultancy**

Consultancy has held a distinct position vis-à-vis research in the following sense. It is an activity well-within the domain of expertise of the concerned faculty (or the group involved). Accordingly, the target of consultancy is, in a certain manner of speaking, guaranteed, when a certain amount of time and effort are invested in it. In contrast, sponsored research takes the faculty outside its comfort zone, into frontiers that are new and completely unexpected.

Consultancy services of the faculty are sought by the industry in diverse areas such as material selection, analyses of engineering processes, process development, software creation, and optimization of systems and processes, to name a few. In these situations, the industry provides financial support for equipment, staff salaries, cost of consumables, and honorarium for the faculty concerned. The prospect of additional emoluments is, of course, attractive and has been a source of motivation for accepting consultancy projects. Moreover, consultancy offers a glimpse into the working of the real world – its demands, timescales, expectations, and quality.

From the latter viewpoint, the Institute has encouraged faculty to practice consultancy so that it retains its cutting edge.

The importance of consultancy has been felt now for over three decades. A 1975 document of R&D lays out the procedures and policies for consultancy services. It clearly states that the proposal should originate from the industry concerned. The faculty is expected to estimate the time and cost required to accomplish the task.

The issue of the extent to which the faculty (indeed the academic staff) can augment its salary has been debated at great length. A document prepared by Dr. B.D. Agarwal, Dean R&D from 1988-1991 explicitly laid down the condition that consultancy earnings should not exceed 50% of the person's salary, when computed over a full year. It could reach 100% if approved by a specially constituted Director-level committee. The message here is that consultancy could very well interfere with research and teaching; checks and balances are necessary. At some point of time, these norms were relaxed and presently we do not have explicit limits on consultancy income. It is understood that faculty would have to balance its act in various domains. Laxity in any one direction would soon be exposed. The impact of peer pressure is indeed quite high.

Consultancy services in the domain of analysis, design, and software development have been the mainstay of this activity over the years. A list of consultancy projects accomplished at IIT Kanpur is presented in Appendix III. A survey of this data shows a sharp increase in the number of projects as well as the quantum of funding.

**Testing services**

The word refers to examining a component or a product against a standard. Examples could be testing the strength of concrete in a construction, compaction strength of soil, calibration of pressure gages, and chemical identification of unknown species. Testing is commonly accomplished in general-purpose laboratories and does not require elaborate preparation or data analysis. The staff of the Institute has been quite active in providing testing services to the neighboring industry of the Kanpur region. Testing is commonly accomplished in general-purpose laboratories and does not require elaborate preparation or data analysis. The 1975 document of the R&D office has clear guidelines on conducting testing in various laboratories of the Institute along with the mode and extent of payment. The Institute is not authorized to

undertake *certification* in any form. At best, one can say that, on a given day, with a given sample, a well-defined test yielded the following results.

**Employment on projects**

Sponsored projects have always been a source of employment at various levels. As practiced today, it includes employees in the category of daily wage workers, technicians, research staff, all the way to post-doctoral fellows. The Institute aspires to have the largest work force at the post-doctoral level but has not had overwhelming success on this front.

Historically, in the absence of an exclusive administrative support system, research related tasks used to be shared by the Institute employees. Till the mid-seventies, they would be remunerated for the additional work, though in an informal manner. Over a period of time, sponsored research entered the mainstream and the need for creating a separate cadre for project staff was felt. As a first step, technical and scientific staff was treated on par with CSIR employees. This model persisted till the mid-eighties but was found to be quite restrictive and alternatives were soon explored.

The first document to streamline project employment was prepared in 1989 by Professor B.D. Agarwal in which the required terminology was also introduced. Thus, terms such as project assistant, project mechanic, project associate, and project engineer were defined. The pay-scale in the form of a consolidated salary with yearly increments was specified. These salaries were loosely linked to scales provided by funding agencies as well as the scholarships received by the graduate students. The IT revolution of the early part of the present decade has resulted in sky-rocketing salaries and the demand for a flexible salary structure is more vocal than ever. In this context, the pay structure has been made flexible with a wide band subject to the conditionality that higher fellowships are paid to deserving candidates.

The document of 1989 classified staff as research, technical, ministerial, and helpers. In a visionary move, the document restricts the number of staff in the last three categories to 60 (sixty) for the entire Institute, irrespective of the number of projects. This number has the approval of the Board. In contrast, there is no limit on the number of research staff that can be hired on projects. Though a justification has not been spelt out for this policy, a clear indication of priorities is visible; the potential for possible complications arising from staff in the semi-skilled and unskilled cadres is also indicated.

It is noteworthy that initial appointments can be *ad hoc*; these are 3-month long engagements meant to cover emergencies in project work. It could be also be used to test a potential candidate. All subsequent hiring is *via* a selection committee. The 1989 document is clear on the importance of merit in research work and plays emphasis on the qualifications and the selection process.

In the year 1997, the option of work-assignment was created. Here, a person could be appointed for up to three months for a dedicated purpose without interviews or even a formal qualification. This flexibility was thought to become a facilitator for project activity. By the year 2007, the work-assignment route had become a channel for hiring casual labor dedicated to miscellaneous tasks such as cleaning and paper work. There is now a concerted effort to create contractors who can supply manpower to the Institute on demand.

With the creation of inter-disciplinary centers of excellence across the Institute and acquisition of expensive equipment, an issue facing the faculty is one of instrument operation, maintenance, and student training. To address these questions, a new cadre of research engineers was created in the year 2005. These engineers (and scientists) are appointed to certain centers on a contract basis for a period of three-to-five years. They write proposals and conduct research, over and above their regular duties at the Center. Projects secured by them serve to pay their salaries while the Institute gives them an opportunity and an ambience to function effectively with a great deal of productivity. Centers with large funding could utilize such research engineers entirely for their ongoing projects. Creation of these positions has helped in terms of keeping continuity in research activities while ensuring steady progress towards the project goals.

There can be considerable variation in the quality of staff employed on projects. There are certainly many success stories – at the level of technicians as well as engineers and scientists. There have been unexpected setbacks as well. Stories of employees leaving the project abruptly are not uncommon. The employment process requires the prospective research staff to give an undertaking on a stamp paper. Monthly salaries are released only on certification from the project investigator. The last month's salary is released only after all dues owed to the laboratory are fulfilled. These measures, introduced in 1989, add to the administrative load but enforce seriousness in the employment of candidates on projects.

In 2006, scaled positions were created for employment on projects. The idea was to give contract positions to persons with experience in a scale that would automatically protect their seniority. This model has succeeded in attracting qualified personnel to large, mission-mode projects over 3-5 years. Once again, in 2006, research engineer positions were created on terms independent of any ongoing projects, with the stipulation that the individual earns his own income from sponsored projects. It is akin to the position of a research professor in US Universities except that the interaction of the person thus appointed with the student body is rather limited. The experiment with this cadre, however, has not been as beneficial to the Institute.

**Committee for the acquisition of research equipment (CARE)**

A large number of major equipment have been procured by the faculty under this scheme, originally called CAME (Committee for the acquisition of major equipment) and named CARE in 1999. The funding for equipment and instruments has greatly been enhanced with agencies other than MHRD (DST, for example) providing financial support for research infrastructure.

Inadvertently, research funding for equipment has overlooked an important factor of maintenance and continuity in manpower. To address these issues, the current practice is to pay for 80% of the equipment cost from the Institute and 20% from ongoing projects of the individual or the group. This strategy has worked well in the sense that equipment is put to good use over its lifetime.

The research activities of IIT Kanpur have been facilitated by large funding to different departments under the Funds for Infrastructure development of Science and Technology (FIST) scheme of DST. In the last few years, many state-of-the-art equipment such as the Transmission Electron Microscope (TEM) as well as many similar multi-user facilities have been installed at IIT Kanpur. For a longer list (year wise), see section on Unique equipment later in this document. The installation of such facilities has encouraged interdisciplinary cutting edge research among very distinct departments. The change is so fundamental that inter-disciplinary may well become the character of the Institute, differentiating it from other IITs and educational institutions.

Regarding research being done across disciplines, a word is in order. The Institute was truly set-up with a vision of cross-disciplinary education. The committee report of 1973

recommends that *all future research programs should be evolved on an inter-disciplinary and inter-departmental basis*. Some examples quoted are Nuclear Engineering, Computer Science and Engineering, and Materials Science, topics that continue to be at the forefront. The Faculty Building, the center-piece of the Institute is a testament to this belief that creativity stems from cross-talk. Originally, rooms in faculty building were allotted in such a way as to produce a mix of individuals with diverse thinking and specialization. The crystallization of Departments was a latter-day phenomenon when laboratory facilities had to be created for each discipline and had to be responsibly managed as well. With the appearance of central facilities and high-value equipment, a re-grouping is most evident. We may as well be returning to our roots!

**Infrastructure**

Sophisticated instruments require extreme control over temperature, dust, and humidity. This requirement was less critical in the mid-eighties where the only laboratory to be carefully air-conditioned was the Computer Center. Indeed, one saw a peculiar situation wherein students would opt for computational work simply to beat the heat and sit in air-conditioned computer laboratories. The design of the computer center in the early 1990s for air-conditioning was quite intricate and required formal engineering calculations. The first ever cluster of HP mainframes was placed here; this layout continues to be use till date.

The power crisis of the mid-nineties delayed large-scale air-conditioning to some extent, but the project culture had already resulted in the acquisition of sophisticated equipment. By the end of the 1990s, a laboratory was expected to have new electrical wiring with true earth, polyvinyl chloride (or tiled) floors, window, central or split air-conditioners, false roofs, false floors (to conceal wiring and guide cool air, particularly in the context of computers), and an enclosure. The first decade of the present century has seen a demand for clean rooms of various specifications with precision air-conditioners maintaining temperatures to within a fraction of temperature unit. It is unthinkable that a laboratory would operate without uninterrupted power supplies (UPS), and more generally, gen-sets. The desirable has become an essential over a matter of 10-15 years. The implication would be clearly in terms of cost; the availability of energy in terms of electricity and trained manpower would have to be ensured. Modern laboratories in the Institute thus require significant planning.

It is a healthy development that architects and contractors are now responsive to the construction of research laboratories. The Samtel Center could install by 2005, the first **clean room** for electronics fabrication. The building assigned to Biosciences and Bioengineering has underground cold water storage for supplementing the main air conditioning system. The design has not worked well, mainly due to inadequate control of humidity, but the effort and the thought process is transparent. The Environmental Sciences and Engineering building, inaugurated in January 2008 has a 5-star TERI-GRIHA rating for ecological sensitivity, right from the construction phase all the way to its full occupancy.

The need to balance the demands of sophisticated equipment against social consciousness such as energy conservation and damage will be the planning paradigm, at least for the coming decade.

**Publications**

The Institute signed a memorandum of agreement in 1993 with Narosa Publishing House, New Delhi for publication of monographs under the *IIT Kanpur Series of Advanced Texts*. The idea was to bring faculty from across the Institute and compile research-level texts for students. Books published under this agreement are Computational Fluid Flow and Heat Transfer (1995, 2003), Modeling of Complex Systems (1997), and Turbulent Flows: Fundamentals, Experiments, and Modeling (2002).

The Institute has not regularly printed a newsletter to report its academic and research activities. In the last decade, a publication by name *Directions* has emerged as the frontline publication of the Institute. It is further driven by the proceedings of REACH, the annual IIT Kanpur symposium initiated in 2007.

Quoting from the REACH-08 website, we have: *IIT Kanpur has initiated an annual symposium to showcase the ongoing research on campus and promote interdisciplinary research and interaction amongst faculty, students, and research staff of the Institute. The series is named* IITK REACH (REsearch And CHallenges) Symposium*. Each year, the focus is on a few major themes of research in the Institute. Faculty working in these areas are invited to speak on their work in a way that is intelligible to a general audience. In addition, some students and distinguished external researchers are also invited. Each theme has one or two coordinators who organize the session and choose the speakers. The*

*participants of the symposium are faculty and students of the Institute identified by the Advisory and Organizing Committees.*

Since January 2008, students have embarked on a research and development newsletter called *NERD*. Despite a curious title, the publication has evinced interest and students have shown enthusiasm towards preparing original articles, distinct from faculty research already in progress. This independence in the thought process is important and must be nurtured.

**Pure research**

IIT Kanpur has a credible record of original research in domains stemming from analysis. Indeed, mathematical analysis of engineering and scientific problems has been its hallmark over the decades. The outcrop of computer science education at IIT Kanpur in the late 1960s can be linked to an analytical framework that has dominated the thinking of its faculty. Offshoots of this style have led to significant research in applied mechanics, algorithms, modeling and simulation, image processing, numerical techniques, and computational fluid dynamics. Historically, the delicate situation prevailing on the electrical power front has posed a major challenge for sustaining large-scale experiments on one hand and very sophisticated characterization tools on the other. The stabilization of the infrastructure in the campus after the year 2000 has seen acquisition of very sophisticated measurement systems across the Institute. Strong winds of experiments are now felt everywhere and a paradigm shift is clearly in place. It is noteworthy that computer technologies have undergone their own sweet revolution and the Institute, since 2005, sees a steady stream of high-performance clusters being acquired all around.

Bucking the trend, small groups of faculty have pursued laboratory experiments as a goal of research and have found small success. Yet another dimension is technology and product development in a purely industry framework and a few examples of this nature can be readily quoted.

Yet, a word of caution is in order. Recalling an editorial in Nature (1928), the Nayudamma committee (1980) emphatically stated the following: *The precise extent to which research workers are wasting energy in repeating experiments that have already been made is difficult to estimate ……. It is indeed more than possible that half the energy expended in experimental research is dissipated in useless repetition*. Further, the committee provocatively argues that *A good amount of research in the country is without review and accountability*. Have

we clearly risen above these concerns? The increase in the number of publications in recent years shows that we have improved our productivity. Yet, a quantitative assessment remains to be carried out. A decade-and-a-half later, The Biswas - Sathyamurthy committee had the following comment to offer (1995): *In spite of the excellence achieved by the faculty in individual research, IITK has made little impact in the minds of our policy makers with its research output.* On industrial collaboration, the committee states …``*precious little has been achieved*." These are strong words indeed. Our interaction in 2008 with defense and strategic research laboratories remains at the lowest possible ebb. Yet, the remarkable record of publications and sponsored projects after 2000 yields hope that we would indeed be at the forefront of research as extolled by our friends and well-wishers.

**Technology development**

In the framework of sponsored research, technology development has been conducted via missions (TDM) financially supported by MHRD. Technologies have also emerged from student-led projects at the undergraduate and graduate levels. Certain consultancy projects have been in the form of technology development. While the number of technologies developed has generally been small, a spurt in industry-specific software can be seen in the 1990s.

Three Technology Development Missions were sanctioned by MHRD in the year 1993 for a period of five years. These missions were respectively entitled Integrated Design and Computer Manufacturing, New Materials, and Communication Networking and Intelligent Automation. Several sub-projects were conducted under the umbrella of these missions. Specifically, sub-missions in IDCM included shape technology, CIM technology, low cost light car, switchgear mechanism, FHP motor performance, and process simulator. The sub-missions in New Materials were polymer composites, metal matrix composites, ceramic powder and sensors, magnetic materials, and ceramic matrix composites. In CMIA, the aim was to use electronics and information technologies to solve problems related to power transmission and distribution. The Ministry offered a four-fold augmentation to the money raised by the investigator from the industry. One of the most successful projects in this respect was on *Rapid Prototyping and Engineering Analysis of Products* that could raise an amount of over Rs 1.5 crores in 1996, a huge amount by the standards of that era. A second notable project under communication

networking has led to a magnificent improvement in the electrical grid after 1996 in the northern region of the country

A recent technology mission, granted in the year 2004 for a total cost of Rs 24 crores, concerns railway safety where financial support stem from the Ministry of Railways (30%), MHRD (50%) and the rest from the industry. A large number of technologies have emerged from this effort. Satellite Imaging for Rail Navigation (SIMRAN) is a project to disseminate train information dynamically in a given geographical boundary in terms of location, speed and direction of movement. The train tracking system uses the Global Positioning System (GPS). Each train has a locator unit to receive information from GPS satellites and continuously identify the position of the train. Highly appreciated by railway authorities and hailed by the media (see newspaper reports of 2007), the project will ultimately revolutionize rail safety. Other technologies include improved metallurgy for railway tracks, wheels and axles, corrosion resistance of railway tracks, rail-flaw detection, an eco-friendly toilet, and sensor development for condition monitoring of wheels and bogies.

A collection of technologies developed at the Institute over the years is summarized in Appendix IX.

**Technology transfer**

A survey carried out in the late 1990s showed that the faculty and research staff had developed products suitable for the industry. Many of them were classified as being in the 'final stage of development', with a few having the reached the 'fully developed' stage. In recent years, the number of patents filed (mostly Indian, but a few international as well) has sharply gone up. However, not many technologies developed here have been commercialized. Occasional instances of exaggerated claims have also been encountered. The excellence achieved by the faculty in research is yet to be matched by its share of technology transfer to the industry.

To fully exploit the technologies developed at IIT Kanpur, the SIDBI Innovation and Incubation Centre (SIIC) was established in 1999. The faculty entrepreneurship policy of IIT Kanpur was approved by the BOG in June 2008. This document lays the methodology for faculty to start companies based on their research ideas and concomitant products, processes and spin-offs. Particularly, in this decade, IIT faculty has become aware of the patenting issues and the number of patents filed/issued has increased from 3 in 2000, 6 in 2005, to 48 in 2008.

**Technology and research parks**

The IIT Review committee in 1986 recommended that steps be taken to *harness the considerable intellectual and infrastructural resources of IITs to meet societal needs.* The committee explicitly stated that the faculty salaries were meant for teaching and research while the possibility of augmenting one's salary through consultancy for the industry was permitted – in fact, to be encouraged. Knowing the penchant of the industry for international technologies and reluctance for in-house research, the committee suggested that IITs create space wherein its faculty could liaise with the industry on a real cost and real time basis. Simultaneously, the possibility of conducting industry-centric research within the IIT campus was envisioned by Dr. N.C. Nigam in the mid-eighties. The goal was to create an administrative framework that would be considerably liberal when compared to the government, thus inspiring growth at an invigorating pace. Explicitly stated, it sought to combine the innovation available in an academic environment with salaries obtained in the industry, indeed a potent combination. The idea, though germinated at IIT Kanpur, has taken roots at IIT Delhi (as FITT - Foundation of Innovation and Technology Transfer) since 1988. Other models such as STEP (Science and Technology Park) at IIT Kharagpur and RDP (Research and Development Park) at IIT Madras and Kanpur were planned. IIT Madras has implemented such as park outside its campus since 2007 while IIT Kanpur itself has adopted an independent approach in this matter. An alternative, the SIDBI Innovation and Incubation Center (SIIC, since 1999) nurtures small laboratory scale ideas till they fructify and become sustainable in the marketplace. The foundations cited above have become financially self-sufficient and indicate that they have fulfilled their promise.

Themes common to these units are distinct from scholarly research, the emphasis resting on product development, industry-related consultancy, testing and calibration, entrepreneurship development, information systems, and creating summer opportunities program.

**Self-financing courses**

In order to encourage awareness as well as to provide exposure to state-of-art subjects in diverse areas of science and technology, the academic staff of the Institute offers courses for faculty members of various NITs, Government Engineering colleges, private colleges, researchers from National R&D Laboratories as well as professionals from private industries. The courses for participants belonging to first and the second categories are offered under the Quality

Improvement Program. The participants belonging to industry pay a registration fee to participate in such courses. Courses last for a week to two weeks and can be intense experience.

A list of courses falling in the category called *self-financing* is provided in the Appendix X. A survey of these courses shows that the faculty has succeeded in addressing topical as well as unusual subjects in the domain of science and engineering. Such courses have helped build material for graduate-level texts as well as research monographs.

**Overheads**

In order to run the activities at R & D office, the sponsored research projects are expected to contribute 20% of the project amount as overhead expenses to the institute. For very large projects of more than Rs. 50 lakhs, a maximum of Rs. 5 lakhs is allowed by major funding agencies for overhead expenses. Such expenses are utilized for various purposes: a) contingency expenses in keeping all records at R & D office, b) salaries of temporary staff. Funding from several agencies come with zero overheads. A survey of project funding listed in Appendix II shows that overheads received have hovered around 2-5% in every decade. With cost of infrastructure and running costs ultimately resulting in an electricity bill on the rise, this fraction of receipts is clearly unacceptable. Overall, the overhead expenses need to be increased to ensure smooth functioning of research in the Institute.

**DPA and PDA**

To encourage faculty obtain external funding, the Department Promotion Account (DPA) and the Professional Development Account (PDA) were instituted in 1993. As a part of the policy, a certain fraction of the project overheads due to the Institute were transferred to the Department account and that of the investigator. Heads of Departments operate DPAs while PDAs are utilized by the project investigator for miscellaneous expenses within the professional domain. IIT Kanpur is a pioneer in the creation of these accounts which understandably gives impetus to sponsored research activities in the Institute. A few but not all IITs have created this mechanism within their domain but the proposal has been uniformly appreciated.

**Project Fund Management**

IITs in general, and IIT Kanpur in particular, were hit by a financial crisis in the early 1990s following years of restrictive financial policies at the national level. The impact of liberalization (set in motion in 1992) was as yet unclear. In this period, funding agencies would trim proposed budgets, often unrealistically, to the detriment of the project objectives. Funding was not assured and continuity of research could not be maintained. Under these circumstances, it became clear that the Institute should be self-reliant and have control over its finances with a provision to generate money on its own. It was felt that the simplest strategy would be to create a *corpus*, an amount arising from the various project-related grants received by the Institute. The corpus could be suitably invested and the earnings could be a source of income.

It was noticed that project funds showed fluctuations but above a threshold value. It was thus felt that an amount below the threshold could be placed in bank instruments such as fixed deposits to earn a higher interest rate. This aspect was examined by Professor A. K. Mittal during his Deanship in the early 1990s.

A document on the creation of a corpus fund of the Institute (dated 1995) explains the importance of financial independence of IITs vis-à-vis performance and output of an institute of national importance such as an IIT. It outlines various possibilities for generating wealth from talents and resources available within. Some of these include technology transfer, raising project overheads, selling off unserviceable land, increasing students' fees, and admission of international students to the academic programs at international rates. The most successful step has been the creation of a permanent endowment from donations received from industrial houses and alumni working around the world. This factor has been most significant, with receipts soaring in the past three years.

The availability of extra resources with the Institute means that projects can be launched even when money has not been received from the funding agency. It could be used for emergency purchases as well as for payment of staff salaries. Careful management of project monies with complete professionalism is one of the success stories of the Institute from which faculty research has derived great benefits.

The availability of additional financial resources at the Institute level has generated a debate of its own. Faculty adopting a hard academic posture has questioned the value of money not earned through hard work. Younger faculty, however, see an opportunity to buy major

equipment that would help us perform at the international level. In turn, faculty formations organized into groups have emerged with the promise that would put the equipment to continuous use. The availability of money within the institute has, in fact, led to interdisciplinary research with participation of faculty across Departments.

**Office of Research and Development**

In the early years, research grants were integrated with those of the Institute and separate accounts were not maintained. In fact, till the early 1980s, Dean R&D used to help the Institute in terms of budget preparation, monitoring of the expenditure and financial liaison with MHRD, and presentation of the budget proposal of the Institute in the Finance Committee. A stand-alone R&D office came into existence in 1971, though manned by just four staff members. Still, there was no separate account for project funds. The creation by Professor T.R. Viswanathan of an absolutely independent account (called Account II) in 1979 (and strengthened later by Professor R.N. Biswas in 1987) for managing project funds was a major development in streamlining and facilitating the execution of projects. At that time, several audit objections were raised regarding this new account. The Institute was able to convince external auditors on the necessity of having and operating a separate account independent of the finances received from MHRD. Today, the R&D office has a staff of around 20. It maintains individual accounts of over 200 projects at any given time, processes papers related to purchase, travel, appointment, and salaries. The number of persons employed on projects exceeds 500.

The creation of Account II at IIT Kanpur in the year 1979 and reinforced in 1987 has been truly revolutionary. It has been so pioneering that every IIT in the country has adopted the model for operating projects. Account II sends out a message that project activities are in a *mission-mode* and hence, time constrained. At this time, cash transactions have practically been minimized, a viewpoint clearly advocated by the Biswas-Sathyamurthy committee of 1995. Procedural niceties are often waived in favor of a decision that facilitates project work. The staff of R&D office functions with the adage that time is precious. It is noteworthy that administrative reforms at IIT Kanpur pre-date those of the country by half-a-decade.

The number of sponsored research projects increased dramatically in the 1980s resulting in an increase in the number of project employees. The Institute then thought it was prudent to increase the size of the R&D office. An important development in 1989, once again during the

tenure of Professor R.N. Biswas was the creation of cadre of quasi-permanent employees. These employees of R&D office are not permanent in the sense that the appointments do not stem from government-sanctioned positions. Instead, they are on a government authorized pay-scale and are paid from R&D funds. The security thus obtained to the staff is crucial for the efficient running of projects. Staff in this category has significantly contributed to the success of the project culture in the Institute.

*News alert*: The 6th pay commission (2009) has enhanced salaries to such an extent that R&D funds will be deeply impacted by this revision!

**Office automation**

Office automation is another major factor that has contributed to the growth of project culture within the Institute. It refers to computerization of all accounts, receipts, and transactions along with complete transparency. Indeed, project accounts can be viewed at any time by the investigator through the Institute website. Though manual as well as computer accounts are maintained by the office, it is targeted that all accounting would be computer-based in the near future and ledgers would be completely eliminated. The role played by office automation in maintaining transparency in all financial operations in projects should be suitably highlighted.

