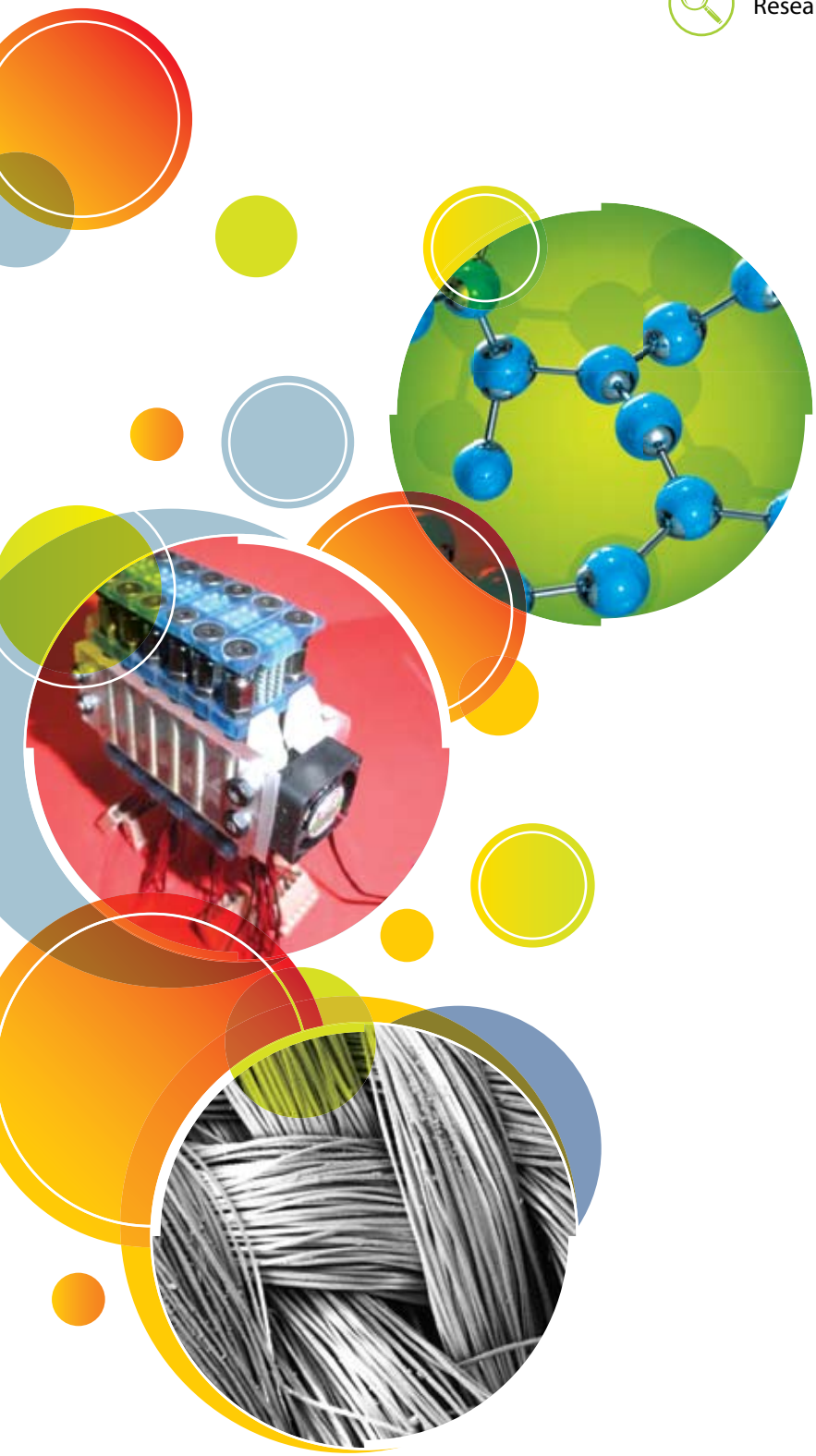
Research Innovation Business @ IITD



Impact...

Human Corneal Construct

Recombinant Therapeutic Proteins

Synthetic Liquid Fuels

Ballistic Armour

FITT FORUM

Newsletter of Foundation for Innovation and Technology Transfer

ISSN-0972-2548
Volume - 19 No. 2, July 2013

Indian Institute of Technology Delhi, New Delhi

Contents

Impactful Research and Innovation

India, a country beset with heterogeneity in several development spheres, is also facing diverse challenges in areas of health, housing, education, water, sanitation, energy, program delivery etc. The solutions being offered to address these vary from good governance to prudent planning and even recourse to innovations *(including technological interventions)*. Concerted efforts in this direction are indeed imperative. While the designated agencies ought to be more effective in their respective roles, it is the top-class academia and other intelligentsia that can be increasingly looked up to for advice and solutions. At the micro level, the research and academic establishments can proffer rational approaches to address the manifold issues by unlocking the potential of their knowledge base; only that they ought to be a little more pro-active and resolute in meeting the societal needs too.