Realizing that expenses in projects are required to follow certain norms, not indistinct from government rules, but with careful flexibility, the need for norms and guidelines was felt. Such norms for project execution were gradually put in place. The first booklet for sponsored and consultancy projects was printed in 1990 and carried details of guidelines in project appointment, purchase, salaries and travel. These have been enshrined in various forms and are available in the Institute website. Rules and regulations of project management are constantly in a state of evolution so that efficiency and accuracy are balanced against accountability and fair practice. Via automation, the office of R&D follows exacting standards, drawn from a culture of focused time-bound research and hard expenditure.

The issue of norms for salaries paid to project employees has been at the center of a never-ending debate. Opinion is equally divided among three directions: payment at market rates, payment in proportion to institute wages, and payment scaled with respect to the student scholarship. Additional conditionality is imposed by the funding agencies that enforce their own norms for salary payment. The current practice is to provide a broad enough band, within which

investigators would be able to place their employees in as comfortable a manner as possible. A nomenclature designed for project employees in the year 1989 continues to be in use today. It involves prefixing ordinary terms such as scientist and engineer with the term project, thus creating a unique brand of positions such as *project scientist* and *project engineer*.

**Institute Research and Development Committee**

Such a committee has been in place, though informally, for the past five years. In the year 2007, it was found expedient to constitute the Institute Research and Development Committee (IRDC) with Board approved mandate and responsibilities. It has representation from all Departments and inter-disciplinary programs. The body has become a useful entity to discuss policy issues and the Institute receives the first level feedback from the faculty. Its members highlight shortcomings in procedural matters and thus sharpen the performance of the R&D office. Furthermore, IRDC identifies frontier areas of research that the Institute should participate in. Such input is vital as a source of guidance when decisions related to financial support for research are to be taken. The IRDC membership participates actively in discussions related to performance of Centers. Some of its suggestions, for example, post-graduate admissions for project employees have been embraced (though in a modified form) by the Institute.

**Large and Mission-mode Projects**

There were not too many industry sponsored projects in the mid-1980s. Initiated in 1991, Government of India identified seven areas in which projects would be conducted across IITs in a coordinated manner. These projects, known as Technology Development Missions (TDM) encouraged cooperation between industry and academia. They are one of the few to attempt inter-institutional collaboration across the IIT system. Each mission, starting from 1993, was of five year duration. IIT Kanpur participated in three of these: (a) Communication, Networking and Intelligent Automation, (b) Integrated Design and Competitive Manufacturing, and (c) New Materials (also see Section on *Technology Development*). The developmental work in both these projects was very well appreciated by the industry. Automation research has actually contributed to better distribution of electricity within and around the Institute. The second mission has helped in establishing the rapid prototyping, rapid tooling, and reverse engineering activities at IIT

Kanpur. In this respect, TDMs have greatly succeeded in infusing society and technology-relevant research at the Institute.

Setting up of the National Wind Tunnel Facility was a major R&D effort undertaken during the period 1990 to 1996, when it was inaugurated. The funding for this national facility was provided principally by ARDB and DST and partly from Institute funds. The facility was conceived and implemented by Professor N.L. Arora. Considering that it was the first one of its kind within our campus and the level of utilization it has gained over the years, the creation of NWTF can be noted as a benchmark in the academic world of the country. The wind tunnel facility is one of its kind in India and, at this point of writing, is heavily used by various organizations from all over the country.

A document prepared by the R&D office in the year 1984 lists the following subjects as potential thrust areas of the Institute cutting across Departments: Fiber reinforced composites, Laser systems, Computer aided design, Environmental engineering, Material sciences, Microprocessor-based instrumentation, Robotics, Transportation engineering, and water resources. The document clearly mentions that the selection of topics is dynamic and will evolve with time. The thrust areas identified for the present decade, namely energy, environment, communication, computer simulation, materials, and bioengineering shows that the evolution has indeed taken place.

The number of funding agencies and the number of projects continued to increase in the 1990s. Owing to the severe resource crunch in the government just ahead of the liberalization era, faculty members sought funds from external agencies for sustaining their research. This period will be recalled for electricity shortages as well as convoluted bureaucracy and excessive import constraints. Research truly could breathe fresh air with the dawn of economic liberalization in the country.

**International projects**

The early years till the late 1970s saw faculty traveling abroad in summer time for conducting research, mainly experiments. The eighties (and the subsequent decades) saw the first phase of research infrastructure come up within the campus, and with it, the culture of staying at the Institute for conducting research. In the last five years, the scale of research is heightened and a prominent development is discerned. One can see international students and faculty spending a

considerable time on campus for discussions, computations, and experiments. This has been possible because of bilateral projects on an international level. Such projects, supported indirectly by the Government of India, provide for financial support to bring international researchers to IIT Kanpur.

i) **Bilateral basis via DST:** International Cooperation Division of Department of Science and Technology has initiated a major move to enter into bilateral R&D agreement with both developed and developing nations. Consequently, IIT Kanpur faculty members have been successful in getting projects with various countries such as USA, Switzerland, Italy, Germany, Slovenia, and Spain.

ii) **Projects through major bilateral funding sources**: Some funding agencies sponsor international projects involving multiple partners from India and a foreign country. One such agency is the UK-India Education and Research Initiative (**UKIERI**) which aims at substantially improving long-term research and educational collaboration between India and UK. UKIERI was announced by the Prime Minister Tony Blair during his visit to India in September 2005 along with Prime Minister Manmohan Singh and launched by the respective agencies in April 2006. IIT Kanpur faculty obtained research funding under UKIERI in the areas of Biomaterials, Tissue Engineering, Himalayan ecosystem, and Nanotechnology.

Funding to promote scientific cooperation between India (Department of Science and Technology) and France (Ministry of Foreign Affairs) is provided by the Indo-French Centre for the Promotion of Advanced Research (**IFCAPAR**) which has been functional since 1987. The idea came up first during a discussion between the Indian Prime Minister, Smt. Indira Gandhi and the French President Mr. Valery Giscard d'Estaing. The first Indo-French collaborative research project at IIT Kanpur was received by Ashutosh Sharma in the area of Polymer Science.

As a source of bilateral funding, the Indo-U.S. Science and Technology Forum (**IUSSTF**) was established in 2000 under an agreement between the Governments of India and United States of America with a mandate to promote, catalyze and nurture bilateral collaboration in cutting edge research areas of science, technology, engineering and biomedical research through substantive interaction amongst government, academia and industry. One of the principal activities of IUSSTF is to fund Indo-US Joint Centers. In 2006, the first center on Manufacturing was established at IIT Kanpur by Professor Amitabha Ghosh. This center has now entered the

second phase with a focus on *Fabrionics*. Lately, IUSSTF has funded two more centers: Biomaterials for Health Care to be coordinated by Dr. Bikrmajit Basu and Microwave Sintering of Materials to be coordinated by Dr. Anish Upadhyay. The center for Biomaterials is considered to be the largest of all such centers funded by IUSSTF.

iii) **Major international funding agency:** Private funding agencies are often registered as charitable organizations, Bill and Melinda Gates Foundation, for example. One other is the Wellcome Trust, an independent charity organization based in UK and established in 1936, with an endowment of around £15 billion. It is UK's largest non-governmental source of funds for biomedical research. In 2006, Wellcome trust awarded three fellowships to our faculty in the areas of biological sciences and quantum computing.

Memoranda of understanding signed with various organizations around the world for collaborative research is summarized in Appendix XI.

**High level summer consultancy**

The scheme envisages that the IIT faculty would spend time in the industry, research laboratory, or an engineering organization during the summer (or winter) months when classes are not in progress. The hosting unit is expected to compensate the faculty for the cost of travel as well as living expenses. Faculty is deemed to be on duty for this period and no special leave is to be sought from the Institute.

Starting as early as 1967 as *High Level Summer Industrial Opportunities Program*, this scheme has been quite popular among the faculty till the mid-nineties. It has not found favor in the present decade where the trend is to seek international assignments. The 1974 document clearly spells out the raison d'aitre for the program: (a) To bring to the participating organization a fresh approach to specific problems based on fundamental analyses rather than experience or past practice in a manner that leverages the faculty strength; (b) To bring to the participating faculty an immediate and relevant practical knowledge of engineering, thus contributing to its own teaching and research.

Faculty has utilized this opportunity to visit defense organizations such as DRDL and ANURAG, private companies such as HLL, TISCO, INFOSYS and GM, and research organizations such as BARC.

**Housing**

To house the ever increasing number of project employees, the first Research Associates (RA) hostel was constructed in the year 1997. The second RA hostel with studio-type rooms inclusive of a kitchenette and bathroom came up in 2002. Today, over 120 project employees stay in its premises. There are plans to construct an RA hostel campus to house at total of 400 employees who work exclusively on projects. The Institute has a policy of housing the scientific and research staff but not technicians and others, such as those on daily wages.

**Intellectual Property Rights**

The world now looks at knowledge as a commodity with a price attached to it. Consequently, we are now aware of patenting issues and intellectual property rights. The R&D office now checks memoranda of understanding signed with third parties (distinct from the government) and non-disclosure agreements. The number of patents filed/issued has greatly increased (Appendix X). The IPR document of IIT Kanpur was formulated and approved by the BOG in the year 1999. To fully exploit the ideas and patents internally generated, the SIDBI Innovation and Incubation Center (SIIC) was established in the year 1999 along the lines of the *entrepreneurship cell,* already available at the Institute. The center supports companies created by the faculty, staff, and students of the Institute. It is hoped that in the coming years, the royalty charges from patents will become a significant source of revenue for IIT Kanpur.

**Institute lecture series**

The series was initiated in 1993 as an avenue to invite scholars who could talk to the campus community on subjects of broad interest. Five-to-six such seminars are held each year. Apart from specialist researchers in their respective domains, eminent historians, policy makers, technologists, and leading thinkers have presented their ideas. Distinguished speakers of the past include Dr V.K. Atre (2001), Mr Prahlada (2002), Mr. N.R. Narayanamurthy (2002), Mr. R. Gopalakrishnan (2002), Professor Lalji Singh (2004), and Dr Harsh Gupta (2004). Recently, luminaries such as Professor Herbert Hui of Cornell University (2007), R. Narasimhan (2008) of TIFR and Paul Craddock of the British Museum (2009) have spoken under the aegis of the Institute Lecture.

**Information Cell**

Keeping in mind the need to project the strengths of the Institute in a highly competitive world, an Information Cell was created in December 1998. The Cell maintains relevant technical information of the Institute in a computerized form, most of it being accessible through the web page. An extensive collection of important and frequently used forms have been assembled in the downloadable format. Other activities of the Cell include bringing out yearly brochures on research activities, preparation of magazine and management of the Desktop Publishing Cell for printing official documents of the Institute including the Convocation material. The Cell projects the accomplishments of the faculty, staff and students and specialized skills and facilities available within the Institute. Information Cell also provides additional services in the form of expertise in creating web pages, posters and brochures for corporate activity across the Institute. Information Cell launched the first webpage of the Institute in the year 1999.

The Institute magazine Directions is published by this cell. Staring off as a newsletter, the magazine is presently seen (since 2006) as a quarterly scientific publication that includes the proceedings of the REACH symposium series.

**Student participation in research**

It is a given that research of the faculty is principally conducted with the assistance of graduate students – master's and doctoral. In the early years, the size of student body in the graduate program was relatively small. Faculty research was not as intense and some of it could be carried out in other research organizations – national and international. Increase in research in general, sponsored research in particular has been concomitant with increase in the size of the graduate student population. Simultaneous increase in the number of project employees has also been observed. The current decade, thus, enjoys the largest number of sponsored projects as well as a significant population of graduate students – happily many in the doctoral program,

Apart from graduate programs, a key feature of the undergraduate studies at IIT Kanpur has been the involvement of B.Tech. and M.Sc. students in research projects. The most common form of this participation is the work on undergraduate projects in the final year of the curriculum, be it a B.Tech., integrated M.Sc. or a 2-year M.Sc. program. The project could be in the nature of scholastic research, product design, or technology development. The usefulness and effectiveness of these thesis/projects have made them an integral part of the undergraduate

course curricula. Often, such projects provide an opportunity to perform basic research or create a product that reflects one's own interest, orientation and also commitment. This participation in undergraduate thesis projects not only gives them a first-hand experience in quality research, it also helps to determine a student's attitude and motivation toward having a research career in the future. IIT Kanpur can be proud of the fact that a large number of its undergraduate students have opted for an academic career; indeed many have returned to their roots to join the IIT system.

Each student is assigned a well-defined research problem generally executable in a period of one or two semesters. On many occasions, quality publications have come out of such undergraduate research projects. The success of this undergraduate thesis program has demonstrated that, with proper instructions and guidance, undergraduate students can effectively participate in research work. In fact, such activities have provided a unique learning experience for the students and have also greatly helped them in the pursuance of graduate research activities right after their undergraduate studies. Another form of (undergraduate) student participation in research is serving as a part-time research assistant where a student can devote up to a certain number of hours every week working with a faculty member in an existing project. Students get valuable training on how to conduct research from such experiences and also they get a chance to work closely with a faculty member and other members of a research team.

The year 2008 has been a watershed in the context of student-led initiatives. The year saw the launch of the *nanosatellite* project. Nanosatellites are as efficient in discharging their duties as their larger counterparts. Space researchers have been stressing the point that microsystems technology and microelectronics can draw great advantages from pre-qualification in a real space environment. To be launched in 2009 by ISRO, the nanosatellite will have body mounted solar panels, communication systems and on-board cameras. The nanosatellite will be used for experimental communication and earth observation applications.

**Provocative issues**

a) Employees

There is really no upper limit to the total tenure of a project employee at present. There are people, numbering over 50, who have remained appointed in projects over 10-15 years by

switching from one project to the other. This matter has been looked at from both legal and professional view points. Legally, the Institute is safe-guarded because the temporary nature of employment is clearly mentioned in the offer letter and the concerned person agrees to the terms of employment in a stamp paper.

Professionally speaking, there is an opinion that by continuing with the same person over many years and projects, probably the best talents are not properly identified. Thus, a subcommittee of IRDC has recommended in early 2009 that employment of an individual should be critically reviewed after six years and every three years, thereafter.

b) Work assignment

Work-assignment as a channel of appointment was introduced around 1999. The idea was to employ individuals on an emergency basis to accomplish certain project-related tasks of great urgency. Such employments do not require an appointment letter of the Institute. They are meant to be a one-time affair of three month duration.

It has been observed over the last one decade that a large number of persons are recruited through the work assignment mode to perform tasks that are of non-technical nature. In addition, the appointment is continued for several years together. We have received legal opinion that such appointments are not tenable in a court of law and must be immediately dispensed with.

c) Right to information act

This act passed in the year 2007 seeks transparency in all government operations including financial transactions, appointments and policy matters. The R&D office has been greatly burdened by the RTI act mainly due to a large number of spurious petitions received in which data over several years is asked for. On occasion, research findings by some of its research staff have also been questioned. The R&D office needs to be carefully organized to deal with this development.

d) Court cases

R&D employees have filed a few court cases, mainly in the context of seeking appointments in the regular cadre of the Institute. In view of clear employment conditions

stated in the appointment letter, it has been possible to satisfy the honorable court that the person has been given a fair deal. However, the pressure to employ non-technical staff in various projects is on the rise.

**Review of research at IIT Kanpur**

We give a glimpse, admittedly limited, of research highlights in various Departments over the past several decades.

*Aerospace Engineering:* Established in 1964, the Department contributed enormously in the areas of aerodynamic testing, in-flight laboratory work, helicopter dynamics, space dynamics, missile guidance, computation fluid dynamics, flight mechanics, and propulsion. Some of the notable achievement is the construction of transonic tunnel in 1970s, which enables the study of wind loads acting on critical structures under varying speeds of subsonic/ transonic/supersonic level. In the 1990s, the establishment and its continuous running of National Wind Tunnel Facility (NWTF) is another success story. NWTF enables the investigation of wind loads on large structures. A number of faculty members of developed some useful analytical/computational tools, which has helped in some mission oriented projects (e.g. GSLV Mach III) of ISRO and DRDO. In the last decade since 2000, research activity in the area of helicopter technology has been initiated.

*Biological Sciences and Bioengineering*: The Department is involved in basic and applied biology research using both experimental and computational techniques. In its brief history, results from several cutting edge research projects in the department have already made an impact at the national and international level. Recently, antagonistic functions of protein variants coded by a gene involved in Lafora disease, a fatal form of neurodegerative disorder has been discovered. Using a model organism, two new proteins have been identified that contribute to germ cell development. The role of tumor suppressor protein in cell-cell adhesion has been established in another model organism. In plant research, using RNAi technology, nematode-resistant plants have been generated which is expected to make a huge impact in the agricultural output. Computer simulations elucidated the specificity of a cancer protein that could help in designing potent anti-cancer drugs. Using structural biology and biochemical techniques,

novel mechanistic difference in proteins important for the survival of bacteria during stress has been identified in Mycobacterium tuberculosis and non pathogenic Eschericia coli. In the bioengineering side, efficient separation technology has been developed for stem cells from umblical cord blood. Other major achievements include disposable bioreactors for therapeutic protein production and extracorporeal device for bioartifical liver. An electrospinning apparatus has been constructed for the fabrication of nanometer scale materials.

*Chemical Engineering*: The Department has a vibrant mixture of expertise in conventional areas such as process engineering, separations processes, optimization and control, polymer engineering and transport phenomena and emerging areas of chemical engineering, such as nano-technology, biological engineering, materials engineering, process intensification, complex fluids and molecular simulations. The foundations for a research and development culture were laid during the early 1960s, when the faculty were involved in setting up the physical infrastructure as well as in creating a thriving intellectual atmosphere. The first paper from the department was in 1964 [K.S. Gandhi, S. Chandra and C. E. Dryden, Calculation Methods for Complex Flow Diagrams, Chemical Age of India, 15(11), 1183-1199 (1964)]. A regular stream of papers in top-ranking journals in the late 1960s and the very early 70s by D. Ramkrishna (well-known as Ramki) launched the department on its journey into research, blossoming with the recent paper in *Science* [A. Majumder, A. Ghatak and A. Sharma, Science, 318, 258-261 (2007)] on the use of thin film/interfacial phenomena for a novel bio-mimetic adhesive]. Research publications from the department spanned a variety of areas and the numbers slowly increased through the 1960s to hover around 25-35 a year from the mid 1970s till about 2003, after which it increased significantly to about 65-75 per year in 2006-2008. This averages to about 3.5 per faculty per year, a very healthy value among the chemical engineering departments across the world. The impact of these research publications is seen in the 5,650 citations received since 1993, giving an average cite of 9.78 per paper.

Our faculty has authored over 35 textbooks and research monographs, several of which have received international acclaim. Our research endeavors have benefitted immensely through funding from governmental (e.g., DST, CSIR, DBT, and AICTE) and industrial partners (e.g., Chevron, HPCL, ART, Shell, Hindustan-Unilever, IPCL, GAIL, and EIL). As a result, the annual research funding grew from about 2.5 million rupees in the mid eighties to 5 million

rupees in the early nineties, to the current level of over 300 million rupees in the last few years. A DST Center on Nanosciences has just come up at IIT Kanpur, with considerable inputs provided by the chemical engineering department. In addition, research in the area of Process Intensification has resulted in the filing of two patents that are currently being adopted by multinational and national companies for commercialization.

Several prestigious national and international awards have been conferred on our faculty in recognition of their research activities and it is heart-warming that the research culture of the Department has percolated to its students and several are making a significant impact in research and development.

*Chemistry*: The Department has made seminal research contributions in domains of both experimental and theoretical chemistry. Pioneers like Profs. CNR Rao, PT Narashiman and MV George set the trend of carrying out very high quality research right from the inception of the Department. This tradition has continued from strength to strength and the Department is today known worldwide for its excellent quality of research. Chemical research from molecular perspectives was the central theme of research activities in the Department from its early days and the trend still continues. The research activities in the Department could be discussed in three major disciplines, namely physical, inorganic and organic chemistry, although interfacial domains such as materials, physical organic and organo-metallic chemistry have also been the areas of active research in the Department since its inception.

In the first two decades, research activities in physical chemistry included applications of spectroscopic and quantum chemical methods to study chemical compounds and materials. These studies led to very important contributions to solid-state chemistry and structure-property aspects of materials as well as chemical bonding, reactivity, electrical and magnetic properties of chemical compounds. Research in inorganic chemistry in this decade primarily focused on structural aspects. By using a variety of modern physical methods, several difficult structural problems were solved and, in addition, the Department also saw some very important and ground-breaking work on paramagnetic shifts and stereochemical phenomena of inorganic compounds. Mechanism of organic reactions and their use as effective synthetic tools were at the centre of organic research in this period. In particular, one must mention the very extensive work on synthesis of organometallic, alicyclic, highly strained polycyclic and biologically active

compounds which received appreciation world-wide. Nuclear chemistry was another area of significant research. It is also noteworthy that the Department proudly participated in carrying out chemical and nuclear analysis of some of the lunar samples procured from USA.

A large number of lateral movements by some key faculty left the Department depleted in the late seventies which had an effect on the overall research output in the next decade. Nevertheless, significant research work continued in the Department. The topics of investigation included theoretical research on molecular reaction dynamics; photochemistry and photosynthetic reactions; bioinorganic, synthetic organic, coordination and organometallic chemistry. Besides, some faculty members in the Department took up the challenge of building their own instruments for their research that led to fabrications of nuclear quadrupole resonance spectrometer and time-of-flight mass spectrometer.

The research facilities in the Department improved significantly in the nineties and in the present decade and this, combined with infusion of many new faculty members with expertise in many different areas, led to a major upscale in research outcome of the Department. The Department is proud to have made many significant contributions in past 15-18 years covering a rather wide domain of chemical research. Examples include novel theoretical and computational work on chemical dynamics in gas phase and also in liquids and interfaces; materials chemistry; laser spectroscopy and quantum computing; photochemistry and physical organic chemistry; bio-physical, bio-organic and bio-inorganic chemistry; transition metal, coordination, organometallic and porphyrin chemistry; main group chemistry including inorganic rings and polymers, supramolecular chemistry; Synthetic organic chemistry including synthesis of large natural and unnatural products, asymmetric synthesis and carbohydrate chemistry; Medicinal, protein and nucleobase chemistry.

Over the past fifty years, the Chemistry Department of IIT Kanpur has established itself as one of the very best not only in the country but also across the globe. With tireless efforts of existing faculty, infusion of new facilities and new faculty colleagues, it is expected to grow to higher levels in the years to come.

*Civil Engineering*: The Department has made some important contributions in various areas such as structural analysis, earthquake engineering, archeology, air pollution, environmental engineering, and transportation. Early contribution in the late seventies was in studying the flight

sledge, which was relevant for space research. In the area of structures and analysis, this department contributed in renovating the Hardinge bridge in Dhaka, Bangladesh after it was damaged during 1971 Bangladesh war. Similarly, the logo of 1982 Delhi Asiad was designed by its faculty. An important contribution was in designing the foundation and the construction of Narora Atomic power plants. In the area of earthquake engineering, this department had noticeable impact in studying the origin of Tsunami and similar natural disasters that have struck the country in the last decade. The department also contributed to scientific understanding of the origin of earthquakes using several numerical tools. In the area of environmental engineering, the department conducted in-flight experiments to study the correlation between aerosol and pollution at various levels of the atmosphere. Another notable contribution is the removal of arsenic from drinking water and this had major beneficial impact on public health.

*Electrical Engineering*: In the decade of the 60s, the department pursued research primarily in Satellite Communication and Radar Signal processing. In the next decade, research and development activities widened significantly. In the 70s, research activities covered the following areas: Phased Array and Synthetic Aperture Radars, Modeling of Communication links using Troposcatter Channels, VLF Communication systems for coal mines, VLF antennas for submarine communication under Project Skylark, Ferro resonance in EHV transmission lines, Graph Theoretic Approach to modeling of HVDC Converters and Deep Level Transient Spectroscopy for defects in solid state devices.

Many other research areas were explored in the next decade of the 80s. Some of the significant research activities/areas that were pursued and important contributions made include: Hardware and software for Microprocessor Based Systems, simulation of Data Networks and packet delay measurements, Algebraic Coding theory and elliptic curves, Determination of model parameters for the human cochlea and vocal tract, Modeling of clutter in radar signals, Voltage Stability models for power systems, Reactive power optimization in power networks, Studies on the phenomenon of Sub-Synchronous resonance in power systems, Control of DC.drives using Phase Locked Loops, Development of patch antennas for microwave applications, Protection of power transmission lines using Haar Transform and Measurement of optical fiber characteristics.

In the 1990s and in the present decade, the Department took up major research projects in many different directions. Significant contributions were made in the following areas in this period: Image and video Processing Algorithms, Video surveillance, Modeling of speech signals, speech recognition, computational methods, multimodal signal processing, analysis of telecom networks, source and channel coding, turbo codes, analysis of diversity receivers, Application of FACTS devices to power transmission, HVDC transmission, ANN and Fuzzy logic applications in engineering, deregulation of the electricity market, modeling of plasma discharge processes, power electronics applications to power systems, electric drives, engineering application of optimization and control, intelligent control, multiphase power conversion, Partial Discharge measurements using texture analysis, Analysis and design of Switch mode rectifiers using thyristors and IGBTs, Active Filtering for non-linear loads on distribution systems, Remote monitoring and Automation for power distribution networks, Dielectric Resonators, radio frequency identification, Fractal Antennas, semiconductor device modeling, MEMS, VLSI, organic electronics and solar cells, opto-electronics and lasers, instrumentation, e-learning and all optical packet switching.

It may be noted that many of the above activities have been pursued under sponsored research projects from governmental research organizations.

*Humanities and Social Sciences:* Driven by the research ideal since the inception of the Institute in the early 1960s, the Department of Humanities and Social Sciences has contributed significantly to the generation of knowledge in a wide range of fields. This research includes the work carried out in its vibrant doctoral program, sponsored and other research projects, and consultancy involving the departmental faculty members.

The doctoral program of HSS in its four-decade existence has led to the completion of around two hundred doctoral theses that testify to the high academic standards that the Institute and department have set for themselves. The disciplines within which doctoral research has been carried out include Economics, English including Linguistics, Philosophy, Psychology, and Sociology.

The departmental faculty has carried out several sponsored research projects. The sponsors include organizations such as Indian Council of Social Science Research (ICSSR), Indian Council of Philosophical Research (ICPR), UNICEF, MEADOW, SAIL, UNICEF, NTPC, Population Council, and different ministries of the Government of India. Consultancy projects undertaken include those sponsored

by various governmental and non-governmental organizations, and as well as by national and international agencies.

The Department has focused on both basic and applied research, bringing in intra-disciplinary and interdisciplinary perspectives. This is amply exhibited in the wide range of topics covered by supervised doctoral research, faculty research and consultancy. Research topics have ranged from higher consciousness, political philosophy, existentialism, aspects of syntax , linguistic etiquette, feminist issues, American, British and Indian literature, through business ethics, attribution, personality, social power, organizational dynamics, interpersonal conflict, privacy and organizational citizenship, to software workforce, grassroots NGOs, water pollution, industrial sickness, power pricing, among others. Faculty research has spanned areas such as issues in human rights, distributive justice, gender roles, intellectual property rights, health psychology, post- traumatic stress, literature and society, postmodernism, translation, the sociology of education, cognitive linguistics, and law and economics. The major areas of consultancy have been rural development, watershed programs, science and technology policy, environmental impact, resettlement and rehabilitation, health, HIV, and industrial design. Some projects funded by the Institute have addressed issues pertaining to the Institute community, such as brain drain and disadvantaged students.

Moreover, a few faculty members actively associated with research NGOs and voluntary developmental organizations have facilitated in the creation of a certain kind of discourse and also in the empowerment processes of those at the periphery. Their work focuses on education and grassroots action among the vulnerable sections of the society. Some faculty members have also participated in inter-departmental research projects and consultancy projects.

The rich outcome of these research endeavors can be seen in the large number of books and articles published by faculty and students in reputed national and international journals.

In addition, the Department has organized many international and national conferences of professional bodies of social scientists in psychology, sociology and econometrics, workshops and seminars on various interdisciplinary themes, and on topics such as communication skills, research and statistical methods.

Overall, the Department of Humanities and Social Sciences has enjoyed an active research culture that augurs well for its future.

*Materials and Metallurgical Engineering:* The department has made substantial contributions in cutting-edge research on the synthesis, processing and characterization of advanced structural materials, electron and spin device materials and biomaterials. In the late sixties, the department started a strong research program in ferroelectric ceramics and transformation toughened

zirconia. From the year 1980 onwards, the department made significant impact in enhancing the productivity of the steel production in country's leading steel companies, such as Rourkela steel plant, Tata steel plant, Vishakhapatnam steel plant, Jindal Vijaynagar steel plant. This was possible because of the innovative changes in the process design as well as solving critical problems related to the inclusions in steels. In the last decade, the department also developed new generation steels with improved strength and toughness for railway wheels and axles in collaboration with Durgapur Steel plant and RDSO Lucknow. In the area of engineering ceramics, the researchers developed titanium diboride based ceramics in 2004-05 for the country's next generation high temperature nuclear reactors. Using a novel processing route i.e. spark plasma sintering, a series of nanostructured ceramics were fabricated. The Department has also contributed significantly in the area of organic electronics along with researchers in Samtel R&D Center. The researchers developed a novel tantalum-tungsten alloy and other tungsten based alloys for various defense applications. Lately (since 2005), the department has established its niche in the area of biomaterials. The researchers have successfully developed a range of hydroxyapatite and polymer based materials for hard tissue replacement materials, which are intended for orthopedic applications. An Indo-US Center of Biomaterials for Health Care has been established in the MME department since 2008.

*Mathematics and Statistics*: The Department which started as the Department of Mathematics in 1960, got its new name as the Department of Mathematics and Statistics in 2004. It has always shared the vision of the Institute in striving for excellence in research and teaching activities and has succeeded in this endeavor to a large extent.

When the Department first started in the early sixties, the main research contributions were in the areas of Complex analysis, Operation Research, Theoretical Fluid mechanics, General Topology, Theory of elasticity, Algebra and in Statistical inferences. Some of the significant contributions were made in the specific topics like in the Entire functions, Dirichlet series, Hydrodynamic lubrication, homological & group algebras and in the minimax estimators.

Gradually with the inclusions of the new faculty members and with the changing interests of the existing faculty members, the areas like Functional analysis, approximation theory, Bio-fluid mechanics, bio-mathematics, harmonic analysis, graph theory, numerical analysis, differential equations, and probability theory also developed. Significant contributions were

made in the specific topics like, locally convex spaces, population dynamics, mathematical modeling, bio-mathematics, spaces of entire functions, Schrodinger Basis, control theory, number theory, stable processes, stochastic differential equations, multivariate analysis and order statistics.

As the time progresses, faculty members become also pro-active in application areas such as Tomography, Coding theory, Mathematical epidemiology, Mathematical ecology, heat and mass transfer, complex dynamical systems, fractals, harmonic analysis, Wavelets, Logic, solutions of partial differential equations, Optimization, boundary value problems, Computational Fluid Dynamics, parallel computing, and also in different areas of theoretical and applied statistics. During the last few decades significant contributions are made in the computer aided tomography, rough sets, commutative algebras, convex optimization, Lie groups, Geometry of Banach Spaces, solutions of Boundary Value problem, numerical solutions of partial differential equations, Hardy-Sobolev operator, order statistics, ranking and selection and related estimation problems, estimation in constrained parameter space, theory of stochastic orders and aging, measurement errors models, agricultural statistics, statistical signal processing, applied probability and also in econometrics.

*Mechanical Engineering:* The Department has played an important role in evolving an *engineering science* based research in India. Equal emphasis has been laid on analysis and synthesis aspects of technology. Significant contributions have been made in both analytical and experimental areas.

In the area of Solid Mechanics and Design, the Department was well-known in the decade of 1980s as a resource center in composite materials and later, in photoelasticity. The high speed camera, developed in 1990 was a prominent contribution. Outstanding contributions have been made since the late 1990s in areas of nonlinear dynamics, chaotic vibrations, active and passive damping and rotor dynamics. Parameter estimation, inverse problems, life cycle estimation and condition monitoring have been the focus areas in dynamics. FEM based analysis of mechanical systems, composite materials and structures have been carried out extensively. Since the mid-1980s, Computer Aided Design (CAD) laboratory was the pioneer in bringing CAD in India during the early eighties and then rapid prototyping technology, during the later periods. The Department has been the leader in the area of optimization and genetic algorithms. Pioneering

work has been carried out in the field of Genetic and Multi-objective Evolutionary algorithm and publications in the period of 2000-2002 have been internationally recognized.

In the area of Fluid Mechanics and Thermal Science, experimental research was initiated in the year 1987 wherein twin research directions were pursued: hotwire measurements in stratified turbulent shear flows and interferometric imaging of Rayleigh-Benard convection. The first interferogram was recorded in late 1990. Since then, great strides have been made in the direction of optical imaging to study the Rayleigh-Benard convection (1993-1995), crystal growth from an aqueous solution (1995-2004) and flow in micro-channels (since 2005). The development of composite schlieren-PIV in 2006 is one of the latest innovations. Seminal contributions have been made in the area of computational fluid dynamics (CFD) and heat transfer (HT), illustrating the flow instability, transition and physics of transport phenomenon. Notable research are in chaotic flow past a bluff body (1999), augmentation of heat transfer in a heat exchanger using vortex generator (1996-2002), simulation of bubble dynamics (after 2006), boiling and very recently, two-phase heat transfer by a novel method called Coupled-Map-Lattice. Recent developments also include applications of LES/DNS through a turbine blade passage to understand the flow transition, turbulence generation, blade-wake interactions and blade cooling performance, which are related to the design of a highly efficient gas turbine engine. Research has been initiated since 2002 in the direction of energy in the form of bio-fuels, emissions from IC Engines, fuel cells and heat pipes (2006 onwards). Since 2004, a general purpose CFD and HT solver that compares well in scope and capability with international CFD software for a wide range of applications has been developed by a research group in the department.

In the field of manufacturing science, the initial research was concerned with analysis of chip formation in metal cutting (1970-1990) and machine tool vibrations (1970-1980). Cutting edge research has been carried out over three decades (1980 till present) in the areas of micro-machining using electro-chemical spray machining, electro-discharge machining and machining of smart materials. Technologies have been developed to achieve micro- and nano-scale machining/finishing. In nuclear engineering, notable research has been done in the direction of image reconstruction tomography, fission and plasma physics, nuclear reactor dynamics and non-destructive testing.

The department presently has a strong group focused on applied materials and mechanics research. This group is engaged in problems in the areas of multiscale modeling of materials, micromechanics of polymers, smart structures, non-contact energy dissipation, defect dynamics waves in solids, mechanics of thin films, carbon nanotubes, nano-composites/polymers, functionally graded materials, multifunctional materials, dislocation, phase transformation, granular media, stochastic fracture mechanics, and polycrystalline plasticity.

A major mission mode activity has been taken up in the form of Technology Mission on Railway Safety. Various projects related to rail-wheel dynamics and control has been undertaken. New initiatives have been taken in the field of turbulence research, unsteady flow in gas turbine, sensors and actuators, nanomaterials, bio-mems and micro-fluidics. Major research initiatives over the last 50 years have been the establishment of CAD Center under UNDP project, Center for Mechatronics, advanced manufacturing with Indo-US initiative apart from the development of multi-purpose CFD software.

The department has also taken lead in the design and development of the Nano-satellite to be launched in collaboration with the Indian Space Research Organisation (ISRO). The launch forms one of the major activities in the Golden Jubilee year of the institute.

*Physics*: The Department, envisioned as a centre of cutting-edge research in both theoretical and experimental areas, set out to do so by hiring best of trained young minds in emerging areas. It started with significant contributions to optical spectroscopy of solids, which later gave rise to fully-fledged groups in condensed matter physics and laser spectroscopy keeping pace with the world-scenario. The necessity of imparting modern world-class training to graduates and undergraduates eventually led to the formation of a full-fledged physics department with activities spanning the entire gamut of contemporary physics research. With the development of nuclear and high energy theory groups along with theoretical and experimental solid state physics groups and experimental nuclear facilities in early years, the department emerged from its nascent state as a leading research center, and a name to reckon with. The present structure and formation can be traced back to the shape and form that the department had taken by the middle of 1970s.

Studies of condensed matter systems have always been a major area of research in the department. Keeping abreast of the global scenario, the department expanded itself from solid

state physics (with focus on technologically important crystals and their defects) to the wide world of condensed matter physics. In the formative days, the studies of the experimental group centered around investigations of phase transitions in complex systems using X-ray spectroscopy, electron paramagnetic resonance and nuclear magnetic resonance techniques. The establishment of the low-temperature helium facility indeed provided a fillip to the research on low-dimensional magnetic systems, metallic alloys, Kondo systems, spin glasses, superconductivity leading to present day emphasis on spintronics and imaging of electronic properties of importance to superconductivity and magnetism. The scanning tunneling microscope and magneto-optical imaging techniques along with the SQUID facility of the Institute are also being widely used in recent years. In parallel to the studies at low-temperature, studies of semiconductors with a strong emphasis on amorphous silicon started in late seventies with experimentalists closely working with theorists interested in disorder in solids, especially in semiconductors and their alloys. These studies emphasize the physics of defects in alloy semiconductors, properties of porous silicon with new emphasis on research in organic semiconductors for large area displays, thin film transistors and solar cells. The department played a key role in participating and setting the research agenda of the unique interdisciplinary studies at the Samtel Center for Display Technologies (SCDT). The research of experimental condensed matter group has always enjoyed a thriving and symbiotic collaboration with the material science program and center for laser technology of the institute.

The focus of research in theoretical condensed matter, on the other hand, has always been on the studies of phase transitions, correlated electron systems, band structure calculations, disordered systems and also computational materials science. This has led to current emphasis on correlated systems and nanoclusters. One of the most outstanding research contributions of the department is undoubtedly the Ramakrishnan-Youssof theory of freezing which successfully predicts the structure of a crystalline solid using the correlations between the atoms of the material in its liquid phase. The Ramakrishnan-Youssof theory, named after its authors who were faculty members of the department, truly opened up a new frontier of research not only in hard condensed matter but also for soft condensed matter where it has been used successfully for predicting structure of colloidal systems. Professor Ramakrishnan went on to coauthor the celebrated paper on scaling theory of localization with Abrahams, Anderson, and Licciardello. The Department also pioneered research on non-linear dynamics and chaos in the country and

works on instabilities, especially magneto-hydrodynamic instabilities are well recognized. The works on the statistical physics of soft matters, disordered systems, vehicular traffic, and traffic-like motion in cells have been widely acknowledged. Members of condensed matter theory group in tandem with members from high energy groups have been contributing substantially to the fascinating area of quantum phase transitions and dynamics, quantum entanglement, information, computation and decoherence.

The initial studies on spectroscopy eventually paved the way for the formation of research group devoted to laser spectroscopy, nonlinear optics, and laser interactions with plasma, tissues and turbid media. Significant contributions have been made to plasma diagnostics of importance to laser ablation of technologically important thin films such as ZnO, simulation of astrophysical phenomena, bio-medical applications of lasers, coherent control of lasers, and the exploration of the exciting properties and applications of metamaterials and materials with negative refractive index.

The initial emphasis of the High energy physics (HEP) theory group was evenly balanced between field theory and phenomenology. Although at that time there was also research activity in low-energy theoretical nuclear physics. In keeping with the global emphasis in HEP, that of the group has also drastically shifted in the initial days from SU(3), current algebra, Regge pole theory, dual models on one hand and newly discovered resonances, scaling experiments on the other. With the advent of gauge theory, standard model, and discovery of neutral currents and charmed quarks, the emphasis shifted to electroweak and perturbative QCD calculations in 70's and later shifted to super symmetry and string theory in 80's and later. In course of time, the HEP group started newer activities such as general relativity and cosmology, quark-gluon-plasma and astrophysics, string activity, foundation of quantum mechanics, quantum information theory and has kept up with the diverse that HEP globally supports. At present, the group has varied and diverse expertise: Quantum field theory, Particle Phenomenology, string theory, astrophysics, General relativity and cosmology, QCD, Quark-gluon-Plasma, Neutrino Physics and is ready to meet the challenge of new experimental revelations from large hadron collider (LHC). HEP group members also contributed to the field theoretical studies of condensed matter systems.

The research in experimental nuclear physics started with the low-energy van de graff accelerator, which went to become one of the premier centers for techniques such as Ruhterback

scattering spectroscopy, channeling, and preparation of metastable materials through ion-beam mixing. In parallel, techniques such as Massbauer spectroscopy and positron annihilation were honed to investigate the properties of solid state materials and phase transitions, and nanocrystals of minerals. Currently, the group has transformed to a interdisciplinary centre for science and engineering of ion beams equipped with a modern 5 MeV tandem accelerator, and facilities for focused ion beams. These facilities are being used for manufacturing nano-devices.

**Values**

An attitude required for research is available at the Institute more in the form of peer pressure than as a set of definitive principles. The intangible atmosphere wherein expectations in the form of quality and impact are emphasized has helped the community. Minor aberrations have had long term impact on the system as a whole. The Institute has not cultivated an honor code; happily, a need has not been felt as yet. Yet, in an era of IPRs and patents, awards and honors, a formalization of values and code of conduct is desirable. A code based on punctuality, responsibility, integrity, accountability, and excellence will resonate with those engaged in research at the Institute.

**Closure**

The Institute was committed towards teaching, academic programs and development of instructional laboratories and workshops in the first two decades. Since the late 1970s, research as an agenda took off. In other words, the initial model of research as an activity between a teacher and a student, primarily as a student thesis, gave way to pairs of faculty joining hands and collaborating on a sponsored project. Mostly, faculty combinations would be within a Department. The late 1990s, loose formations across the Institute could be seen in the sponsored as well as consultancy projects. The beginning of the first decade of the twenty-first century saw definite interdisciplinary groups assembling for the purpose of conducting research programs under the nom de plume of centers. The Institute has now graduated from student thesis, evolving to become funded projects all the way to form of research programs – a mighty evolution indeed.

By the 1980s, the Institute had reorganized itself to facilitate sponsored research, created offices, and set them up as a task of priority. The scope of research was subsequently enhanced

to include technology mission, technology transfer, and IPR and the mid-1990s, R&D had come to mean all professional activities of the faculty outside of teaching. The decade starting from the year 2000 has seen enormous increase in the quantum of research funding, interdisciplinary research as well as international projects. The publication record sees a parallel in the growth of research funding at the Institute.

The future sees the Institute declaring itself as a leading research organization where it would be able to provide financial support to the faculty from its internal budget in cutting edge areas. The aspiration is to create well-endowed laboratory space that can be given on demand for project work along with a collection of research personnel.

**Recommendations**

The Institute has a creditable record of individual excellence in research. It has groomed several generations of students to pursue higher studies and adopt research as a professional career. The importance that research enjoys as an activity is undeniably high. Recent acquisitions in terms of large equipment position us competently for conducting inter-disciplinary projects on a truly large scale. Yet, we need to be conscious of improvements, as listed, that we should work for.

i) There is considerable scope for enhancing quality, quantity, impact, and citation of our work.

ii) Soon, we would be asked if we have provided value for the investment. Wealth creation for the country is relevant, particularly when we conduct large-value projects. Wealth may be created via patents and IPR.

iii) A research complex that has self-contained basic amenities, for example, clean room, will empower research. This complex will be the equivalent of the Faculty Building in terms of integrating faculty from various Departments.

iv) International collaboration, in particular, drawing internationals scholars to our campus is highly desirable.

v) A well-knit vision wherein ideas germinating in laboratories reach the market place along with a structure to administer the process is desirable.

vi) Issues such as maintenance of sophisticated equipment and availability of skilled manpower are unresolved. Can we create a vast cadre of post-doctoral fellows?

vii) Large projects where we provide leadership on a national scale are to be aspired for. Similarly, can we prepare position papers for the government on subjects that we clearly understand?

viii) It is never too frequent to ask of ourselves, are we relevant to our society?

ix) With research intensified, systemic checks would have to be exercised to ensure character, integrity and honesty in our code of conduct.

# THROUGH THE YEARS: A BIRD'S EYE VIEW

## The sixties

While IIT Kanpur was established in 1960, the early years saw an emphasis on undergraduate teaching. The main source of research funding was either the Ministry of Human Resource Development or Kanpur-Indo American Program (KIAP). Gradually, the emphasis on research and development increased and the first Dean of Research & Development, Professor H. K. Kesavan was appointed in 1964. Even in these early years, several books and papers were published by the faculty. During 1961-70, the publications per year were 134, most of them in international journals, including such prestigious journals as Science and Nature. Right from the beginning, book-writing has been a strong point of IITK faculty and in the first decade as many as 60 books were published. Despite teaching being the primary responsibility, a research orientation permeated education at the Institute leading to the adoption of engineering science as the basis of curriculum development. It is noteworthy that postgraduate programs at the Institute started at around the same time as the undergraduate, with graduate-level electives being offered to sophomore and junior level students. The culture of giving projects and term papers to supplement examinations can also be attributed to the research mindset of the faculty, almost since the inception of the Institute.

The first major facility to be created is the Computer center (1964) established in 1969 at its current location.

## The seventies

In the early seventies, Government of India established the Department of Science and Technology as well as the Aeronautical Research & Development Board and the era of sponsored projects started. In this decade, several other government sponsoring agencies (Defense Research Development Organization, Department of Electronics, Board of Research in Nuclear Sciences) were also established. In 1971, a stand-alone R&D office was set-up at IIT Kanpur.

One of the first major projects to be sponsored at IITK was the Advanced Centre of Electronic Systems (ACES). The main objective of this project was to develop a microwave communication system for the Himalayas. In the early years, the R&D office was manned by just 4 staff members and there was no separate account for project funds. The creation of another account (Account II) in 1979 for managing the project funds was a major development in streamlining and facilitating the execution of projects. At that time, several audit objections were raised regarding this new Account but the Institute was able to convince the auditors on the necessity of having a separate account. By the end of this decade, the number of on-going projects was 171 (sponsored) and 130 (consultancy) with a total budget respectively of Rs 338 and 39 lakhs.

## The eighties

The number of sponsored research projects increased significantly in the eighties resulting in an increase in the number of project employees as well as office staff. Specifically, 649 sponsored projects and 663 consultancy projects with respective budgets of Rs 63.7 and 7.9 crores were granted over the decade. An important development in 1989 during the tenure of the then Dean, Professor R.N. Biswas, was the creation of cadre of quasi-permanent employees. These employees are paid from R&D funds and are

utilized for the efficient running of projects. There were not too many industry sponsored projects in this decade.

With the increase in the number of projects and associated project staff, project employment was streamlined and the first document detailing the project staff classification was prepared in 1989.

Among projects, major funding was received from UNDP to set-up the Computer-Aided Design (CAD) laboratory in 1985.

## The nineties

The number of funding agencies and the number of projects continued to increase in the nineties. The number of sponsored projects increased from 31 (sponsored) and 73 (consultancy) in 1990 to 63 (sponsored) and 113 (consultancy) in 1999. The first booklet, detailing the guidelines for sponsored and consultancy projects, was printed in 1990.

One of the major R&D efforts undertaken by IIT Kanpur in this decade was the setting-up of the National Wind Tunnel Facility. The funding for this national facility was provided by ARDB, DST and IIT Kanpur. This facility is one of its kind in India and is heavily used by various organizations from all over the country. Some of the other major projects completed in this decade include technology development missions (since 1993) related to integrated manufacturing, new materials and intelligent automation of power transmission. These projects had a strong industry-association as well as product development. Collaboration with CDAC Pune brought the first parallel computer (PARAM) to the campus in 1995. The successful *ernet* (educational research network) project inducted the faculty into the domain of emails (1993) and was followed soon by internet (around 1996). The project provided leadership across the country in setting up computer networks for educational purposes. The Institute webpage was first hosted by the information cell in 1999.

To advance cooperation between industry and academia, Government of India identified seven Technology Development Missions (TDMs) spread across all IITs. IIT Kanpur participated in three of these: i) Communication, Networking and Intelligent Automation, ii) Materials, and iii) Integrated Design and Competitive Manufacturing. The developmental work in these projects was very well appreciated by the industry.

To encourage faculty to obtain external funding, the Department Promotion Accounts and the Professional Development Accounts were instituted in 1993. IIT Kanpur was the first Institute to adopt this practice. To house the ever increasing number of project employees, the first Research Associates (RA) hostel was completed in 1997. The Institute signed a memorandum of agreement in 1993 with Narosa Publishing House, New Delhi for publication of monographs under the *IIT Kanpur Series of Advanced Texts*.

In 1999, the CARE scheme was started under which part of the interest from the Endowment Fund is used to purchase major equipment. Several sophisticated equipment have been procured under this scheme. Currently, the entire scheme is supported from the Institute budget.

An encouraging development during this decade was the significant increase in the number of sponsored and consultancy projects originating from the industry. Till the end of nineties, most of the projects were narrow in scope with a modest budget. With tremendous improvement in infrastructure, particularly electricity, this trend changed from the year 2000 onwards.

The number of sponsored and consultancy projects continue to increase each year. In 2008, the number of on-going projects was 102 (sponsored) and 101 (consultancy) with sanctioned budgets respectively of Rs. 53 and 8 crores. Coinciding with this trend is the increase in the number of awards conferred on the faculty. A noteworthy development in this decade is the increase in the number of industry-sponsored projects. In this period, several large inter-disciplinary projects (for example, Media Lab Asia, Railway Technology Missions) have been successfully completed. Another development in this decade has been the setting up of several Cells, such as Space Technology Cell with ISRO, Railway Research Cell with RDSO, HAL Research Cell, and IGCAR-IITK cell. A new culture of Centres as domains of research, as opposed to Departments as degree-granting academic bodies emerged. Thus one saw the creation the Samtel Centre for Display technologies, Prabhu and Poonam Goel Centre for Computer and Internet Security, and National Information Centre for Earthquake Engineering. The first decade of the twentieth century saw the Institute embark on the triumvirate subjects of bio-nano-info (respectively, bioengineering, nanotechnology, and information technology). Academic programs as well as research projects in these areas proliferated. The faculty hiring now reflects this trend.

To fully exploit the technologies developed at IIT Kanpur, the SIDBI Innovation and Incubation Centre (SIIC) was established in 1999. The faculty entrepreneurship policy of IIT Kanpur was approved by the BOG in June 2008. This document lays the methodology for faculty to start companies based on their research ideas and concomitant products, processes and spin-offs. Particularly, in this decade, IIT faculty has become aware of the patenting issues and the number of patents filed/issued has increased from 3 in 2000, 6 in 2005, to 48 in 2008.

To help the Dean, R&D in formulating policies and defining thrust areas, the BOG constituted the Institute Research & Development Committee in 2007. This has representation from all departments and inter-disciplinary programs. To help in the running of Centers and operation of sophisticated equipment, a new cadre of research engineers was created in 2005. Their pay scales and perks are similar to permanent Institute employees but their salary comes either from projects secured by them or from R&D funds. To house the ever increasing number of project employees, another RA hostel was completed in the year 2004.

In this decade, a publication, *Directions*, has been published regularly to highlight the recent developments in frontier areas. From 2007, IITK has also instituted an annual research symposium to showcase major themes of research in the Institute.

## Anecdotes (believe it or not!)

*1981: In a conversation with Dr. K.R. Sarma, an amusing incident was recalled. A faculty colleague visiting from USA wanted to meet various functionaries of the Institute. Dr Sarma met her first as Head, Department of Electrical Engineering. The visitor was subsequently told that Dr Sarma was also the Head, Advanced Center of Electronic Systems (ACES). The visitor then moved over to the office of Dean R&D. As coincidence would have it, Dr Sarma had just taken over as DORD and met the visitor in his third capacity. The visitor must have been most astonished in her meeting with the Director that day since Dr Sarma was, as well, the officiating Director. This situation, though rare in earlier times, is quite frequent now, with a single person officiating in the capacity of several Deans on a given day.*

*1988: When a spatial filter had to be purchased for a laser measurement system, the consignment was held up by customs officials in New Delhi, under the suspicion that it was a small bomb. These officials proceeded to open the filter and promptly dropped the 4 mm diameter lens and a pinhole with a 5 micron hole. The spatial filter was thus received without its vital parts! The day was saved when the Indian agent took up the responsibility of replacement from the principals using techniques quite out of the rule book.*

*1990: In the era of limited air conditioning, it was fashionable to adopt false roofs in the laboratories, particularly for those located in the top floors. The Institute, with all its flora and fauna is well known for supporting wildlife. Even then, on one such occasion, the laboratory inmates were fairly surprised to see a mongoose trapped and roaming around in the gap between the false roof and the real roof. Apparently it had descended into the gap from one of the many ducts that characterize our buildings.*

*1996: One investigator had an urgent need for mirrors of the optical variety. The purchase indent got stuck at the purchase office because the Government of India regulations did not permit purchase of mirrors at all. A closer look at the purchase manual showed that the ban was indeed for bathroom mirrors. The matter was resolved by clever re-wording: the investigator had the quotations redrawn and simply went for a* laser grade $\lambda/4$ reflector.

*2000: When a large motor, around 1 MW capacity had to be purchased for a central facility, we were in for a rude surprise. Most notable vendors gave substantive quotations while one (well-known) vendor gave a quote for a substantially lower amount. The first response was one of delight since we are forever short of money for equipment. This vendor was shortlisted with great fanfare. Yet, months after the order was placed, there was no news of supply of the motor, and foul play was finally suspected. The order had to be cancelled and the entire purchase process, repeated. It turns out that we were a victim of cut-throat competition of the real world.*

*2005: A modern laboratory purchased a computer-operated machine that could produce very intricate parts and shapes. The machine was heavy and had to be properly installed at the ground floor. It needed water supply and had to be close to a tap as well as a drain. On a rainy day, the drain became a source of water in the laboratory and brought with it a fairly large snake! The staff promptly killed it but not without remorse. One fellow went to the extent of shaving his hair off.*

*Such incidents are far less common now – our building density as well as population on campus is quite high and we see animal life receding from our midst.*

2008:

# History of R & D at IIT Kanpur
## *At-a-glance*

| Year | Milestones |
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| 1959 - 1960 | ➢ Started on 14th Dec 1959<br>➢ IITK is registered as a society under the Societies Registration Act in Jan 1960.<br>➢ Central library comes into existence in the Harcourt Butler Technology Institute (HBTI) campus.<br>➢ KIAP program is initiated.<br>➢ *Engineering science* is adopted as the basis of curriculum development. |
| 1960 - 1961 | ➢ Out of 7500 applications, 100 undergraduate students are selected and the classes are flagged off on 9th Aug 1960. |
| 1961 - 1962 | ➢ Students are admitted through JEE. |
| 1962-1963 | ➢ Postgraduate students join.<br>➢ IITK moves from HBTI to its own campus.<br>➢ Central library is moved to the workshop shed on campus. |
| 1963-1964 | ➢ Computer Center is created. The first solid-state computer (IBM – 1620) arrives in an educational institute in India.<br>➢ Foundation stone of the present library is laid.<br>➢ The first PhD student is admitted into the program in Philosophy. |
| 1964-1965 | ➢ The Institute shifts to its present campus from HBTI.<br>➢ A student Counseling Service starts with the help of Prof. K. K. Singh of the Humanities and Social Science Department. |
| 1965-1966 | ➢ May 1965, 66 students graduate from IITK.<br>➢ October 1965, first convocation is presided by Dr. S. Radhakrishnan, President of India.<br>➢ Library moves into its own building.<br>➢ TV Centre becomes functional. The TV Centre was the second biggest in India, the first one being the All India Radio Delhi.<br>➢ In January 1966, posts of Dean: Faculty Affairs and Dean: Research & Development are created.<br>➢ Prof. H. K. Kesavan of Electrical Engineering is the first Dean: Research and Development. |
| 1966 – 1967 | ➢ IBM-7044, one of the largest computers in India at that time arrives on campus. |
| 1967 - 1968 | ➢ The first Honorary Doctor of Science degree conferred to Prof. Norman C. Dahl, KIAP Leader, making him an alumnus of IITK.<br>➢ The first Ph.D degree in Electrical Engineering with specialization in Computer Science is awarded. |

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| 1968 - 1969 | ➢ Prof. C. N. R. Rao of Chemistry Department takes over as Dean: Research and Development. |
| **1961-1970** | ➢ 134 journal papers published per year, a total of 60 books published. |
| 1970 - 1971 | ➢ In the area of Nuclear Engineering and Technology, 3MeV Van De Graff generator is established by Prof. G. K. Mehta in a building specifically designed for experimental work involving radiation. The facility is intended for training and research in Nuclear Physics and Engineering. |
| 1971 - 1972 | ➢ Degree programs at the M.Tech and Ph.D levels are offered in Computer Science by a new Computer Science Program with its own convener. |
| 1971 - 1972 | ➢ A stand-alone R&D office is created. |
| 1972 - 1973 | ➢ Prof. T. R. Viswanathan of Electrical Engineering is Dean: Research and Development. |
| 1974 - 1975 | ➢ Prof. N. C. Nigam of Aero Engineering is Dean: Research and Development. |
| 1976 - 1977 | ➢ Prof. M. A. Pai of Electrical Engineering is Dean Research and Development. |
| 1977 - 1978 | ➢ The first ever B. Tech program in Computer Science in India is launched.<br>➢ Advanced Centers: Two centers in the areas of Electronics systems and Materials Science are established |
| 1978 - 1979 | ➢ Prof. K. R. Sarma of Electrical Engineering is Dean: Research and Development.<br>➢ Account II as a project account is created. |
| **1971-1980** | ➢ 171 sponsored projects (Rs 338 lakhs) and 130 consultancy projects (Rs 39 lakhs) generated. |
| 1980 - 1981 | ➢ Prof. D. Chakraborty of Metallurgical Engineering is Professor-in-charge, Research and Development. |
| 1981 - 1982 | --- |
| 1982 - 1983 | ➢ Prof. P. Dayaratnam of Civil Engineering is Dean Research and Development. |
| 1984 - 1985 | ➢ The Department of Computer Science and Engineering is formally established.<br>➢ The Institute celebrates its Silver Jubilee.<br>➢ Center for Mechatronics is created. |
| 1985 - 1986 | ➢ Prof. R. N. Biswas of Electrical Engineering took over as Dean Research and Development.<br>➢ CAD project is initiated in Mechanical and Civil engineering with Dr S.G. Dhande as the coordinator. |
| 1986 - 1987 | ➢ Some of the laboratories which have continued to assist the industry through these testing jobs are: Structural Analysis and Design Lab, Soil Mechanics Lab, Electro-Mechanical Energy Conversion Lab. & Analytical Testing Lab. |
| 1987 - 1988 | ➢ Center for Laser Technology is established. |

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| 1988 - 1989 | ➢ MHRD provided special funding for the areas of weakness, emerging technology and Modernization of Laboratories. The total financial outlay on ongoing sponsored research projects including the special funding by the MHRD is nearly Rs. 17 crores.<br>➢ The cadre of quasi-permanent employees is created.<br>➢ Prof. B. D. Agarwal of Mechanical Engineering took over as Dean Research and Development.<br>➢ The classification of employees on projects (project associates and others) is created. |
| 1989 - 1990 | ➢ Many of the R&D Projects undertaken by the Institute are directly concerned with the social needs of the country while other projects concern research in the frontier areas of science and technology providing foundation for the futuristic development of the country. The process of development especially industrialization, has resulted in rapid urbanization in the country. With a view to reduce pressure on major urban areas, the Institute undertakes projects to provide efficient public transportation system.<br>➢ Another challenging task that scientists of this Institute undertake is the prediction of weather in tropical regions. A group of researchers, in collaboration with Florida State University, USA develop mathematical models to study the complex monsoon phenomenon.<br>➢ The field of telematics and computer networking, artificial intelligence, high voltage DC transmission technology, computer-aided design and manufacturing (CAD/CAM), robotics, lasers, simulation and control of chemical processes, composite materials constitute a typical spectrum of the frontier areas being pursued at the Institute.<br>➢ Satish Kaura (BT/EE/66), who set up Samtel group is the first recipient of the IITK distinguished Alumnus Award.<br>➢ The first booklet on guidelines for project management is printed. |
| **1981-1990** | ➢ 649 sponsored projects (Rs 63.7 crores) and 663 consultancy projects (Rs 7.9 crores) generated. |
| 1991 - 1992 | ➢ Department of Aerospace Engineering sets up a National Wind Tunnel Facility (NWTF) under the sponsorship of ARBD at a cost of Rs. 176 lakhs.<br>➢ In the Department of Aerospace Engineering, DST approves a grant of Rs. 100.8 lakhs for the instrumentation of the tunnel (NWTF).<br>➢ Department of Aerospace Engineering acquires a 6 seater aircraft for the flight laboratory with financial support from MHRD.<br>➢ Department of Civil Engineering developed a package on |

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| | Traffic Simulation which has been implemented by CRRI and Ministry of Surface Transport.<br>➢ In the Department of Civil Engineering an antenna shield for conducting SODAR (Sound Detection and Ranging) experiments designed and fabricated was installed in Antarctica by the 10th Antarctic Expedition.<br>➢ Department of Computer Science and Engineering made an important achievement in the development of Anusaarak or Very Simple Machine Translation System that allows a reader who is familiar with one Indian language to follow arbitrary text in another Indian language.<br>➢ Department of Metallurgical Engineering achieved a notable success in preparing carbon clusters, isolating and characterizing C-80. Only one or two groups in India have succeeded in this frontline effort.<br>➢ A CW dye laser pumped by an Argon ion laser has been developed in the Center for Laser Technology, for the first time in India.<br>➢ Prof. A. K. Mittal of IME is Dean: Research and Development. |
| 1992 - 1993 | ➢ The Department of Mechanical Engineering develops indigenously a very high speed recording system capable of recording events at the rate of 850,000 frames per second.<br>➢ In the Department of Physics, a notable success was achieved in preparing diamond like carbon and porous silicon.<br>➢ The *ernet* project introduces the faculty to the culture of emails.<br>➢ MOU is signed with Narosa Publishers for the *IIT Kanpur series of Advanced Texts.* |
| 1993 - 1994 | ➢ The Department of Chemistry received a major funding from DST to establish a National Centre for Single Crystal X-ray diffraction facility.<br>➢ The Department of Electrical Engineering, designed an Indian Languages Speech Synthesizer for vocally handicapped and spastic persons.<br>➢ The scheme of PDA and DPA is introduced (and is widely adopted by other Institutes).<br>➢ MHRD-sponsored Technology development missions in (a) integrated manufacturing, (b) new materials and (c) intelligent automation of power transmission are initiated. |
| 1994 - 1995 | ➢ Prof. Sachchidanand of Electrical Engineering is Dean: Research and Development.<br>➢ The first parallel computer (PARAM) from CDAC Pune is introduced. |
| 1995 - 1996 | ➢ In the Department of Electrical Engineering, a MOU had been signed with M/s Phase Devises Communications Ltd. |

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| | (PDCL), Kanpur for establishing R & D Cell in EE Department.<br>➢ In the Department of Electrical Engineering, negotiations with Bharat Electronics Ltd (BEL), Bangalore had been finalized for Technology Transfer of "High Voltage Transistor".<br>➢ Department of Mechanical Engineering conducted a cooperative research with Don State Technical University in Russia and also conducted an intensive course on Computer Aided Design at the University of Aden in the Republic of Yemen.<br>➢ Department of Materials and Metallurgical Engineering: A study on the transport phenomenon in steelmaking tundish system had been started, which had been sponsored by the Steel Authority of India Ltd.<br>➢ Department of Physics: New collaborative research programs with Northeastern University, USA; ICTP, Italy and Warsaw University, Poland; Shinshu University, Japan; Concordia University, Canada were started. |
| 1996 - 1997 | ➢ Department of Computer Science and Engineering had bagged a prestigious project in the area on natural language processing. It had been executed jointly with University of Hyderabad. An IIT Kanpur center is established in Hyderabad for the same purpose.<br>➢ Collaboration with SIDBI was formalized by the Department of Industrial and Industrial Engineering.<br>➢ The Institute becomes *internet*-aware. |
| 1997-98 | ➢ Prof. H. C. Karnick of CSE is Dean: Research and Development.<br>➢ RA hostel comes into existence.<br>➢ FEAT laboratory is set-up. |
| 1998-99 | ➢ A repayable financial of Rs. 6 crores by ICICI is sanctioned to the Institute for setting up facilities such as Material Testing Facility, augmentation of National Wind Tunnel Facility, Networking and Internet Services Centre, Technology Incubation and Development Center.<br>➢ Second phase of Technology Development Missions is initiated.<br>➢ Under the Integrated Design and Concurrent manufacturing Scheme a Reverse Engineering system consisting of FARO ARM scanner and SURFACE software for point cloud data analysis was installed and made operational,<br>➢ Mechanical engineering: Two rapid prototyping machines are installed; A prepeg machine is successfully designed and fabricated. |

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| | ➢ Facility for Ecological and Analytical Testing is established for detection of harmful or banned chemicals in processed textiles.<br>➢ The low speed closed circuit national wind tunnel facility was inaugurated.<br>➢ CARE scheme for procurement of large equipment is introduced.<br>➢ In the Department of Chemistry a 400 MHz FTNMR spectrometer is installed. |
| 1999-2000 | ➢ IITK is at no. 1 position in *India Today* rankings.<br>➢ Prof. S. G. Dhande of Mechanical Engineering is Dean: Research and Development.<br>➢ The Board of Governors decides to name the Central library as P. K. Kelkar library and to install the bust of Prof. Kelkar in his memory.<br>➢ *Directions* launched as an Institute publication.<br>➢ IIT Kanpur launches its first webpage.<br>➢ SIDBI funds Rs. 2.35 crore for establishing SIDBI Innovation and Incubation Center (SIIC) and Rs. 2 crores as corpus fund.<br>➢ Construction of NWTF is completed and the facility is inaugurated. |
| **1991-2000** | ➢ Projects increase from 31 (sponsored) and 73 (consultancy) in 1990 t 63 (sponsored) and 113 (consultancy) in 1999. |
| 2000-2001 | ➢ RDSO funds 1 crore for establishing Railway Technology Mission.<br>➢ MoU signed between IITK and ISRO for establishing Space Technology Cell at IITK.<br>➢ Resource Centre for Indian languages Technology Solutions - Devnagari and Nepali is started.<br>➢ Department of Biological Sciences and Bioengineering is established under the auspices of MPLAD funds provided by Mr. Aurn Shourie, honorable Union Minister of Communication and Information Technology and Disinvestment.<br>➢ Samtel Center comes into existence due to grants from Samtel Ltd. And DST. |
| 2001-2002 | ➢ MoU between IITK and Media Lab Asia is signed for establishing Kanpur-Lucknow hub.<br>➢ National Information Center for Earthquake Engineering was established in order to help the country in building earthquake-resistant structures. |
| 2002 - 2003 | ➢ Prof. Manindra Agarwal recognized for his work on Complexity Theory and developing a Polynomial Time Algorithm for Primality Testing<br>➢ WiFi multihalf network is set-up between IITK and Lucknow<br>➢ Prof. Deepak Kunzru of Chemical Engineering is Dean: |

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| | Research and Development. |
| 2003 - 2004 | ➢ IIT Kanpur receives a grant of Rs. 3300 lakh from the Ministry of for Technology Mission on railway safety.<br>➢ Kanpur-Lucknow hub of Media Lab Asia establishes a Digital Mandi and an experimental wireless VOIP phone based PCO extension counter at a nearby village.<br>➢ Technology developed at the Resource Center for Indian Languages transferred to eight centers for machine aided translation from English to Oriya, Bengali, Marathi, Assamese, Manipuri, Konkani, Urdu, Punjabi, Malayalam and Sanskrit.<br>➢ The work done on nano-sciences at the Department of Chemistry is recognized for the Global Indus Technovator Award 2003 given by India Business Club of Massachusetts Institute of Technology, USA.<br>➢ E-classrooms established at Raipur and Bilaspur and training of forty five teachers is completed under the IIT Kanpur-Government of Chattisgarh collaboration.<br>➢ TV Center undergoes metamorphosis to Media Technology Center where the NPTEL project on distance education is carried out.<br>➢ Prabhu and Poonam Goel Center for Internet and Computer Security is created. |
| 2004-2005 | ➢ IITK is number 1 in *India Today* ranking.<br>➢ IIT Kanpur identified as one of the nodal agencies under the National Program on Nanosciences and Nanotechnology to establish a Unit/Centre for Nanosciences in the Northern region of India with a budget of Rs.11.3 crores<br>➢ Noted Journalist and Rajya Sabha MP Dr. Arun Shourie donates Rs 11 crores from his MPLAD funds for establishment of Environmental Sciences & Engineering Department at IIT Kanpur.<br>➢ Ministry of Earth Sciences gives a grant of Rs 1 crore for creation of NICEE (in earthquake engineering). |
| 2005-2006 | ➢ Major Multi-disciplinary Facilities Added are Focused Ion Beam Facility, Tandem Accelerator, 500 MHz Nuclear Magnetic Resonance (NMR) Spectrometer:<br>➢ Prof. S. C. Srivastava of Electrical Engineering is Dean: Research and Development. |

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| 2006-2007 | ➢ A Memorandum of Understanding (MoU) has been signed between Hindustan Aeronautics Limited (HAL) and the Indian Institute of Technology, Kanpur on to conduct basic and advanced research and tackles multidisciplinary problems in aircraft systems technology and its application.<br>➢ The broad areas initially identified for carrying out collaborative technology development work are Environmental Control and |

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| | Hydraulic Systems analysis by FEM and CFD,<br>➢ Multi-disciplinary facilities added are those under the FIST Scheme of DST while the Centers for Nanotechnology is created..<br>➢ IRDC constituted by the Board.<br>➢ Mechanical engineering receives a grant of Rs 10 crores from DST for procurement of sophisticated equipment. |
| 2007 - 2008 | ➢ IITK is number 1 in *India Today* ranking.<br>➢ Dr. Animangshu Ghatak, Department of Chemical Engineering publishes a paper in *SCIENCE*.<br>➢ Centre for Archaeology and Cultural Resource Management is established.<br>➢ Autodesk-IIT Kanpur digital innovation laboratory is created.<br>➢ REACH symposium is inaugurated as an annual event. |
| 2008 - 2009 | ➢ Prof. K. Muralidhar of Mechanical Engineering is Dean: Research and Development.<br>➢ IGCAR-IITK cell is created.<br>➢ Centre for Uttar Pradesh Power Transmission Corporation Ltd (UPPTCL) is established.<br>➢ Centre for BSNL-IITK Telecom Centre of Excellence is established.<br>➢ Center for Nanoscience is inaugurated by Dr T. Ramasami, Secretary, DST.<br>➢ Center for Environmental Science and Engineering is established.<br>➢ Faculty entrepreneurship policy is approved by the Board.<br>➢ Formal review of MOUs and agreements commences. |
| 2009 - 2010 | ➢ Golden Jubilee Year starts from August 2009.<br>➢ MOU signed with ISRO for launching a nano-satellite (*Jugnu*).<br>➢ Lunar-rover activities commence in collaboration with ISRO.<br>➢ Boeing-sponsored *autonomous vehicle* development project for students begins.<br>➢ Pan-IIT solar energy initiative convenes with IITK as the overall coordinator.<br>➢ Students launch a technical magazine called NERD; students re-group into a body called POWER and enter into the domain of independent research. |
| **2001-2010** | ➢ Patents filed increase from 3 in 2000, to 6 in 2005, to 48 in 2008. The annual sponsored project allocation increases to Rs 53 crores in 2008.<br>➢ The culture of cells and centers takes firm ground with the creation of Prabhu and Poonam Goel Center for computer and internet security, Space Technology Cell, Environmental Science and Engineering, Autodesk-IITK laboratory, and Railway Technology Cell. |

[Assistance provided for this section by Avanti Joshi and Sudha Chandrasekhar is acknowledged.]

# Creation of Major Facilities

1. National Wind Tunnel Facility (NWTF) was established in 1999. It has unique and nationally recognized capabilities to evaluate aerodynamic performance of flight and road vehicles as well as wind effects on civil structures. It has various simulation and measurement systems, interchangeable test sections and is capable of testing at wind speed up to 80 m/sec. Also see the write-up in Appendix VIII.

2. Computer Center

Computer Centre provides Internet Services, Linux and Windows Labs, High Performance Computing, Application Software and Office Automation Services 24 hours a day, 365 days a year.

This center was established in 1964 and it was started in Western Labs under Department of Electrical Engineering. It moved to its present building in 1969 when it was recognized as an independent facility in the Institute. During its early days, there was the Unit Record Equipment which could mechanically process Hollerith punch cards.

IBM-7044 (photograph dates 1969)

IBM-1620 was the first computer acquired by IIT Kanpur. IBM 7044 mainframe computer along with its satellite computer IBM-1401 was added in 1969 when the centre was also moved to the present CC building.

Several specialized computers such as IBM-1800 and PDP-1 were added in subsequent years.

The next major upgrade was the addition of DEC-1090 mainframe computer in 1979, which was the first time sharing computer of IIT Kanpur. This was first computer which had terminals.

PDP-1

HP Servers (photograph dated 1990)

In 1989, CC purchased networked computers of HP 9000 series which included four servers, four high end workstations, and twelve normal workstations. These belonged to super-mini range of computers. To provide access to this computing environment, the first campus network was laid which connected the computer center to terminals installed in various locations in the academic area. This was a 10 Mbps coaxial cable based LAN.

During the same period Convex C-220, a Vector Computing server for high end numeric computing was installed. It was the mini-super computer of those days.


Convex-220

In 1987 the first PC lab was setup providing DOS environment. These labs have been growing over the years and today we have both Linux and Windows labs.

In 1995 the campus network was upgraded to 100 Mbps Fiber Backbone and 10 Mbps UTP Access Network, providing connectivity to all the departments, faculty and staff offices and labs. In 2000 this network was also extended to student hostels. In 2005 the network was again upgraded to Gigabit network. Currently Computer Center supports a campus network with more than 12000 nodes.

The first 64 Kbps internet link was setup in 1998 and today the bandwidth has increased to 110Mbps and it will soon be upgraded to 1 Gbps.

In 1999 the first 16 node beuwulf cluster was installed. From 2000 to 2002, CDAC PARAM-10000, 16 node IBM SP, 15 CPU SUN E10K SMP server and 16 CPU SGI Origin 3400 SMP server were purchased. In 2004 a 96 Node (Dual Processor) SUN cluster was purchased and in 2006 a 48 node (Dual Processor) HP cluster was added. In past few years, several quad processor SMP servers and a HP 16 processor Itanium (Dual Core) SMP server have also been acquired by CC.

In 2006, HP-EVA 8000 virtual storage with 33 TB disk space, along with 6 node HP-EFS clustered virtual file server were added. This provides transparent user area shared over all the servers in CC.

Computer Center at IIT Kanpur has always maintained state of the art computing infrastructure for its users and will continue to do so.

The role of the computer center in the research profile of the Institute is immeasurable. The reputation of the Institute as a hot-bed of computational research has been acquired mainly from the corridors of this unique and extensive facility.

## 3. 4-I laboratory

The laboratory came up as modern manufacturing facility in February 2004. The laboratory integrates design and manufacturing with the fast changing tools of conceptualization and fabrication. The 4 Is stand for innovation, integration, incubation, and implementation. The goal of the laboratory is to realize products from design concepts. It houses state-of-the-art

CAD and CAM tools with capabilities related to acquisition, modeling, and prototyping. The fabrication units available are fused deposition system, abrasive water jet cutting machine, CNC milling, turning NC center, Rapid prototyping machine, and laser cutting machine. The 4-I laboratory is a unique facility where students participate in the operation of the machines in a flexible atmosphere.

## 4. Tandetron

The Van de Graff accelerator has now been replaced by a Tandetron accelerator (tandom accelerator) using DST funding to the tune of Rs 15 crores. The facility has been created by Professors G.K. Mehta and V.N. Kulkarni. It is accompanied by a focused ion beam (FIB) system for materials processing. A maskless lithography system is also available for fabrication of nanosensors.

## 5. Sequential Quantum Interference device (SQUID)

This new laboratory, housed in the Southern laboratory is equipped with a Superconducting Quantum Inteference Device (SQUID)-based extremely sensitive magnetometer, and a Physical Property Measurement System (PPMS) capable of reaching temperatures as low as 300 mK and magnetic field as high as 140 thousand Gauss. The SQUID magnetometer allows one to measure magnetic moment of extremely weak samples over a wide range of temperature extending from 1.6 K to 400 K and magnetic field strength as high as 50 thousand Gauss.

SQUID constitutes key equipment for research in the areas of advanced magnetic materials, superconductors and spintronics, and used extensively by various research groups of IIT Kanpur and several laboratories outside. The PPMS system, on the other hand, is important for addressing a variety of fundamental issues related to superconductivity, magnetism, electronic transport in low dimensional systems, and quantum phase transitions. These two key pieces of equipment make the laboratory a unique research facility in India and put IIT Kanpur in the club of leading laboratories in the world where first-rate research is carried out on superconducting devices and technologies, magnetic thin films and devices, semiconductor heterostructures, nanotechnology and spintronics.

## 6. Computer-aided design (CAD) laboratory

In 1984-85, the industry in India was looking for new directions in engineering design. The method of CAD was already developed in the West. CAD (Computer Aided Design) laboratory at IIT Kanpur was inaugurated in early 1985.

Major projects implemented in the CAD laboratory are the following:

a) UNDP project on computer aided design program (1985-1990)
b) UNDP project on computer aided design program (phase II) (1990-1995)
c) MHRD-supported Technology mission on Integrated Design on Computer Manufacturing (IDCM) (1996-2001)
d) ADA project related to LCA (1985-1986)

e) Ministry of Leather project related to saddle design (2003-2008)
f) Media laboratory Asia (2001-2003)
g) Archaeological Survey of India supported project on Cultural Resources Management (2003 onwards)

The Government of India has laid great emphasis on rapid industrialization and use of modern technologies to achieve its social, industrial and economic objectives. Therefore, in the mid-Eighties, Government gave thrust to use computers in Government and industries for improving quality and productivity of the industrial output. Accordingly, the Computer Aided Design Program was initiated with assistance of UNDP in 1982. The objective of introducing CAD was optimization of industrial design and process control in designated critical production areas.

CAD laboratory introduced the following technologies for the first time on a national level. The subject of computer-aided design was introduced in the curriculum in the mid-eighties. In a pioneering effort, this was followed up with a series of short-term courses for the industry. Technology mission project of 1996 introduced Rapid Prototyping technology. Jointly, CAD and rapid prototyping revolutionized product development. The most important advantage was the reduced time for launching new products. The ability to physically interact with a model allowed design teams to accurately communicate ideas, perform form-and-fit checks of complex mechanism such as engine components. In 2001, The Media Lab Asia project was launched with MIT for research in areas of education, health, entertainment, and wireless communication. The project has developed software packages such as *Info Sculpture* and useful products such as *Suchik* and *Infothella* for the rural society. The indigenous saddle development project of 2003 helps save valuable foreign exchange and has put India's name in world map of equestrian and horse riding. The second phase of this project has now commenced. The archaeology project initiated in 2003 has recorded very antique and valuable sculptures from Mathura Museum and the Centre of Ancient History and Archeology at Allahabad University.

The CAD laboratory has major facilities for rapid prototyping, reverse engineering, and rapid tooling. Modern equipment such as FDM -1650 and Cubital - SGC are two widely used rapid prototyping machines. A state-of-the art optical digital scanner generates point cloud data with an accuracy of better than 0.1mm/m object size. A six-degree Faro Arm Scanner collects data from an object. Silicon vacuum casting machine and Tafa spray gun are used in the rapid tooling procedure.

## 7. Liquid nitrogen and liquid helium plant

The Institute has been successfully operating an in-house central cryogenic facility consisting of liquid nitrogen and liquid helium production plants. Right in the first decade of the Institute, it was realized by some enthusiastic faculty members from the Department of Physics (such as Prof. Rajat Sen) and some other faculty members from across the Institute (such as Prof. CNR Rao from Chemistry) that a liquid nitrogen facility must be created in the Institute for doing low temperature research such as temperature-dependent magnetic susceptibility, Electron Paramagnetic Resonance (EPR) spectral measurements and superconductivity. Hoping to create such a facility, these faculty members took initiative and eventually procured liquid nitrogen plant at IITK during 1964/1965. In fact, it was a gift from

AIRCO Company, USA, as a part of Kanpur Indo-American Program (KIAP). In the meantime, many other faculty members (such as Prof. A. K. Mazumdar, Department of Physics) also showed keen interest on such kind of research. Then a situation arose to replace the old facility, which served the IITK faculty for about 15 years. In early 1980, IITK procured the second facility from Indian Oxygen Ltd., which fulfilled the research need of IIT-K faculty for about 18 years. In the recent past, this facility has undergone a renaissance with the induction of a new nitrogen liquefier which produces ~ 20 liter/hr. of liquid nitrogen. We have also ordered a new helium liquefier system from funds provided by the department of science and technology under its FIST scheme and augmented by our Institute. Once commissioned, this high capacity (~ 20/liters/hr.) , fully automated liquefier manufactured by M/S BOC-Linde of the United States will empower a large number of faculty members of this institute to carryout world-class research in frontline areas such as nanoscience, spintronics and superconductivity. This central facility will also meet the liquid helium requirements of the NMR laboratory. Additionally, this high capacity plant should allow us to assist other government of India laboratories like CDRI, Sanjay Gandhi Medical Centre, Toxicology laboratory and DMSDE in running their liquid helium based facilities. This will certainly reinforce our leadership in running and maintaining sophisticated machines.

# Unique equipment

**2000**

| Dept. | Name of the Equipment |
|---|---|
| CHM | Purchase of PCR Thermocycler |
| CHE | Proposal for the acquisition of a Scanning Probe and Atomic Force Microscope |
| MME | Multipurpose thin film deposition unit based on electron beam evaporation |
| CHE | Rheological Characterization of Complex non-Newton Materials. Purchase of Rheometer with constant temperature bath |
| CHM | Purchase of Auto Sampler for 400 MHz. High resolution NMR machine |
| PHY | Power Supply for Varian 15" electro-magnet. |
| CE | Enhancement of the Cyclic Testing Facility at the Structural Engineering Laboratory |

**2001**

| Dept. | Name of the Equipment |
|---|---|
| MSP | Preparation, Processing and Characterization Of Nano-particles |
| CHE | Virtually-Instrumented Polymerization reactor with on-line optimal control facility. |
| EE | Pico-second optimal source. |
| ME | Optical measurement facility for advanced flow and heat transfer applications. |

**2002**

| Dept. | Name of the Equipment |
|---|---|
| LTP | Modernization of Raman System and Removal of Obsolete Data Acquisition System. |
| PHY | A Thin Film and Multi-layer Preparation Unit using DC Magnetron Sputtering. |
| MME | Electro-chemical Impedance Measurement System. |
| ME | Thermal analyzer equipped with Thermal-Gravimetric Analyzer, Differential Scanning Calorimeter and Dynamic Mechanical Analyzer |
| ME | NOX and THC Emission measurement system for Internal Combustion engines. |
| ACMS | X Ray diffraction System |

**2003**

| Dept. | Name of the Equipment |
|---|---|
| CELT | Optical Spectrum Analyser |
| MME | 3-D Surface Profilometer to Characterize Material Surfaces |
| CHM | Closed Cycle Refrigeration System |
| CE/(EEM) | HPTLC System |
| CE | Drill Core Scanner for Magnetic Susceptibility & Natural Gamma Ray Measurements |
| PHY | Coincidence Doppler Positron Annihilation Radiation System |
| MME | Particle Size Analyzer |
| ASE | Laser Scatting Particile Size Analyzer. |

**2004**

| Dept. | Name of the Equipment |
|---|---|
| NWTF | Stereoscopic PIV System for Flow Diagnostics in Aeronautical & Non-Aeronautical applications |
| Samtel Center | Ultrahigh Vacuum Molecular Beam Deposition System for Organic Thin Films. |
| ACMS | Vibrating Sample Magnetometer (VSM) facility |

**2005**

| Dept. | Name of the Equipment |
|---|---|
| CE | Scanning Mobility Particle Sizer (SMPS) for Gas-Borne Nanoparticulate Systems |
| MME | Installation of Reciprocating Wear and Friction Tester Facility |
| CHM | Augmentation of ESI-Q-ToF with Atmospheric Pressure Chemical Ionization (APCI) and Photoionization (APPI) Interfaces |
| CE | Servo-Hydraulic Actuators for Load Application at Structural Engineering Laboratory |
| ME | Hot-Isostatic Pressing Facility for Processing Advanced Materials |
| PHY | Polarized Confocal Imaging of the Cervical Epithelial Tissue for Neo plasia (early cancer) Detection |

**2006**

| Dept. | Name of the Equipment |
|---|---|
| EE | Shielded Anechoic Chamber |
| MME | Precision Ion Beam Milling System |
| BSBE | Density Gradient Separation cum Fractionation Facility |
| EE | Encapsulation System for Organic Photovoltaic Devices/Panels |
| CE | Cyclic Triaxial Testing System to Evaluate Shear Strength and Liquefaction Potential of Noncohesive Soil |
| CHE | Optical Microscope for Research on Microfluidics and Contact Mechanics on Soft Materials |
| LTP | Tunable Laser in the Wavelength range of 1480-1640nm |
| ME | Engine Exhaust Particle Sizer (EEPS) Spectrometer with Rotating Disk Diluter & Software |

**2007**

| Dept. | Name of the Equipment |
|---|---|
| CE | Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES Model 720-ES) for Simultaneous Elemental Analysis |
| CHM | Establishment of a Gas Chromatography and Mass Spectrometry (GC-MS) facility |
| ACMS | Establishing a Cascaded Dilatometer Facility |
| MME | A Facility to process Nanostructured Materials: Spark Plasma Sintering Set up |
| CE | Terrestrial Laser Scanner (TLS) for High Resolution Surveying Modeling and Digital Archiving |

**2008**

| Dept. | Name of the Equipment |
|---|---|
| ME | Equipment related to micro-fabrication facility |
| PHY | Fiber coupled microscope and multichannel detection system for Raman spectrometer |
| ME | Laser Doppler anemometry for the unsteady velocity measurements in a water tunnel test facility for flow control |
| CHM | Establishment of a micro-analytical facility |
| MME | Surface profilometer |
| CHE | Laser light interferometer and digital holographic system |

# Appendix I
# Names of Deans: Research and Development

| Year | Name | Department |
|---|---|---|
| 1964 | H.K. Kesavan | Electrical Engineering |
| 1965 | H.K. Kesavan | Electrical Engineering |
| 1966 | H.K. Kesavan | Electrical Engineering |
| 1967 | H.K. Kesavan | Electrical Engineering |
| 1968 | C.N.R. Rao | Chemistry |
| 1969 | C.N.R. Rao | Chemistry |
| 1970 | C.N.R. Rao | Chemistry |
| 1971 | C.N.R. Rao | Chemistry |
| 1972 | T.R. Viswanathan | Electrical Engineering |
| 1973 | T.R. Viswanathan | Electrical Engineering |
| 1974 | N.C. Nigam | Aero Engineering |
| 1975 | N.C. Nigam | Aero Engineering |
| 1976 | M.A. Pai | Electrical Engineering |
| 1977 | M.A. Pai | Electrical Engineering |
| 1978 | K.R. Sharma | Electrical Engineering |
| 1979 | K.R. Sharma | Electrical Engineering |
| 1980 | D. Chakravorty | Metallurgical Engineering (Prof-in-charge) |
| 1981 | D. Chakravorty | Metallurgical Engineering (Prof-in-charge) |
| 1982 | P. Dayaratnam | Civil Engineering |
| 1983 | P. Dayaratnam | Civil Engineering |
| 1984 | P. Dayaratnam | Civil Engineering |
| 1985 | R.N. Biswas | Electrical Engineering |
| 1986 | R.N. Biswas | Electrical Engineering |
| 1987 | R.N. Biswas | Electrical Engineering |
| 1988 | B.D. Agarwal | Mechanical Engineering |
| 1989 | B.D. Agarwal | Mechanical Engineering |
| 1990 | B.D. Agarwal | Mechanical Engineering |
| 1991 | A.K. Mittal | IME |
| 1992 | AK. Mittal | IME |
| 1993 | A.K. Mittal | IME |
| 1994 | Sachchidanand | Electrical Engineering |
| 1995 | Sachchidanand | Electrical Engineering |
| 1996 | Sachchidanand | Electrical Engineering |
| 1997 | H.C. Karnick | Computer Science & Engineering |
| 1998 | H.C. Karnick / S.G. Dhande | |
| 1999 | S.G.Dhande | Mechanical Engineering |
| 2000 | S.G. Dhande | Mechanical Engineering |
| 2001 | S.G. Dhande | Mechanical Engineering |
| 2002 | Deepak Kunzru | Chemical Engineering |
| 2003 | Deepak Kunzru | Chemical Engineering |
| 2004 | Deepak Kunzru | Chemical Engineering |
| 2005 | S.C. Srivastava | Electrical Engineering |
| 2006 | S.C. Srivastava | Electrical Engineering |
| 2007 | S.C Srivastava | Electrical Engineering |
| 2008 | K. Muralidhar | Mechanical Engineering |
| 2009 | K. Muralidhar | Mechanical Engineering |

# Appendices II and III

## Summary of sponsored and consultancy projects received over the years

[The fourth column gives the amount sanctioned for the particular year.]

| S.No. | Year | Spons. Proj. | | Cons. Proj. | | Intern. | NAME OF AGENCY | | | | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | Amt. (crores) | No. | Amt. (crores) | Project | MHRD | DST | BSNL | MCIT | DAE | DBT | | ARDB | DRDO | ISRO | MOCI | | CSIR | CHIPS | RDSO | ISRO | | UPPTCL | | Amt. (crores) |
| 1 | 2008 | 102 | 52.85 | 101 | 8.22 | 1.65 | 1.25 | 8.49 | 14.5 | 1.08 | 0.04 | 2.12 | | 0.55 | 1.17 | 0.88 | 10.0 | | 2.16 | 0.67 | 0.37 | 0.88 | | 1.00 | | 45.16 |

| S.No. | Year | Spons. Proj. | | Cons. Proj. | | Intern. | NAME OF AGENCY | | | | | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | Amt. (crores) | No. | Amt. (crores) | Project | MHRD | DST | AICTE | MCIT | DAE | DBT | DIT | ARDB | DRDO | ISRO | MPLDS | MIT | CSIR | CHIPS | RDSO | ISRO | MLA | TMRS | ICICI | Amt. (crores) |
| 1 | 2007 | 111 | 41.82 | 109 | 6.63 | 1.85 | | 19.00 | 0.21 | 1.70 | 0.34 | 2.18 | 1.29 | 1.29 | 1.30 | 1.20 | | | 3.02 | 1.50 | 0.07 | | | | | 33.10 |
| 2 | 2006 | 138 | 91.40 | 96 | 6.00 | 3.05 | 0.28 | 71.57 | 0.09 | 0.67 | 1.61 | 7.28 | 2.02 | 2.02 | 2.24 | 0.90 | 0.00 | | 0.61 | | 0.09 | 0.66 | 0.11 | | | 90.15 |
| 3 | 2005 | 121 | 55.68 | 94 | 4.08 | 4.24 | 4.47 | 3.81 | 0.16 | 2.72 | 0.58 | | | | 1.36 | 1.31 | 2.00 | | 0.61 | | | | 0.82 | 9.40 | 0.00 | 27.24 |
| 4 | 2004 | 97 | 41.49 | 102 | 5.38 | 6.41 | | 14.52 | 0.56 | 4.76 | 3.27 | 0.34 | | 0.95 | 1.06 | 0.88 | 0.90 | 0.00 | 0.50 | | | | 1.02 | 16.41 | | 45.17 |
| 5 | 2003 | 94 | 40.08 | 108 | 5.22 | 0.72 | 10.92 | 9.59 | 0.16 | 1.53 | 0.62 | 1.67 | 0.80 | 0.25 | 1.29 | 0.41 | 1.85 | 0.79 | 0.86 | 2.03 | | | 0.48 | | | 33.25 |
| 6 | 2002 | 93 | 18.74 | 144 | 6.15 | | 7.20 | 11.05 | 0.15 | | 0.37 | 0.07 | | 0.43 | 0.09 | 0.76 | 0.00 | | 0.37 | | 0.78 | | 0.00 | | | 21.27 |
| 7 | 2001 | 69 | 16.00 | 153 | 3.12 | | 1.34 | 2.87 | 0.06 | | 0.19 | 0.30 | | 0.03 | 0.72 | 0.12 | 7.11 | 1.39 | 0.96 | | 0.25 | | 4.52 | | | 19.86 |
| 8 | 2000 | 74 | 12.55 | 130 | 1.84 | | 1.02 | 2.72 | 0.71 | | 0.72 | | | 0.34 | 0.37 | | 1.20 | 2.60 | 0.39 | | 1.27 | 0.26 | | | | 11.60 |
| 9 | 1999 | 63 | 6.59 | 113 | 1.84 | | | 2.38 | 0.14 | | 0.78 | | | 0.41 | 0.26 | | | | 0.66 | | | 0.29 | | | | 4.92 |
| 10 | 1998 | 86 | 8.34 | 115 | 1.61 | | 2.12 | 2.72 | 0.49 | | 0.12 | 0.28 | | 1.25 | | | | | 0.87 | | 0.01 | 0.11 | | | | 7.97 |
| 11 | 1997 | 82 | 13.94 | 71 | 0.90 | | | 4.04 | 1.04 | | 0.32 | | | 0.49 | 0.17 | 0.05 | | | 0.49 | | | | | | 5.40 | 12.00 |
| 12 | 1996 | 75 | 7.44 | 52 | 0.50 | | | 3.30 | 0.79 | | 0.17 | | | 0.44 | 0.25 | | | | 0.23 | | | | | | | 5.18 |
| 13 | 1995 | 65 | 5.40 | 100 | 1.67 | | | 0.88 | 1.13 | | 0.34 | | | 0.27 | | | | | 0.16 | | | | | | | 2.78 |
| 14 | 1994 | 65 | 3.45 | 81 | 0.46 | | | 1.12 | | | 0.17 | | | 0.22 | 0.07 | 0.10 | | | 0.25 | | | | | | | 1.93 |
| 15 | 1993 | 55 | 3.87 | 52 | 0.33 | | 0.91 | 1.75 | | | | | | 0.43 | 0.17 | | | | 0.07 | | | | | | | 3.33 |
| 16 | 1992 | 69 | 6.88 | 6 | 0.40 | | 2.29 | 2.00 | | | 0.36 | | | 0.23 | 0.19 | 0.09 | | | 0.24 | | | | | | | 5.40 |
| 17 | 1991 | 58 | 3.52 | | | | 1.48 | 1.09 | | | 0.04 | | | 0.29 | | | | | 0.05 | | | | | | | 2.95 |
| 18 | 1990 | 31 | 4.28 | 73 | 0.19 | | 1.02 | 0.66 | | | | | | 1.99 | | | | | | | | | | | | 3.67 |
| 19 | 1989 | 51 | 3.75 | 180 | 0.30 | | 2.48 | 0.12 | | | | | | 0.27 | | | | | | | | | | | | 2.87 |
| 20 | 1988 | 56 | 4.48 | 141 | 0.40 | | 2.73 | 0.67 | | | | | | | | | | | | | | | | | | 3.40 |
| 21 | 1987 | 37 | 4.30 | 120 | 0.25 | | 1.70 | 0.65 | | | | | | 0.28 | | | | | | | | | | | | 2.63 |
| 22 | 1986 | 34 | 6.50 | 110 | 0.15 | | 0.30 | 0.59 | | | | | | | 0.11 | | | | 0.06 | | | | | | | 1.06 |
| 23 | 1985 | 25 | 5.00 | 60 | 0.10 | | | 0.29 | | | | | | | 0.10 | | | | | | | | | | | 0.39 |

| S.No. | Year | Spons. Proj. | | Cons. Proj. | | Intern. | NAME OF AGENCY | | | | | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | Amt. (lakhs) | No. | Amt. (lakhs) | Project | MHRD | DST | AICTE | MCIT | DAE | DBT | DIT | ARDB | DRDO | ISRO | MPLDS | MIT | CSIR | CHIPS | RDSO | ISRO | MLA | TMRS | ICICI | Amt. (lakhs) |
| 25 | 1984 | 28 | 200 | 38 | 5.2 | | | 42 | | 90 | | | | 6 | | 5 | | | | | | | | | | 143 |
| 26 | 1983 | 22 | 100 | 35 | 4.87 | | | 17 | | | | | | 11 | | | | | | | | | | | | 28 |
| 27 | 1982 | 19 | 100 | 30 | 4.44 | | | 9 | | 12 | | | | | 20 | | | | | | | | | | | 41 |
| 28 | 1981 | 17 | 50 | 11 | 4.09 | | | 14 | | | 2 | | | | | | | | | | | | | | | 16 |
| 29 | 1980 | 21 | 115 | 15 | 2.08 | | | 44 | | | | | | 10 | 18 | | | | | | | | | | | 72 |
| 30 | 1979 | 16 | 135 | 32 | 8.87 | | | 14 | | 109 | | | | 5 | | | | | | | | | | | | 128 |
| 31 | 1978 | 24 | 60 | 21 | 7.13 | | | 23 | | | | | | 22 | | | | | | | | | | | | 45 |
| 32 | 1977 | 27 | 33 | 30 | 7.87 | | | 12 | | | | | | 6 | | | | | 1 | | | | | | | 19 |
| 33 | 1976 | 25 | 38 | 35 | 6.71 | | | 8 | | 15 | | | | 5 | | | | | | | | | | | | 28 |
| 34 | 1975 | 27 | 30.13 | 6 | 4.1 | | | 1 | | | 4 | | | 1 | 2 | | | | 9 | | | | | | | 17 |
| 35 | 1974 | 26 | 27 | 4 | 0.73 | | | | | | 5 | | | 3 | 2 | | | | 9 | | | | | | | 19 |
| 36 | 1973 | 15 | 7.24 | | | | | | | | 2 | | | 7 | 1 | | | | 3 | | | | | | | 13 |
| 37 | 1972 | 7 | 4.95 | 1 | 1.5 | | | | | | | | | 1 | | | | | 2 | | | | | | | 3 |
| 38 | 1971 | 2 | 1.63 | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 39 | 1970 | 2 | 1.05 | 1 | 1.5 | | | | | | 2 | | | | | | | | | | | | | | | 2 |

{Titles of projects are separately available.}

# Appendix IV

## List of Research Publications

{separately available}

# Appendix V

## Evaluation of Research Publications

Based on the data available in the Annual reports of IIT Kanpur, an analysis of the research output has been carried out in the following categories: i) international journal, ii) national journal, iii) International conference proceedings, iv) National conference proceedings and v) Books. Our compiled data are presented in the following tables and also in the figures given below.

Total Publication in different decades since the inception of IIT Kanpur

(Source: Annual reports of IITK)

| Decade | International Journal | National Journal | International Conference | National Conference | Books | Publications in Science/Nature* |
|---|---|---|---|---|---|---|
| **1961-70** | **1085** | **254** | **115** | **130** | **60** | **09** |
| **Pub/year** | **109** | **25** | **12** | **13** | **6** | |
| **1971-80** | **987** | **205** | **113** | **59** | **60** | **01** |
| **Pub/year** | **197** | **41** | **23** | **12** | **12** | |
| **(Publication list is missing in Annual Reports of 75-76, 76-77, 77-78, 78-79, 80-81)** | | | | | | |
| **1981-90** | **2549** | **581** | **480** | **340** | **176** | **_** |
| **Pub/year** | **283** | **65** | **53** | **38** | **20** | |
| **(Publication list is missing in the Annual Reports of 81-82)** | | | | | | |
| **1991-2000** | **3011** | **470** | **665** | **417** | **183** | |
| **Pub/year** | **335** | **52** | **74** | **46** | **23** | |
| **(Publication list is missing in the Annual Reports of 94-95)** | | | | | | |
| **2001-2007** | **3821** | **505** | **1110** | **623** | **301** | **1** |
| **Pub/year** | **546** | **72** | **158** | **89** | **43** | |

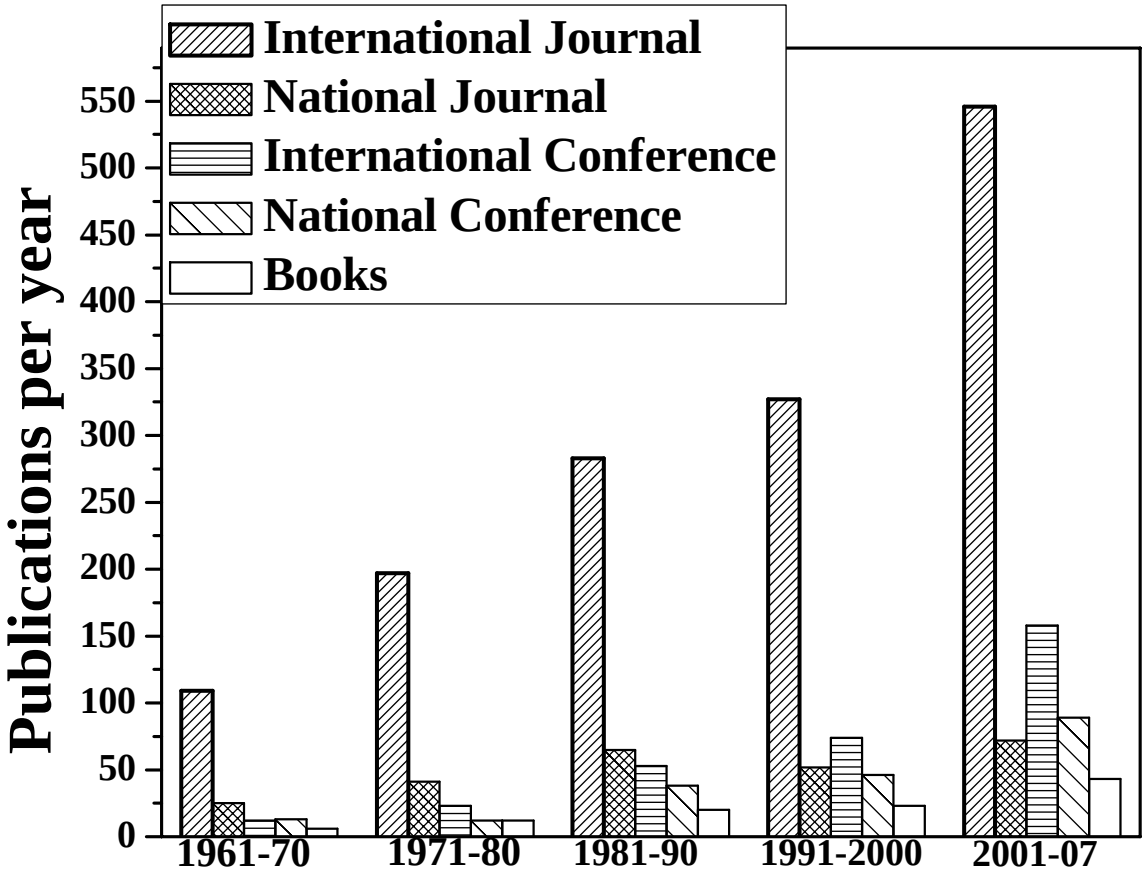


Figure: Total Publication in different decades since the inception of IIT Kanpur

(Source: Annual reports of IITK)

The following points emerge from our analysis:

a) Comparing the number of publications in international and national forums, it is clear that right from the beginning there was an emphasis in publishing in international journals to reach out to the international scientific and engineering community.

b) The first decade itself (1961-70) noticed an international journal publication for 100 per year on average, while the publications in national journals were one-tenth of it. It is likely that KIAP program played a key role in orienting this trend of publishing in international journals of high quality. This decade noticed a total of seven publications in SCIENCE and NATURE, still unmatched by any other decade in the history of this institute.

c) The next three decades (71-80, 81-90 and 91-2000) saw a linear increase in the number of international journal publications, with an increase of 50 papers/per year in respective decades. The rate of increase was slightly less in the second decade, which can be linked to several factors, such as withdrawal of the KIAP program, turmoil in the campus and lack of sufficient governmental funding. This continued till the end of last century, when our institute clearly saw resurgence in the funding situation, research facilities, and consequently a leap in the number of publications.

d) The number of papers published in international conference proceedings noticeably increases in the last decade. Better availability of funds, both from institute and government funding agencies, to attend international conferences has definitely played a role in this increase.

e) In terms of books, it is noticed that book publication has increased from 6 to 23 per year over the past five decades. The strong academic environment prevailing in the campus must be credited for this accomplishment. It encourages faculty members to write books in the area of their expertise. The support from CDTE cell in this context is noteworthy.

f) An analysis of publications from science and engineering departments separately reveals a similar trend, both in terms of research publications, conference proceedings and books. It is noteworthy to mention that while science departments started publishing vigorously right from the first decade, the engineering departments took some time to take off in terms publishing in international and national journals in large numbers. However, the numbers increase significantly in later decades.

Publications from Science Departments
(Source: Annual reports of IITK)

| Timeframe | International Journal | National Journal | International Conference | National Conference | Books | Publications in Science/Nature* |
|---|---|---|---|---|---|---|
| **1961-70** | **717** | **119** | **35** | **11** | **29** | **03** |
| **Pub/year** | **72** | **12** | **4** | **1** | **3** | |
| **1971-80** | **467** | **88** | **25** | **6** | **31** | **02** |
| **Pub/year** | **94** | **18** | **5** | **1** | **6** | |
| **(Publication list is missing in Annual Reports of 75-76, 76-77, 77-78, 78-79, 80-81)** | | | | | | |
| **1981-90** | **1160** | **233** | **56** | **43** | **45** | **---** |
| **Pub/year** | **129** | **26** | **6** | **5** | **5** | |
| **(Publication list is missing in the Annual Reports of 81-82)** | | | | | | |
| **1991-2000** | **1069** | **109** | **66** | **63** | **26** | **01** |
| **Pub/year** | **119** | **12** | **7** | **7** | **3** | |
| **(Publication list is missing in the Annual Reports of 94-95)** | | | | | | |
| **2001-2007** | **1548** | **103** | **122** | **92** | **45** | **---** |
| **Pub/year** | **221** | **15** | **17** | **13** | **6** | |

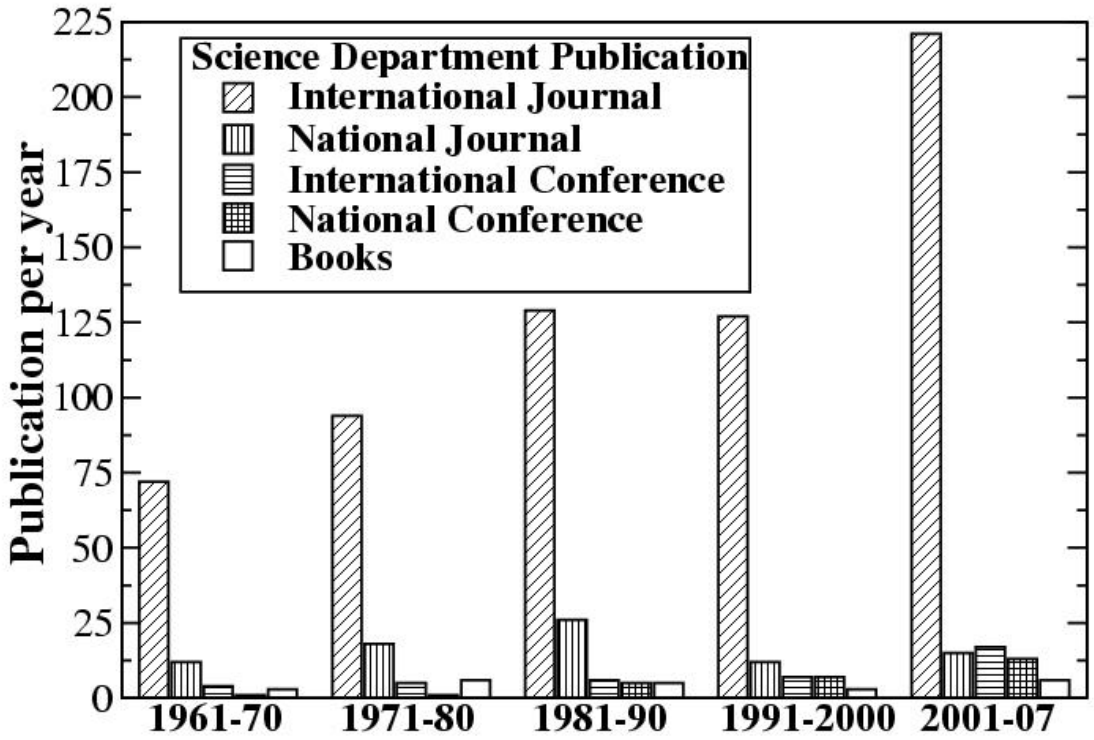


Figure: Publications from science departments in different decades

(Source: Annual reports of IITK)

# Publications from Engineering Departments

(Source: Annual reports of IITK)

| Timeframe | International Journal | National Journal | International Conference | National Conference | Books | Publications in Science/Nature* |
|---|---|---|---|---|---|---|
| **1961-70** | **338** | **79** | **67** | **114** | **21** | **03** |
| **Pub/year** | **34** | **8** | **7** | **11** | **2** | |
| **1971-80** | **487** | **87** | **81** | **46** | **19** | **---** |
| **Pub/year** | **97** | **17** | **16** | **9** | **4** | |
| **(Publication list is missing in Annual Reports of 75-76, 76-77, 77-78, 78-79, 80-81)** | | | | | | |
| **1981-90** | **1288** | **194** | **407** | **252** | **76** | **---** |
| **Pub/year** | **143** | **22** | **45** | **28** | **8** | |
| **(Publication list is missing in the Annual Reports of 81-82)** | | | | | | |
| **1991-2000** | **1823** | **305** | **596** | **328** | **122** | **03** |
| **Pub/year** | **203** | **34** | **66** | **36** | **14** | |
| **(Publication list is missing in the Annual Reports of 94-95)** | | | | | | |
| **2001-2007** | **2217** | **336** | **951** | **500** | **219** | **02** |
| **Pub/year** | **317** | **48** | **136** | **71** | **31** | |

# Publications from all Departments

(Source: Annual reports of IITK)

| Timeframe | International Journal | National Journal | International Conference | National Conference | Books | Publications in Science/Nature* |
|---|---|---|---|---|---|---|
| **1961-70** | **1085** | **254** | **115** | **130** | **60** | **06** |
| **Pub/year** | **109** | **25** | **12** | **13** | **6** | |
| **1971-80** | **987** | **205** | **113** | **59** | **60** | **02** |
| **Pub/year** | **197** | **41** | **23** | **12** | **12** | |
| **(Publication list is missing in Annual Reports of 75-76, 76-77, 77-78, 78-79, 80-81)** | | | | | | |
| **1981-90** | **2549** | **581** | **480** | **340** | **176** | **_** |
| **Pub/year** | **283** | **65** | **53** | **38** | **20** | |
| **(Publication list is missing in the Annual Reports of 81-82)** | | | | | | |
| **1991-2000** | **2939** | **470** | **665** | **417** | **183** | **04** |
| **Pub/year** | **327** | **52** | **74** | **46** | **23** | |
| **(Publication list is missing in the Annual Reports of 94-95)** | | | | | | |
| **2001-2007** | **3821** | **505** | **1110** | **623** | **301** | **02** |
| **Pub/year** | **546** | **72** | **158** | **89** | **43** | |

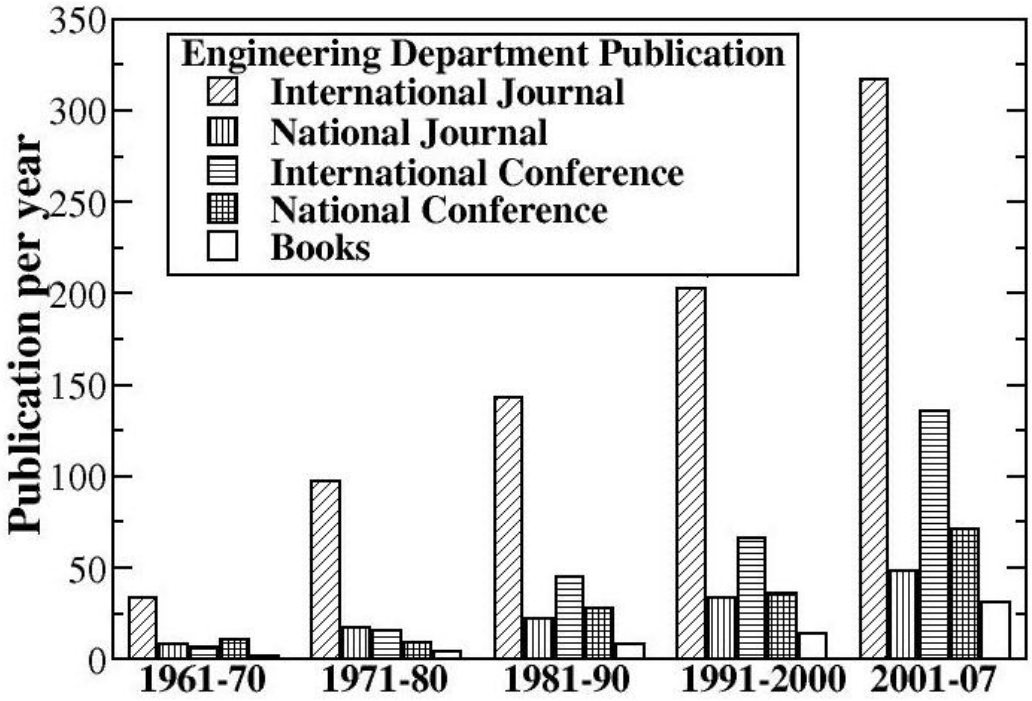


Figure: Publications from engineering departments in different decades

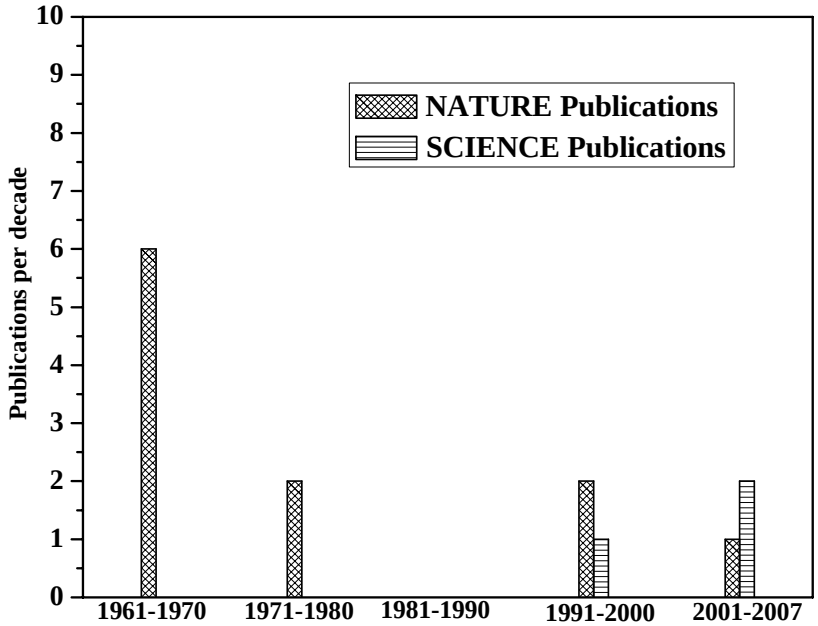


Figure: Publications in Science and Nature over the decades.

# Publications in SCIENCE and NATURE

1. Simultaneous observation of columnar defects and magnetic flux lines in high temperature E $Bi_2Sr_2CaCu_2O_8$ superconductors, Author(s): DAI HJ, YOON SW, LIU J, et al., SCIENCE, Vol. 265(5178), pp.1552-1555, SEP 9 1994.

2. Tracing modern human origins
Author(s): Harpending H, Eswaran V., SCIENCE, Vol. 309(5743), pp. 1995-1995, SEP 23 2005

3. Microfluidic Adhesion Induced by Subsurface Microstructures
Author(s): Majumder A, Ghatak A, Sharma A
Source: SCIENCE Volume: 318 Issue: 5848 Pages: 258-261 Published: OCT 12 2007

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1. Surface-active Characteristics of Sodium Salts of Anacardic Acids of Varying Unsaturation
ARUN K. BISWAS, ANIL B. RAY
NATURE 200, 1203 - 1203 (21 Dec 1963), doi: 10.1038/2001203a0, Letter

2. Solution of a Biharmonic Equation
R. D. BHARGAVA, NATURE 201, 530 - 530 (01 Feb 1964), doi: 10.1038/201530a0, Letter

3. Chlorine-36 produced by Neutron Capture in Meteorites
P. S. GOEL
NATURE 203, 1162 - 1163 (12 Sep 1964), doi: 10.1038/2031162a0, Letter

4. Influence of Carbon Dioxide in the Calcite–Sodium Oleate Flotation System
V. Y. SAMPAT KUMAR and A. K. BISWAS
NATURE 217, 1255 (30 March 1968);

5. X-ray Studies of Clay Minerals in Investigations of Contact Metamorphism
D. M. RAO and K. V. G. K. GOKHALE
NATURE 218, 760 (25 May 1968);

6. Production Rate of 10Be from Oxygen Spallation
P. S. GOEL
NATURE 223, 1263 - 1264 (20 Sep 1969), doi: 10.1038/2231263a0, Letter

7. Modification of a model membrane structure by embedded photochrome
D. BALASUBRAMANIAN, SURESH SUBRAMANI, C. KUMAR
NATURE 254, 252 - 254 (20 Mar 1975), doi: 10.1038/254252a0, Letter

8. Lattice images of dislocations in the ferroelectric material Ba2Bi4Ti5O18
J. L. HUTCHISON, J. S. ANDERSON & C. N. R. RAO*
NATURE 255, 541 - 542 (12 June 1975)

9. Problems of Indian Science
Author(s): SINGH R.P.
Source: NATURE Volume: 371 Issue: 6495 Pages: 278-278 Published: SEP 22 1994

10. Arsenic poisoning in the Ganges delta
Author(s): Acharya SK, Chakraborty P, Lahiri S, et al.
Source: NATURE Volume: 401 Issue: 6753 Pages: 545-545 Published: OCT 7 1999

11. Predecessors of the giant 1960 Chile earthquake
Author(s): Cisternas M, Atwater BF, Torrejon F, et al.
Source: NATURE Volume: 437 Issue: 7057 Pages: 404-407 Published: SEP 15 2005

# FIRST SIGNIFICANT JOURNAL PUBLICATION IN DEPARTMENTS

**Aerospace Engineering**
P.N. Murthy and G. Subramanian, Minimum weight analysis based on structural reliability; AIAA, **6** (1968) 2037-2039.

**Biological and Biosciences Engineering**
D. Dubey and S. Ganesh, 2008, Modulation of functional properties of laforin phosphatase by alternative splicing reveals a novel mechanism for the EPM2A gene in Lafora progressive myoclonus epilepsy, Human Molecular Genetics **17** (2008) 3010-3020.

**Chemical Engineering**
G. Narashiman (CHE), AIChE Journal, **11**, 1965, 550-554.

**Chemistry**
S. Singh and C.N.R. Rao (CHM), Steric Effects on Hydrogen Bonding; J. Am. Chemical Society, **88 (**1966) 2142-2144.

**Civil Engineering**
P. Paramasivan and J.K. Sridhar Rao, Buckling of plates of abruptly varying stiffness; Journal of the Structural Division, Proceedings of the American Society of Civil Engineers; ST-6 (1969) 1313-1337.

**Computer Science and Engineering**
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# APPENDIX VI

## Significant projects accomplished at IIT Kanpur

a) Among the earliest centers to be set-up at the Institute are the Advanced Centers of Electrical Science (ACES) and Material Science (ACMS). The former originated from academic programs offered to defense officers who came here for a Masters degree in electrical engineering. Under ACES there was a large project proposal developed Dr(s) K.R. Sarma and Birendra Prasada on building a microwave communication system in the Himalayas. This proposal is considered a pioneering effort in writing large proposals for funding from the government. ACMS came in the late 1970s through a grant from MHRD. A noteworthy project from UNDP gave major funding for Computer Aided Design (CAD) described later. It may be considered the first international project of the Institute. CAD project played a role of truly revolutionizing design and drawing education in the country.

b) SIDBI Incubation and Innovation Center (SIIC) was set-up in the year 1999 with a fund of Rs 2.39 crores from SIDBI bank. It is an incubation centre for setting up new industries. Entrepreneurs can use expertise available in-house and infrastructure on a payment basis. At SIIC, the institute facilitates interaction between venture capitalists and entrepreneurs. SIIC is presently concerned with patent preparation and filing as well as intellectual property rights.

c) SAMTEL Center for Display Technology (SCDT) brings together industry, academia, and the Government to facilitate research in certain frontier areas with a focus on product development and commercialization. SCDT has been a success story by world standards. It has led to the creation of cell-phone screen developed jointly by engineers, faculty and students. The center has been well-managed by Dr(s) Y.N. Mohapatra, Satyendra Kumar, and Deepak Gupta.

d) India Infrastructure research cell is jointly run by the Institute with the National Institute of Design, Ahmedabad. Dr(s) Prem Kalra and Rajeev Shekhar have provided lead roles in this initiative.

e) Prabhu Goel Security Centre is worth a million US dollars and has been set up by Manindra Agarwal and Dheeraj Sanghi. The vision of this center is to become a nodal R&D unit in the country for Computer and Internet Security. The significant achievements of this center include developing i) *Transcrypt* (an encryption file system), ii) Encryption File System for enterprises, iii) evolving a Smart Card OS standard for the country, and iv) introducing the electronic passport (*e-passport*) technology. There is a proposal to develop a National identity (ID) card in which all particulars of a citizen would be codified.

f) Research I Foundation for improving the academic excellence of the Computer Science Department was formed with a corpus amount of Rs. 11 crores from Mr. N.R. Narayanamurthy. The visiting faculty apartments were built using this budget.

g) National Information Centre for Earthquake Engineering (NICEE) is a major activity of the Institute and is well-recognized. It is an information clearing house for all contarctors – public and private, in the domain of earthquake engineering. Pioneering work in setting up the center as well as document preparation was carried out by Dr(s) S.K. Jain and C.V.R. Murty. Related to NICEE is the successful NPEEE training program. As a part of the center, a pseudo-dynamic testing laboratory is expected to be developed soon.

h) A major initiative on catalysis research and petroleum engineering has been launched by the Chemical Engineering faculty in collaboration with Hindustan Petrochemicals Limited and Chevron, USA. Professors D.P. Rao and Deepak Kunzru have played important roles in creating this research direction.

i) Nanoscience initiative: Nanoscience unit has unique facilities related to maskless lithography. It has been set-up by Professor Ashutosh Sharma. The national initiative on NanoScience and Technology of the Department of Science and Technology has funded two unique interdisciplinary proposals to setup twin units of Nanoscience and Nanotechnology at IIT Kanpur. The goal is focused development of technologies based on the rapidly developing subject of nanosciences can be undertaken. At IIT Kanpur, the Nanoscience Unit was initiated in 2005 with a total outlay of Rs. 13.5 crores and the Unit on Nanotechnology was started in 2007 with a total cost of Rs. 11.5 crores, both for a period of 5-years. Some of the major current research projects include a) Nano and meso-scale patterning and fabrication technologies for polymers with applications in fluidics, sensors and manufacturing of smart and functional structures, b) Intelligent organized structures for gas absorption and catalysis and carbon MEMS including micro batteries, c) catalytic filtration, air and water purification, and carbon MEMS, iv) Development of super-hydrophobic surfaces and super-adhesives based on meso-patterning, and d) Development of ways and means to synthesize ordered arrays of quantum dots and nanowires of optically, electrically and magnetically functional materials, including the stress engineered meso-structures.

j) Nanotechnology: The Nanotechnology initiative was been set up by Professor Y.N. Mohopatra. This initiative has major ongoing research activities in the following areas: a) development of printable organic electronics with Organic-RFID tags as the first demonstrator prototype and b) development of a versatile focused ion beam tool based on microwave plasma ion beam for applications in patterning and templating of soft-materials and substrates.

k) Indo-US Advanced Manufacturing: The initiative was launched in the year 2006 though it was conceived much earlier. The thought process involved in the joint-project is the following. It has been felt that the philosophy of making things and fabricating devices is going to experience revolutionary changes. According to most experts it is almost certain that the third Industrial Revolution is almost knocking at the door as our capabilities in the fields of molecular engineering, micro and nano system technology, material science and computer engineering are making very fast progress. Once our ability to manufacture micro and nano sized devices and autonomous machines mature, it will bring unprecedented changes in the

human society. Fabrication technology is also being further enhanced as our ability to make things with a bottom-up approach instead of the traditional top-down approach is developing at a rapid rate.

Considering these aspects a number of scientists and engineers from various Indian and US universities came together in March 2004 to attend the Joint Indo-US Workshop on Advanced and Futuristic Manufacturing, held at IIT Kanpur. The event was sponsored by the Indo-US Science and Technology Forum, New Delhi. This event was followed up by a few faculty members from IIT Kanpur, IIT Kharagpur, UIUC, Northwestern University and UCI in the form of joint seminar programs, workshops and collaborative research activities. IIT Kanpur also appointed Professors Shiv Kapoor, Marc Madou and Kornel Ehmann as Distinguished Visiting Professors. Finally based on the proposal submitted by IIT Kanpur in collaboration with the other four universities, Indo-US Science and Technology Forum sanctioned the Indo-US Joint Centre for Advanced and Futuristic Manufacturing in April 2006.

The second phase of the Indo-US initiative was launched in mid-2008 with a focus on a new area, to be called fabrionics against the following background. It is being increasingly felt that soon it will be necessary to develop scores of engineers and researchers who will be expert in the field of material manipulation for diverse requirements at micro, nano and molecular levels. Knowledge in applied quantum mechanics and molecular engineering, microfluidics and microsolidics, nanometrology, simulation of molecular dynamics and materials science, biomimetics, and metrology and measurements will be essential for working in the area of Futuristic Manufacturing through Material Manipulation at Micro, Nano and Molecular levels. The following research areas have been identified:

1. New strategies / approaches for fabrication and shape generation through material manipulation at meso, micro and nano scales
2. Fabrication at small scales using exotic materials – soft materials, bio materials, polymers , gels, composites
3. Generative manufacturing processes – direct metal deposit techniques for micro sized parts
4. Shape generation by self assembly technique and self patterning
5. Micro fluidic-based micro devices – both modeling-simulation and development
6. AFM based technology for mRNA isolation and protein sequencing
7. Smart material actuated micro mechanisms and micro devices
8. Protein motors for actuating autonomous nano robots and manipulators
9. Micro machine tools and micro factories
10. Hybrid Multi-scale process development

l) Quantum computing: Dr. Debabrata Goswami initiated an interdisciplinary area of Quantum computing at IIT Kanpur in 2003. His research group has contributed in performing both experimental and theoretical research in interdisciplinary areas, focusing on coherent control and future technology development in optoelectronics, computation and medicine. An Indo-US joint center entitled *Quantum Computing: Back Action* was held at IIT Kanpur during 6-12$^{th}$ March 2006.

m) National Program for Technology Enhanced Learning (NPTEL) a distance-education project as a collaborative venture of al IITs was initiated in the first decade of the twenty first century. Dr Gautam Biswas participated in this project and soon it was found that IIT

Kanpur produced the largest number of web- and video-courses. This experiment led to the distance education project with the Government of Chattisgarh and later, the Cyber-University idea with French Universities, under the umbrella of MHRD.

n) Railway Technology Mission: In a major initiative, Indian Railways and MHRD have funded a set of projects intended to improve safety in rail travel. Dr N. S. Vyas is the mission coordinator that includes projects from Railways Design and Standards Organization (RDSO) Lucknow, Durgapur Steel plant and other Government industries. One of the most significant accomplishments is the project known as SIMRAN that monitors position of trains and generates signals for preventing collisions. Given the size of the rail network in the country, the impact of this development is truly enormous. As part of this project, the researchers at IIT Kanpur have developed new steel compositions for better strength and impact resistance properties.

o) RFID (Radio frequency). Boeing may give us a contract. Dr Samresh Kar and SC Srivastava.

p) Anupravaha: This is a project in the domain of computational fluid dynamics. A group of faculty from Mechanical Engineering coordinated by Dr. V. Eswaran has developed user-friendly software for solving fluid flow and transport equations. The software is quite general in terms of geometry. It can accommodate a variety of fluid flow phenomena including unsteady vertical flows, turbulence, phase change, electric fields, and chemical reactions. The software has been developed for use in Bhabha Atomic Research Center, Mumbai.

q) Center for Environmental Science and Engineering: The Center, created using MPLAD funds of Mr. Arun Shourie focuses on remedial technologies for improving the quality of the environment. The building itself has been given a Five Star rating by TERI (The Energy Research Institute) at New Delhi on the basis of its green features. The building has insulated walls, ceilings, window glasses, reflective terrace, rainwater harvesting, ecofriendly refrigerants for air-conditioning, and use of solar energy for water heating and lighting. In fact, trees cut during the construction of the building have been carefully replanted. The focus areas of the Center are sensors, water, and public health.

# Appendix VII
# Creation of Cells

1. Space technology cell
2. Railway technology cell
3. HAL-IITK cell
4. IGCAR-IITK cell

# Appendix VIII
# Description of Centers

## Advanced Center for Electronic Systems

Among the earliest centers to be set-up at the Institute are the Advanced Centers of Electrical Science (ACES) and Material Science (ACMS). The former originated from academic programs offered to defense officers who came here for a Masters degree in electrical engineering. Under ACES there was a large project proposal developed Dr(s) K.R. Sarma and Birendra Prasada on building a microwave communication system in the Himalayas. This proposal is considered a pioneering effort in writing large proposals for funding from the government.

# Advanced Center for Materials Science

Advanced Centre for Materials Science was created in 1978 through a grant from MHRD with a view to make available major materials preparation and characterization facilities under one-roof. These state-of-the-art research facilities are regularly upgraded, and maintained by suitably trained competent staff. The centre has been serving the needs of the materials community from the institute as well as other academic and industrial establishments for over thirty years. For every laboratory there is a users' committee consisting of members drawn from various departments of the institute. For routine maintenance electronics and machine shops are there. Besides we also have support services of stores and administrative office.

The main areas of research at the Center are the following:

Electro optics & Materials
Virtual Instrumentation
Computer Controls
Small Angle Neutron Scattering
Corrosion of Advanced Ceramics

The Center enjoys the following facilities:

Electron microscopy Lab
Magnetics Lab
Materials Processing Lab
Materials Testing Lab
X-ray Lab

# Center for Archaeological Sciences and Technologies

It was created in January 2008 with the following objectives: Set up a multi-institutional, multi-disciplinary R&D center at IIT Kanpur to nucleate and strengthen development of technologies in archaeological applications and cultural resource management. The center has partners at the University of Allahabad and the Archaeological Survey of India (Ministry of Culture). Its current activities are:

- Terrain Mapping and Archaeo-scientific Studies of Ahicchatra (District: Bareilly, UP): Project (GPS, GIS, GPR, Total station) survey for creating a database with the aim to help archaeological study. Collaboration with ASI.
- Evolution of Varanasi (using remote sensing, GIS, GPS) to generate a GIS based database to help in archaeological investigation. Sponsored by DST, Collaborating with the Department of Archaeology, BHU.
- Seismic Retrofitting and Terrestrial Laser scanning of Roomi Gate at Lucknow. Collaborating with ASI.

The center has succeeded in establishing a dialog between archaeologists on one hand and scientists and engineers on the other. In addition, a GIS database has been developed for the Ahicchatra site and its antiquities have been documented. Ground penetrating radar profiling of this site is in progress.

# Center for Mechatronics

The first formal course on Robotics for undergraduate and postgraduate students was introduced in 1983 in the Department of Mechanical Engineering. The following two events of 1984, arranged by Professor Amitabha Ghosh gave impetus to activities in this area:

- An *All India Workshop on Robotics*, held at IIT Kanpur in August 1984 and jointly organized by IIT Kanpur and AIEI (now CII), in which about 50 delegates from the industry and the academia participated.
- The *National Symposium on Robotics* organized at IIT Kanpur in December 1984 in which more than 100 delegates and a number of experts from abroad participated. This symposium was sponsored by DST, DOE, DRDO, BHEL, Ordinance Factory Board, IIT Bombay, IIT Delhi, IIT Madras, TELCO, GODREJ, and Thapar Corporate R&D Center. Invited lectures were delivered by Dr. S. Inaba, President, FANUC, Japan, Mr. Fumio Fukuchi, Chief, Robot System Division, Hitachi, Japan, and Professor N. Martensson from Sweden among others.

Thereafter, the activities in Robotics at IIT Kanpur greatly increased in the form of additional elective courses, M.Tech., and Ph.D theses, and sponsored projects.

It was realized that to have a balanced growth in an area such as Robotics, it was necessary to involve more than a single department. The subject attracted faculty and the students from four academic departments and one interdisciplinary program. It was with this objective that the Center for Robotics was established at IIT Kanpur in 1989. A project grant of about Rs. 50 lakhs from the Ministry of Human Resource Development (MHRD) was utilized to set-up the Center.

To reflect evolution in the subject from robots all the way to intelligent vehicles, the center was renamed Center for Mechtronics in the year 2004.

# Computer Center

Computer Center provides a host of services to the employees of the Institute, including email, web and internet access, DNS, FTP, high performance computing, and PC laboratories for conducting courses for students. It hosts general purpose as well as special purpose software suitable for design, drawing, and analysis.

This center was established in 1964 and it was started in Western Laboratories under Department of Electrical Engineering. It moved to its present building in 1969 when it was recognized as an independent facility in the institute. During its early days, there were Unit Record Equipments which used to mechanically process Hollerith punch cards. IBM-1620 was the first computer acquired by IIT Kanpur. IBM 7044 mainframe computer along with its satellite computer IBM-1401 was added in 1969 when the centre was also moved to the present building

Several specialized computers such as IBM-1800 and PDP-1 were added in subsequent years. The first major upgradation was the addition of DEC-1090 mainframe computer in 1979, which was the first time sharing computer of IIT Kanpur. This was the first computer which had independent terminals.

In 1989, the computer center purchased networked computers of HP 9000 series which included four servers, four high end workstations, and twelve normal workstations. These belonged to the super-mini range of computers. To provide access to this computing environment, the first campus network was laid which connected the computer center to terminals installed in various locations in the academic area. This was a 10 Mbps coaxial cable based local area network (LAN). During the same period Convex C-220, a vector computing server for high end numeric computing was installed. It was classified as a mini-super computer of that era.

In 1987, the first PC lab was setup providing DOS environment. These laboratories have been growing over the years and today we have both Linux and Windows-based personal computers. In 1995 the campus network was upgraded to 100 Mbps fiber backbone and 10 Mbps UTP Access Network, providing connectivity to all the departments, faculty and staff offices and research laboratories. In 1995, PARAM 9000, a 24 node parallel computer was installed through an MOU with CDAC Pune. This event signaled the onset of parallel computing and algorithms at the Institute. The full power of parallelization of computer programs, however, would be realized only a decade later on powerful clusters. In the year 2000, this network was also extended to student hostels. In 2005 the network was again upgraded to a gigabit network. Currently, the computer center supports a campus network with more than 12000 nodes.

As a plan for the future, the center aims at housing high performance clusters procured from projects (individual as well as institutional) while providing amenities such as uninterrupted power and air-conditioning. In turn, these machines could be networked to provide a rich platform and a powerful resource across the Institute.

# Facility for Ecological and Analytical Testing

Facility for Ecological and Analytical Testing (FEAT) was set up at IIT Kanpur in 1997 to carry out testing of various organic and inorganic materials and generate awareness about eco-testing and its importance in the export business. The drive for clean products due to strict scrutiny of export material has made it important to establish good eco-testing laboratories all over the country. The Government of India has initiated a series of measures to ensure adequate testing facilities for industries. One such measure has been the establishment of FEAT at IIT Kanpur.

For setting up FEAT, the Ministry of Textiles gave IIT Kanpur a grant of over Rs. 2 crores. The laboratory started functioning in February 1998. Apart from the initial grant, the facility is expected to be self-sustaining. Development of natural dyes and of alternate solutions for banned dyes stand at the top of the activities of FEAT. Although the facility was initially expected to carry out only testing and analysis of textiles based samples, FEAT took the initiative to test samples from within the Institute and other industries as well. This has helped in better utilization of its infrastructure.

The original goals of the facility are as follows:

1. Eco testing for sensitive chemicals such as amines, pesticides, formaldehyde, pentachlorophenol and heavy metals.
2. Advanced training in operation and maintenance of test equipment.
3. Chemical analysis pertaining to alloys, water effluents, and environmental contaminants.

In addition, FEAT is accredited in respect of test certification, transfer of technology for testing equipments, calibration and interpretation of test standards.

FEAT is equipped with major instruments such as

1. Gas Chromatography-Mass spectrometer(GC-MS)
2. High Performance Liquid Chromatography(HPLC)
3. Atomic Absorption Spectrometer(AAS)
4. Gas Chromatography(GC)
5. UV-VIS spectrometer(UV-VIS)
6. Inductively Coupled Plasma Spectrometer(ICP)
7. Microwave Ashing Furnace(MAF)
8. Microwave Digestion System(MDS)
9. Total Organic Carbon Analyzer(TOC)
10. High Performance Thin Layer Chromatography(HPTLC)

Some of the early clients of FEAT include Ordinance Equipment Factory, IFFCO, ICI Katalco, UP State Handloom Corporation, ITI, Jet Detergents, Holistic Biotech, and Northern Railway Electric Locoshed.

# ISRO-IIT Kanpur SPACE TECHNOLOGY CELL

The ISRO-IITK Space Technology Cell was established on March 02, 2001 with the signing of Memorandum of Understanding between the Chairman, Indian Space Research Organization and the Director, Indian Institute of Technology Kanpur. It follows the realization of importance attached to generation of knowledge through academic Research & Development effort to ensure a truly self-reliant and self generating space program for our nation in future years.

The mission of the cell is to visualize and identify the challenging issues and complex multi-disciplinary problems in the years to come. A proactive approach will be adopted with regard to the future needs of the Indian Space Programs by creating an extensive research base and optimal utilization of knowledge, expertise and experience. The Space Technology Cell intends to harness the advanced areas of space science and technology by taking up quality and quantity research of high worth to the Indian Space Programs, thereby contributing to the all-round development of the nation and optimal benefit to its citizens.

The following subjects have been identified as thrust areas for collaboration:

1) Structural Engineering dealing with composites and smart structures.
2) Dynamic Analysis and Control of Spacecraft and Launch Vehicles.
3) Software related to different applications.
4) Identification of new advanced space technology and its application areas.

# Media Technology Centre

Established in 1965, under Kanpur Indo-American program with the objective of helping in developing a scientific temper and extension of education through audio visual means, it was a unique setup among all IITs. The TV Center became visible in 1973 with the live broadcast of the 3rd cricket test match between India and England, held at the Green Park stadium Kanpur. Eminent personalities to appear on programs produced by the TV Center include Dr. S. Radhakrishnan, Pandit Ravishanker, Shri P.N. Haksar, Dr. Raja Ramanna and Mr. Khushwant Singh. TV Centre produced 12 educational programs on basic concepts of science for the ISRO's 1st SITE experiment.

Towards the end of 1976, video technology appeared on the scene and soon a number of films on science and education were prepared. Sponsored by IRDT, a workshop on video film production was organized for the benefit of teachers of Polytechnics.

In 1988, Government of India approved the education technology project which enabled TVC to acquire the latest professional equipment.

Realizing the dearth of trained man power, a one year training program was started for program assistants in 1991. The trainees subsequently were absorbed in organizations such as Doordarshan, Zee TV, and El TV.In the decade of 1990-2000, TV Center made an 8 hours program on cancer operation followed by a similar effort for and eye operation. Contributions were made to UGC and Doordarshan in terms of educational programs. Indian Army's 45 cavalry unit sponsored the making of the film *Veerabhagya Vasundhara*, broadcast through Doordarshan. The documentary *Parvatia's village*, spnosred by Department of Rural Development, UP Government, was repeatedly broadcast by Doordarshan.

TV Center of yore has evolved into the Media Technology Center and is in the midst of implementing the NPTEL project. National Program on Technology Enhanced Learning (NPTEL) is a Ministry of Human Resource Development (MHRD) initiative to promulgate quality education among the Engineering Colleges in the Country through Video and Web-based learning material. It is implemented in a collaborative manner utilizing quality faculty of premier educational institutions. The seven Indian Institutes of Technology and the Indian Institute of Science Bangalore are presently involved.

The main objective of this program is to enhance quality of engineering education in the country by developing curriculum based video and web courses. The program took off under the chairmanship of Professor M.S. Ananth, Director, IIT Madras in the year 2003. With faculty and Instructional Design teams, participating from each of the participating Institutions, the effort has produced lectures in video format as well as web-based format.

Indian Institute of Technology Kanpur has setup the space for the Media Technology Center with a web-studio to create, conduct, and record courses.

# Center for Nanotechnology

The national initiative on Nano-Science and Technology funded a unique interdisciplinary proposal to setup a Centre for Nanotechnology at IIT Kanpur in January 2007 with a budget of Rs 12 crores. The goal of the project is development of technologies based on the rapidly developing subject of nanoscience. At IIT Kanpur, the project has been formulated to carry out technology development in the following three *inter-related* areas:

(i) Development of Printable Organic Electronics with Organic-RFID tags,
(ii) Nano and meso-scale patterning of polymers with applications in fluidics, sensors and manufacturing of programmable structures, and
(iii) Development of a versatile focused ion beam tool based on microwave plasma ion beam for patterning and templating of soft materials and substrates.

The importance of nanoscience is widely recognized and there has been a spurt of research, development and inventions in the area. Focused and synergistic efforts are needed to complete the chain of innovation by enabling their use in practical devices and ultimately convert them to technologies. Accordingly, the objectives of the new center are the following:

a) Providing facilities and systems so as to enable demonstration of prototype devices using ideas and inventions in nanoscience and technology, and make the fruits of nanotechnology available to user agencies, and promote industry-academia interaction with such technologies as the foci;

b) Setting up enabling facilities for nanotechnology based device development with specific initial focus on printable electronics using soft materials such as molecular solids and polymers and their heterostructures with inorganic systems;

c) Encouraging researchers in nanotechnology to harness the capabilities in nanopatterning and structures in soft materials for applications in fluidics, sensors, and manufacturing;

d) Developing technology tools such as focused Ion Beam as a product and demonstration of its capabilities in prototyping of devices based on nanotechnology;

e) Providing an academic platform, leadership, knowledge base and enabling technologies in polymer electronics and nanoengineering based on continuous fundamental research, innovations, brain-storming and networking with industry, research organizations and educational institutions.

f) Training of graduate students, research associates, post-doctoral fellows and faculty of other institutes/universities in nanomaterials, nanotechnology and polymer based devices, thereby creating a base of experts in the country.

# Nanoscience Unit of DST

Dr. T. Ramasami, Secretary, Department of Science & Technology, Government of India, inaugurated the DST Unit on Nanosciences on December 7, 2008 at the Nanosciences Laboratory Building, IIT Kanpur

The unit aims at studying mesoscale structures, patterning and properties with emphasis on soft materials and thin films. It has been set-up to create a state-of-the-art facility for soft matter nano-science and nanotechnology. It will explore new techniques of nano-fabrication based on soft lithography, self-assembly and self-organization. Projects related to nano-scale understanding, fabrication and use of soft materials in coatings, NEMS, and functional interfaces are in progress. The floor area available is 2500 sq. ft. of class 1000-100 clean rooms

**Specific Scientific Objectives**

- Development of novel and facile techniques for patterning, structuring and fabrication using soft materials like polymers, gels, biological materials
- Development of functional interfaces such as super-hydrophobic surfaces and super adhesives based on mesopatterning of surfaces
- Attachment –detachment energetic of sub-micron particles to surface and modulation by surfactants
- Synthesis of ordered arrays of quantum dots and nanowires including doped oxide and metal alloys and magnetic materials
- Exploration of interfacial instabilities and failure mechanism in soft nano-structures
- Development of soft composites including polymer-nanoclay composites, thin film of meso-porous silica and its nanocomposites
- Magnetic nanoparticles and assemblies
- Development of computational nanomechanics
- Micro-SQUIDS and nanoscale magnetic including magnetic relaxation and supermagnetism
- Fabrication of carbon meso-structures based on soft
- Exploration of interfacial instabilities and failure mechanism in soft nano-structures
- Development of soft composites including polymer-nanoclay composites, thin film of meso-porous silica and its nanocomposites
- Magnetic nanoparticles and assemblies
- Development of computational nanomechanics Micro-SQUIDS and nanoscale magnetic including magnetic relaxation and supermagnetism
- Fabrication of carbon meso-structures based on soft fabrication techniques
- Microfluidicbased devices and sensors

# National Information Center of Earthquake Engineering

India has a very serious earthquake problem. To mitigate earthquake disasters, the profession needs to be up-to-date on developments in the field. The National Information Center of Earthquake Engineering (NICEE) at Indian Institute of Technology Kanpur is intended to collect and maintain information resources/publication on earthquake engineering and make these available to interested users, as well as to undertake other outreach activities with a view to mitigate earthquake disaster. Created in the year 2004 from a grant of Rs Rs 1 crore from the Ministry of Earth Sciences to Dr. S.K. Jain, the Center is operated such that the costs on infrastructure development and administration are minimized.

The objectives of NICEE are:

- To be on the constant look out for the new publications, audio-visual materials, etc., in the area of earthquake engineering
- To create and maintain a good storehouse of information/publications/ other audio-visual materials on earthquake engineering
- To disseminate information about availability of the above material at IIT Kanpur to the interested professionals/researchers/academicians and others
- To make available the material to the interested persons in the country in a timely manner
- To undertake other activities related to information dissemination in earthquake engineering
- To publish and disseminate earthquake engineering publications

# National Wind Tunnel Facility

National Wind Tunnel Facility (NWTF) was established in 1999 at IIT Kanpur by Dr. N.L. Arora using financial support from AR&DB, DST, as well as MHRD. It fulfills needs of research and testing in areas of aeronautical and non-aeronautical engineering. NWTF houses the most versatile and efficient wind tunnel in India. It has various simulation and measurement systems, interchangeable test sections and is capable of testing at wind speed up to 80 m/sec. NWTF is committed to take up sponsored and consultancy projects as well as supporting the academic research at IIT Kanpur.

The National Wind Tunnel Facility is a user's facility available to the aerospace industry for national projects and non-aeronautical users in civil engineering and automobile industry. Graduate and undergraduate students from Aerospace, Civil, and Mechanical Engineering departments are provided an opportunity to carry out their research at NWTF. Faculty members from various departments of the institute participate in the functioning of NWTF.

The facility focuses on the following areas of research:

- Wind Tunnel Instrumentation
- Missile Aerodynamics
- Decelerator Aerodynamics
- Unsteady and High Angle of Attack Aerodynamics
- Take-off and Landing Characteristics of Aerospace Vehicles including Ground Effect
- Development of High Lift Devices
- Transport Aircraft Studies Including Aerofoil Development.
- Helicopter Aerodynamics
- Aerodynamics of Road Vehicles
- Wind Effect on Structures Including Interference Effect.
- Aerodynamics Wind Power Devices
- Air Pollution Dispersion

The wind tunnel facility is now in a state of expansion. The foundation laying ceremony for the augmentation of the National Wind Tunnel Facility was held on Monday 6th October, 2008.

# Prabhu Goel Research Centre for Computer and Internet Security

The Prabhu Goel Research Centre for Computer and Internet Security at IIT Kanpur was established with a grant of US$ 1million. The centre was inaugurated on June 3, 2003 by Dr. Vidyasagar, Executive Vice President, Advanced Technology Centre, TCS Hyderabad.

The vision of the centre is to become the nodal R&D centre in the country for all aspects of computer security and to educate various governmental and non-governmental organizations on the security issues and help them in this regard. The centre is therefore undertaking research, training, and consulting activities in the area of computer and Internet security. The centre also collaborates with defense and security agencies in developing various security technologies. IIT Kanpur has already been doing work in the area of Computer Security. The establishment of this centre is expected to give a tremendous fillip to this activity.

The following projects are have been in progress over the past few years:

TransCrypt

Bulk Encryption Device- Hardware based Encryption/Decryption Solution

MIDS- Malware Infection Detection System

Netlog Server

Previous Projects

Sachet - A Network Based Intrusion Detection System.

Gigabit PickPacket - A Network Monitoring Tool for Gigabit Networks.

Zarc - Antispamming Software

Secure Linux

Tied-LibsafePlus- Runtime Protection from Buffer Overflows

Trinetra and Indra - Symmetric key cryptography algorithms.

PickPacket - A Network Monitoring Tool.

SCOSTA - Smart Card Operating System for Transport Applications.

Cryptanalysis

Tool to crack WEP (RC4) encryption

# Samtel Center for Display Technologies

Samtel Center for Display Technologies (SCDT) was formally established on 5th March 2000 through a memorandum of understanding between Samtel Group of Industries and IIT Kanpur. This has been a beginning of one of the most significant efforts towards meaningful industry-academia interaction to meet the challenges of emerging technologies in electronic displays. The objectives of the center are:

1. To conduct R&D so as to nurture and support growth of science and technology of electronic displays;
2. establish a tripartite relationship between industry, academia and governmental agencies so that the country can become a global leader in Display Technology; and
3. develop human resources in display technology.

SCDT has created quite a few processing facilities on its stand-alone premises. Two of these are described below.

**Clean Room Processing & Fabrication:**

The Centre has set-up a clean room (Class 1000, Area 220 square meters) with the cleaning and entry protocols comparable to industry standards. This is a unique facility in the country where even under-graduate students get access to the clean room facilities equipped with the best device processing and characterization facilities. The facilities include: Integrated Glove Box Vacuum Deposition for polymer based devices and, Ultra High Vacuum R & D OLED System for small molecule devices, ITO Deposition, Oxygen Plasma Treatment of ITO, Spin coating, Vacuum Drying and UV-Ozone Treatment. A yellow room with mask aligner and photo-lithographic facilities is also established.

**Diagnostic tools:**

All the electronic and optoelectronic characterizations required to pronounce the in-house materials to be of international standard have been painstakingly developed. The Centre has now expertise on a whole array of characterization techniques at the level of materials and device essential for optimization of process or structures. They include: thickness profiler, time resolved photoluminenscence, imaging microscope, impedance and spot radiometer electroluminescence, transient spectrometer, optical and electrical PL quantum efficiency measurement set-up, and spectroscopic ellipsometry. Solar Cell I-V characteristics, spectral response and set-ups for device life-time and reliability testing have been developed.

# SIDBI Innovation and Incubation Centre

IIT Kanpur set up the SIDBI Innovation & Incubation Centre (SIIC) in the year 1999 in collaboration with Small Industries Development Bank of India at a cost of Rs 2.39 crores. The idea is to foster innovation, research, and entrepreneurial activities in technology-based areas. SIIC provides a platform to Start-ups prospective entrepreneurs and entrepreneurs to convert their innovative ideas into commercially viable products.

SIIC facilitates the modification and upgradation of software and products developed by the faculty, staff, and students of IIT Kanpur to the industry requirements with the help of a commercial partner. The concerned faculty member acts as a mentor. The commercial partner is also responsible for marketing and customer support.

The following facilities are provided by the center to the incubatee soon after the proposal is approved for support:

Seed Money
In-Campus accommodation
Mentoring
Business plan development
Business promotion
Incubation space
Various types of office support
Library and documentation
Assistance in obtaining finance
Advertisement agencies
Legal experts
Electronic and animation cell
Access to a variety of resources of IIT Kanpur

As a new initiative during 1998-99, the Ministry of Science and Technology, Government of India launched a novel initiative known as *Technopreneur Promotion Programme* (TePP) jointly operated by the Department of Scientific and Industrial Research (DSIR) and Technology Information, Forecasting and Assessment Council (TIFAC) of the Department of Science and Technology (DST) to tap the available innovative potential within the country. TePP is a mechanism to promote individual innovators to become technology-based entrepreneurs. SIIC was declared a TePP Outreach Centre (TOC) in the Kanpur region in the year 2004. This essentially means that the technopreneurs in the region will now get benefits of the scheme faster and in a simpler manner.

INCUBATEE COMPANIES at SIIC (commencement date in brackets)

1) Weather Risk Management Services Pvt. Ltd. (June 2006)
2) Hexolabs Media and Technology Pvt. Ltd. (January 2007)
3) Aurora Integrated Systems Pvt. Ltd. (September 2006)

4) Simmortel Voice Technologies Pvt. Ltd. (March 2007)
5) Innovative Embedded Systems ((September 2005)
6) Whorl Engineering Solutions Private Limited (September 2004)
7) Multifacet Software Systems Pvt. Ltd. (November 2004)
8) EI Devices Software Solutions Pvt. Ltd. (September 2007)
9) IAITO INFOTECH Pvt. Ltd. (February 2008)

Graduated Incubatees (year of exit in brackets)

a. Whirlybird Electronics Pvt. Ltd. (2006)
b. Adya Systems Pvt Ltd. (2006)
c. Zion Technology Labs Pvt. Ltd. (2006)
d. Handshake Infotech Pvt. Ltd. (2005)
e. Messiah Labs (2003)

# Railway Technology Cell

Railways have been the engine of economic and technical growth and development in India. Railway Safety is not merely an area of national concern but also poses challenges to the engineering and research community.

The Railway Technology Cell, created in June 2007 helps focus attention and drive modern technologies of monitoring, control, communications, design, electronics and materials towards railway safety. Similar national programs on space and defense research have not merely achieved goals specific to the missions, but have also provided impetus to technology endeavors in institutions all across the country. A technology mission on railways operated through a cell will similarly help to initiate and incubate design and development projects of significant.

Technology issues on railway safety and economy relate to multitude of engineering disciplines. The cell will help to pool relevant engineering knowledge, expertise and resources available in various research organizations and academic institutions in order to address these issues in an efficient manner.

The Railway Technology Cell is presently conducting projects identified under the Railway Technology Mission. The Mission objective is to develop and adopt state-of-the-art safety, control and design technologies defined by needs related to Indian conditions. The Mission has formulated and implemented projects aimed towards achieving higher throughput, lower cost of transmission per unit and safer train movement.

The overall goals of the cell are summarized below:

1. To develop and adopt state-of- the-art safety and control technologies defined by needs related to Indian conditions; to implement projects aimed at achieving higher throughput, lower cost of transmission and safer train movement.
2. To encourage and initiate R & D activities pertinent to Indian Railways in academic institutions and laboratories and establish convergence and synergy among them.
3. To evolve and establish the academia-research institution-industry consortium approach as a viable and vibrant mission mode of research and development.
4. To disseminate technologies through participatory approach to other application areas.

# UTTAR PRADESH POWER TRANSMISSION CORPORATION

This Memorandum of Understanding was signed between Indian Institute of Technology Kanpur and the UP Power Transmission Corporation Ltd. on February 26, 2008. The objective of this memorandum is to create a collaborative arrangement between IITK and UPPTCL to accelerate the development of the electrical transmission system in the State of Uttar Pradesh through appropriate application of science and technology, Such collaborative effort would enable the State of Uttar Pradesh to utilize the scientific, technological and managerial resources of IITK for introducing modern technology, for accelerating economic growth and updating its technological skills. IITK, in turn will get the opportunity to utilize the skills of its highly qualified and globally recognized faculty to tackle the real life problems of electrical power systems.

IITK and UPPTCL have agreed to collaborate in the following areas:

1. System studies in the evaluation of Anpara C and Anpara D thermal power (765 and 400 KV) to Unnao and their distribution to load centers.

2. Construction of transmission lines and finalizing equipment specification.

3. Load flow analysis of transmission networks.

# Center for Laser Technology

The Center for Laser Technology (CELT), created in the year 1988, acts as a nodal point for all laser related research at IITK. It runs a unique interdisciplinary M.Tech program which draws faculty from the Departments of Aerospace Engineering, Chemistry, Chemical Engineering, Electrical Engineering, Mechanical Engineering, Metallurgical Engineering, and Physics. The research activities at the center span a wide spectrum of topics involving diverse academic disciplines leading to interdisciplinary research of high caliber and productive output in terms of large scale projects completed at the Center. The Center also coordinates all academic activities related to M.Tech. students in the Laser Technology Program.

# Center for Environmental Science and Engineering

The Center, created in January 2008 using MPLAD funds of Mr. Arun Shourie focuses on remedial technologies for improving the quality of the environment. The building itself has been given a Five Star rating by TERI (The Energy Research Institute) at New Delhi on the basis of its green features. The building has insulated walls, ceilings, window glasses, reflective terrace, rainwater harvesting, ecofriendly refrigerants for air-conditioning, and use of solar energy for water heating and lighting. In fact, trees cut during the construction of the building have been carefully replanted. The focus areas of the Center are sensors, water, and public health.

# Autodesk Inc- IIT Kanpur Digital Innovation Lab

The Autodesk IITK digital Innovation Laboratory was inaugurated in January 2008 and has been set up in the Drawing Hall Complex. Autodesk India has provided a comprehensive suite of their software products, Hewlett Packard has provided 20 high-end graphics workstations while IITK has renovated and prepared the site for housing the laboratory. The laboratory, arising from the MoU signed between Autodesk and IITK conducts research and teaching centered around the Autodesk software as well as other compatible software installed on the workstations. These include Autodesk Inventor, a solid modeling and virtual simulation tool, Mapguide Studio, a tool for geospatial data management and high end animation tools such as Maya and 3dMax.

## Current Usage

1. Several training sessions have been conducted by certified Autodesk personnel on Inventor, Max3d and Maya. Each training session was attended by 25 students.
2. Maya and Max3ds are being used extensively by the students of the Design Program.
3. The Civil Engineering Department uses Mapguide 3D to develop novel GIS applications.
4. Courses have been conducted for HAL engineers, students attending the SURGE program and the laboratory has been used for the undergraduate courses ME251 and TA101.
5. A group of students conducted a series of courses on Inventor for other students of the Institute. In addition, the laboratory and its resources are regularly used by students for various specialized requirements.

## Future Plans

1. Facilitate transition from AutoCAD to Inventor: conduct courses for students and faculty in collaboration with Autodesk personnel on the use of solid modeling tools.
2. Encourage development of design and analysis tools centered on the software available.
3. Encourage use of Inventor in undergraduate and research projects as well as regular courses.

# Appendix IX
# Selection of Technologies developed

# Appendix X
## List of self-financing courses

| Year | Principal Investigator | Title |
|---|---|---|
| 2008 | Onkar Dikshit | Fundamentals of Surveying with Special Emphasis on Use of Total Stations for Civil Engineering Operations |
| 2008 | Padma S Vankar | Advance Analytical Course for Life Sciences and Biotechnology |
| 2008 | Shantanu Bhattacharya | Nanotechnology Workshop |
| 2008 | Vinayak Eswaran | Fundamentals of CFD & HT |
| 2008 | Sudhir Misra | Workshop On Construction Safely |
| 2008 | Mukesh Sharma | Air Dispersion Modeling: Fundamentals and Applications |
| 2008 | Swagato K Ray | Organizing Advanced Training in Mathematics School for Lecturers Series |
| 2008 | V K Jain | Micromachining |
| 2008 | B V Phani | Finance |
| 2007 | N Sathyamurthy | Non-Adiabatic Interactions in Molecular Systems |
| 2007 | Onkar Dikshit | Geographical Information System (GIS) |
| 2007 | Sanjay G Dhande | Micro/Nano Manufacturing and Production Management & Control |
| 2007 | Prem K Kalra | Short Course On Audio/Video |
| 2007 | S K Gupta | Newer Optimization Techniques for Chemical Engineering Applications |
| 2007 | Prem K Kalra | Outreach Program for Colleges Connected Through E-Learning Infrastructure |
| 2007 | B V Phani | Tepp Training-cum-Orientation Program |
| 2007 | S N Singh | Performance Analysis and Trading of Wind Power Generation N Emerging Power System |

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|---|---|---|
| 2006 | C V R Murty | Short Course on Nonlinear Seismic Analysis of Structures |
| 2006 | C V R Murty | Short Course on Architecture for Earthquake Resistance of Building, Surat |
| 2006 | Onkar Dikshit | Use Of Modern Technologies In Archaeology |
| 2005 | C V R Murty | Sensitization Program in A&N Islands on Earthquake resistant Constructions |
| 2005 | Animangsu Ghatak | Adhension and Friction and Soft Interfaces |
| 2005 | Kripa Shanker | Mechanics, Machines & Manufacturing at IIT, Kanpur |
| 2004 | Ashish Dutta | Short Term Course Robotics and Automation |
| 2000 | Sanjeev Swami | Marketing on the Internet |
| 2000 | E Rathakrishnan | Conference on National Convention of Aerospace Engineering |
| 2000 | A K Mittal | Workshop on Intellectual Property Rights |
| 2000 | J P Gupta | Hazard Analysis in Chemical Industry and Inherently Safer Plant Design |
| 2000 | Amalendu Chandra | Winter School on Statistical Mechanics (Sponsored by DST) |
| 2000 | Ajai Jain | IBM Teachers Training Program |
| 2000 | | E-Commerce for Small Business |
| 2000 | Shobha Madan | Conference on VIIth Discussion Meeting on Harmonic Analysis |
| 2000 | B Deo | Process Dynamics of Steel Making |
| 1999 | A Raina | 22nd All India Conference of Linguistics |
| 1999 | A P Sinha | Eco-friendly Production and Modern Marketing of Ferrous and Non Ferrous Products |
| 1999 | Rajat Moona | Electronic Design Automation |
| 1999 | P Gupta | ACM annual International Collegiate Programming Contest-Central Asia |
| 1999 | Kalyanmoy Deb | Optimizing Engineering Design using Evolutionary Techniques |
| 1999 | V Sinha | International Symposium on Automotive Electronics |
| 1999 | N K Batra | International Symposium on Materials for New Millennium |

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|---|---|---|
| 1999 | V Sinha | Mobile Radio Communication Networks |
| 1999 | N L Arora | Workshop on Wind Tunnel Testing |
| 1999 | S K Jain | Seismic Design of RC Buildings and Bridges at Imphal |
| 1999 | Ajai Jain | MS Office for Institute Employees / Wards |
| 1999 | Sanjay G Dhande | Computer Aided Technologies for Design and Manufacture of footwear and leather Products sponsored by SIDBI |
| 1999 | J P Gupta | Hazards Analysis in Chemical Industry and Inherently Safer Plant Design at Bombay |
| 1999 | Ajai Jain | IBM Teachers Training Program |
| 1999 | A Mukherjee | E-Commerce: Small Business on the Internet |
| 1999 | Sanjay G Dhande | Computer Aided Design using Ideas |
| 1999 | P K Panigrahi | Experimental Methods in Thermal Sciences |
| 1999 | K K Saxena | Planning and Partnership |
| 1999 | Rajat Moona | Interra Training Program |
| 1999 | B P Pundir | Vehicle Emissions and Control Technologies (QIP + STC) |
| 1999 | Mukesh Sharma | Air Quality Monitoring and Management (QIP & STC) |
| 1999 | Rajat Moona | Cadence Induction Training Program |
| 1999 | R K Bansal | Probability, Random Processes and Elements of Information Theory (QIP) |
| 1999 | S K Jain | Seismic Design of Reinforced Concrete Buildings |
| 1999 | P K Kalra | Neural Network Lab. Training Program |
| 1999 | Navpreet Singh | System Administration & Networking |
| 1999 | Ajai Jain | ACSET Summer Course |
| 1999 | Deepak Gupta | TISL Teachers Training Program |
| 1999 | P K Kalra | Fuzzy Logic and its Engineering Applications |

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|---|---|---|
| 1999 | A K Mittal | Internet Applications for Small Business |
| 1999 | A P Sinha | Small Industrial Enterprise Management |
| 1999 | E Deo | Stainless Steel-Making in AOD in New Millennium (Basic + Recent Developments) |
| 1999 | K R Srivathsan | Providing Electrical Engineering Laboratory Facilities at SSJ, Kanpur University |
| 1999 | P Jalote | CMM Workshops at various places held during Oct.1998 and March 1999 |
| 1999 | B Sahay | Textile and Apparel Design |
| 1999 | M R Madhav | Developments in Reinforcement of Ground and Slope |
| 1999 | A P Sinha | Accounting, Budgeting & Control |
| 1999 | Y N Singh | E-mail Configuration, Installation and Management Web Server Technologies |
| 1998 | S K Aggarwal | Compilers for Advanced Computer Architectures |
| 1998 | Onkar Dikshit | Geoinformatics for Resource Evaluation & Management (QIP + CEP) |
| 1998 | N K Sharma | Workshop on Enhancing Performance through Team Building held at Itawah |
| 1998 | A P Sinha | Accounting for Engineering |
| 1998 | Aloke Dutta | Analog Electronics |
| 1998 | Rahul Varman | Design of Organization Structures & Systems (QIP + CEP) |
| 1998 | N K Sharma | Workshop on Enhancing Performance through Team Building held at Itawah |
| 1998 | P Jalote | Workshop on Requirements Management at HCL Infosystems Ltd., New Delhi |
| 1998 | S K Jain | Seismic Design of Bridges |
| 1998 | A P Sinha | Industrial Marketing (sponsored by SIDBI) |
| 1998 | P K Kalra | Internet Lab |
| 1998 | Aloke Dutta | Analog Electronics (at Cadence Design System, Noida) |
| 1998 | P Jalote | Course on CMM conducted at ICIL, Pune |
| 1998 | Y N Singh | Configuration, Installation and Management of Networks and Internet |

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|---|---|---|
| 1998 | D Sanghi | Giving Lectures at Motorola Inc., Bangalore |
| 1998 | V K Jain | NC Machine and Part Programming (ISTE + CEP) |
| 1998 | S C Srivastava | Power System Stability and Control (QIP+CEP) |
| 1998 | J P Gupta | Hazard Analysis in Chemical Industries (at Baroda, Gujarat) |
| 1998 | K R Srivathsan | Windows NT & Visual C++ (for DRDO) |
| 1998 | Vinod Tare | Operation and Maintenance of UASB based Plants (for Min.of Env.) |
| 1998 | Rajat Moona | Electronics Design and Automation (EDA) at Noida |
| 1998 | C V R Murty | Architectural Considerations in Seismic Design of RC Buildings (QIP+CEP) |
| 1998 | P K Kalra | Neural Networks & Fuzzy Logic (at RDSO, Lucknow) |
| 1998 | B Dasgupta | Advanced Topics in Robotics (QIP) |
| 1998 | Rajat Moona | Real Time Operating System (at Motorola, Bangalore) |
| 1998 | N K Sharma | Quantitative Methods in Marketing |
| 1998 | N N Kishore | An Intensive Course on Finite Element Method (for RDSO at Lucknow) |
| 1998 | S K Jain | Seminar on Earthquake Resistant Construction (for Hilti India, at Bombay) |
| 1998 | T P Bagchi | Delivered Lecture at Centre for Productivity, Lucknow |
| 1998 | A P Sinha | Small Industrial Enterprise Management |
| 1998 | K R Srivathsan | Signal Processing (for RDSO, Lucknow) |
| 1998 | S K Jain | Seminar on Earthquake Resistant Construction at Delhi |
| 1998 | Dheeraj Sanghi | TCP/IP and Unix Network Programming (at Hyderabad) |
| 1998 | T V Prabhakar | Invited Lectures in DE Shaw (at Hyderabad) |
| 1998 | J P Gupta | Hazards Analysis in Chemical Industry (at Chennai) |
| 1998 | Vinod Tare | Waste Treatment Methods |
| 1998 | Rajat Moona | Short Course on EDA (at Cadence India Pvt.Ltd., Noida) |

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|---|---|---|
| 1998 | Dheeraj Sanghi | Unix Network Programming and Internet Protocol Version 6 (at Bangalore) |
| 1998 | R R K Sharma | Production Management |
| 1997 | A S R Sai | Design and Construction of Pre-stressed Concrete Structures (at Delhi) |
| 1997 | K R Srivathsan | Digital Broadcast Technologies |
| 1997 | R R K Sharma | Manufacturing Strategy |
| 1997 | Dheeraj Sanghi | Computer Networks (QIP+CEP) |
| 1997 | Raj Narayan | Corrosion and its Control |
| 1997 | P K Kalra | Reliability, Availability and Maintainability Engineering for Manufacturing Industries |
| 1997 | Dheeraj Sanghi | Tutorials on Emerging Trends in LAN/WAN Communication (at Ahmedabad) |
| 1997 | A P Sinha | Marketing for Service Industry |
| 1997 | Kalyanmoy Deb | Genetic Algorithms in Engineering Design |
| 1997 | C V R Murty | Experiments in Structural Engineering |
| 1997 | C Venkatesan | Helicopter Technology |
| 1997 | H Hatwal | Robotics and Artificial Intelligence |
| 1997 | J P Gupta | Hazards Analysis in Chemical Industry (at Bombay) |
| 1997 | D Mazumdar | Modelling of Modern Steel Making |
| 1997 | P K Kalra | Neuro Fuzzy Systems and its Applications |
| 1997 | Santokh Singh | Marketing and Financial Data Analysis for Business Control |
| 1997 | V K Jain | Advanced Machining Processes (QIP+CEP) |
| 1997 | S K Jain | Seismic Design of Reinforced Concrete Buildings (at Madras) |
| 1997 | S K Aggarwal | CADENCE Training Programme |
| 1997 | Vinay K Gupta | Structures Random Vibration Approach (at Bangalore) |
| 1997 | S K Jain | Seismic Design of Reinforced Concrete Buildings |

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|---|---|---|
| 1997 | P K Basudhar | Engineering Ground (QIP+CEP Course) |
| 1997 | A Mukhopadhyay | Mathematical Tools for Discreet Algorithms (QIP+CEP course) |
| 1997 | A P Sinha | Small Enterprise Management |
| 1996 | S. Puspavanam | Process Modelling and Control |
| 1996 | J.P.Gupta | Hazards Analysis Chemical Industry |
| 1996 | S.K. Jain | Seismic Design of Reinforced concrete Buildings |
| 1996 | C. Venkobachar | Defluoridation of water |
| 1996 | V.K. Gupta | Seismic Risk in India |
| 1996 | V. Tare | Environmental Pollution control |
| 1996 | S.K. Aggrawal | Compilers for Architecture |
| 1996 | R. Moona | Advanced Computer Architecture |
| 1996 | S.K. Aggrawal | Cadence Training Program |
| 1996 | P.K. Chatterjee | Fiber Optics Communication and Networking sensors |
| 1996 | K.Deb | Genetic algorithms for Engineering |
| 1996 | K.Deb | Optimization Techniques for Engineering Design |
| 1996 | S.K.Choudhury | Production Technology |
| 1996 | R.Balasubramanian & Raj Naraian | Corrosion and its Prevention |
| 1996 | R. Shekhar | Environmental Audit & Environmental Impact assessment |
| 1996 | T.P.Bagchi | ISO-9000 Lecture Delivered at M/s. ZAZ tannery |
| 1996 | A.P.Sinha | Small Industrial Enterprise management |
| 1996 | T.P.Bagchi | Statistical Methods in ISO-9000 |
| 1996 | U.B.Tewari | Mathematics Training Talent Search Program |
| 1996 | P.C.Joshi | Quantitative Methods for Process Improvement |

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|---|---|---|
| 1996 | S.K.Shukla | Advanced Statistic for chemical Engineers |
| 1996 | K.S.Singh | Computer Course on UNIX & C |
| 1996 | K.S.Singh | P.C. Maintenance Training |
| 1996 | N.K. Sharma | Giving Lectures at LML Kanpur |
| 1996 | T Gangadharaih | HYDRO'96 |
| 1996 | S.K. Choudhary | XI National convention Production Engineers |
| 1996 | A.P. Sinha | Workshop on INRA'96 |
| 1996 | P.K. Ghosh | National Symposium on Plasma science |
| 1996 | C. Ventobachar | Defluoridation of Water |
| 1996 | R.Balasubramanian & Raj Narain | Corrosion and its Prevention |
| 1996 | T.P.Bagchi | Statistical Methods in ISO-9000 |
| 1996 | D.Manjunath | Workshop and Tutorial and High Speed Networking |
| 1996 | K.S.Singh | Computer Orientation Training |
| 1996 | P.C.Joshi & Santokh Singh | Quantitative Methods for Process Improvement |
| 1996 | D Mazumdar & B. Deo | Modeling of Modern steel |
| 1995 | Vinay Gupta | Seismic Risk in India |
| 1995 | Ajai Jain | Topics on Computer Networks |
| 1995 | S.K. Jain | Seismic Design of Reinforced Concrete Building |
| 1995 | P.K. Chatterjee | Fiber Optics Communication Networking and Sensors |
| 1995 | P.K. Kalra & P. Chatterjee | Fiber Optics Communication Networking and Sensors |
| 1995 | K.Deb | Fuzzy Logic Control |
| 1995 | R. Shekhar & V. Tare | Environmental Audit and Environmental Impact assessment |
| 1995 | P.K. Ghosh | National symposium on Plasma Science |

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|---|---|---|
| 1995 | S.G. Dhande | Modern Design Methodologies |
| 1995 | S.K. Jain | Seismic Design of Reinforced Concrete Buildings |
| 1995 | Ajai Jain | VLSI Testing & Design for Testability |
| 1995 | P.K. Kalra | Neural Networks |
| 1995 | R. Tewari | Computer Training |
| 1995 | L.P.Singh & S.C. Srivastava | National Workshop on Voltage Instability in Electric Power Systems |
| 1995 | M. Prasad | Wind solar and Nuclear Energies |
| 1995 | S.K. Chakraborti | Building Construction & Allied Civil works |
| 1995 | Sachichidanand & S.K. Aggrawal | Cadence Training Program |
| 1995 | C.V.R. Murty | Workshop on Disaster Management |
| 1995 | B. Deo | Artificial Intelligence Methods in Iron and Steel Making |
| 1995 | S.K.Jain | Seismic Design of Reinforced Concrete Buildings |
| 1995 | S Madan | Mathematics Training Talent search Program |
| 1995 | L.P.Singh & S.C.Srivastqava | Modern Trends in Power systems Production |
| 1995 | P.Jalote | Software Cost Estimation |
| 1995 | P. Das | Techniques for Competitive Re-design (sponsored) |
| 1995 | A.P. Sinha | Small Industrial Management |
| 1995 | R.S .Misra | Seminar-cum-workshop on Objectivity in Social Science |
| 1995 | A.P. Sinha & S. Sadagopan | Small Industrial Management |
| 1995 | B. Deo | Artificial intelligence in Iron & Steel Making |
| 1995 | B.K. Misra | Modeling and Simulation of Processing Units |
| 1995 | A Khanna | Real Time Distributed Computer control of Chemical Processes |
| 1995 | A Ghosh & P.K Kalara | Neural Networks and its Applications |
| 1995 | A. Dutta & A | Fibre Optics and its Application |

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|---|---|---|
| | Ghosh | |
| 1994 | S.P. Mehrotra | Continuous Casting of Steel |
| 1994 | Vijay Gupta | Noise and Vibration Control |
| 1994 | S.K. Aggarwal | Computer Course Taught at IIM Lucknow |
| 1994 | Dr B Rath | Workshop on Rehabilitation & Resettlement |
| 1994 | P Jalote | Software Engineering Principles Methods and Standards |
| 1994 | T.V. Prabhakar | Course for Engineer of Tata Information Systems |
| 1994 | T.V. Prabhakar | Computer Networking |
| 1994 | K Ramesh | Computer Applications in Experimental Mechanics |
| 1994 | N.K. Batra & S.K Gupta | Advances in Joining Processes |
| 1994 | D. Sahghi & G. Barua | Unix Networking Programming |
| 1994 | Amit Ray | Leather Design (formal) Leather Batik & Leather Embossing |
| 1994 | G. Barua | Short Course on TCP-IP Protocol (Delhi) |
| 1994 | B. Deo | Modem Trends in Met. Process Simulation |
| 1994 | N.S.V.K. Rao | Dynamics Analysis of Machine Foundations & Structures |
| 1994 | T.V. Prabhakar | Object Oriented Software Development |
| 1994 | Vijay Gupta | Net Saving from CEP Courses |
| 1993 | S.K.Jain | Seismic Design of Reinforced Concrete Building |
| 1993 | J.P.Gupta | Quantitative Risk Assessment |
| 1993 | R.M.K.Sinha | NLP Teachers Training Program |
| 1993 | P Gupta Bhaiya | Computer Controlled Modular Instrumentation |
| 1993 | N.K.Batra | Modern Trends in Material Joining |
| 1993 | T.V. Prabhakar | Data Base Instrumentation Techniques File Structures |
| 1993 | K.R.Srivatsan & A. Dutta | Fiber Optics and its Applications |

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|---|---|---|
| 1993 | S.Ramaseshan | P.C. Aided Analysis and Design in water Resources |
| 1993 | G. Barua | Micro Kernels for Engineers of Tata Information System |
| 1993 | T.P.Bagchi | Industry Applications of Taugchi Methods for Process Performance |
| 1993 | S.K.Jain | Seismic Design of Reinforced Concrete Buildings |
| 1993 | G.K.Dubey | Semiconductor Controlled Drives & their Applications |
| 1993 | D.C. Agrawal | Processing and Characterization of Advanced Ceramics |
| 1993 | R.M.K.Sinha | NLP Training Program LO1 For Linguistics |
| 1993 | A.P.Sinha | Small Enterprise Management |