We need to reorient our research thought and practice from a national strategic perspective. While a few institutions have clarity and requisite practices in place, a large number seem to meander - without a meaningful purpose. While no one can question the need for basic research (and top class at that!), it is what we actually do that becomes important. Aside of usual performance metrics of research publications, securing research grants etc. There is a philosophical message in the argument that we (at least the top institutions!) should *do what needs to be done rather than what we can do!* This may appear slanted towards the more applied aspects of research but, even in the theoretical space this sounds worthy of thought. Purposeful approach can deliver top class outcomes, and can also drive creativity in R&D. Similarly, innovations have a huge impact if these are need-driven. And we need a plenty of these – affordable/frugal yet robust and effective. From a larger country perspective though, we have to also seriously work towards creating billion dollar technology based innovations that are globally impactful. As a nation, we ought to look much beyond 'Juggad' as an innovation philosophy!

The present redone issue of the FITT FORUM captures this purposeful flavour at the Institute where several high impact research projects involving cross-functional expertise have taken shape. This high-expectational approach may trigger yet more of similar such projects if the results are indeed promising. Towards this, the Institute encourages collaborations and active engagement with industry. The gradually increasing user-inspired R&D efforts at the Institute are a welcome sign.

Prof RK Shevgaonkar
Director, IIT Delhi
& Chairman, FITT

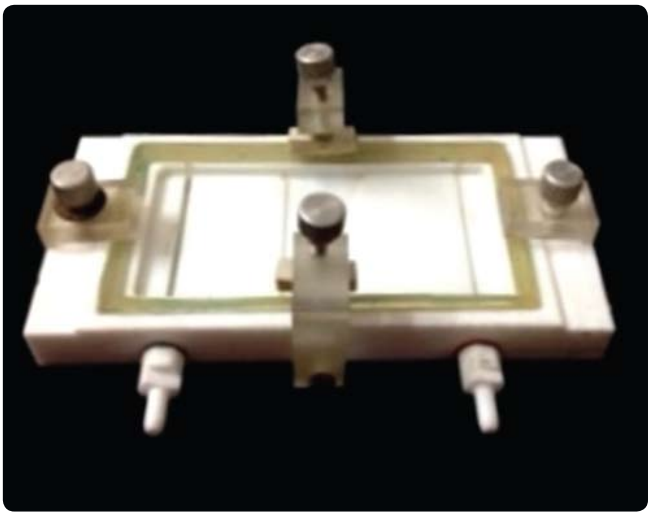
High Impact Research

Cell Sheet Engineering for Assembly of Human Corneal Construct

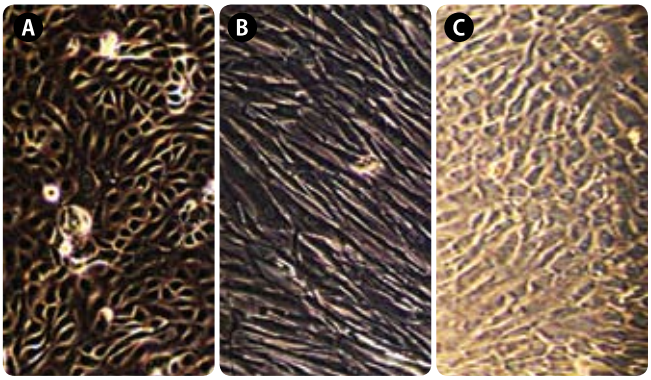
(IIT Delhi & AIIMS, New Delhi Collaboration)

Prof PK Roychoudhary, DBEB; Prof J Gomes, KSBS;
Dr B Kundu, KSBS; Dr S Ghosh, TT

Cornea is a transparent, dome-shaped, 0.3mm thick tissue which covers front of the eye, and contributes to two-third of the eye's focusing power. Eye diseases affecting the cornea are second major cause of blindness worldwide, other than cataract. Therefore, novel methods to overcome the problems, associated with corneal diseases, need to be developed, for instance, through tissue engineering. However, several attempts of generating a tissue engineered corneal construct failed. The constructs due to presence of synthetic scaffold material, are not transparent which impairs transparency.

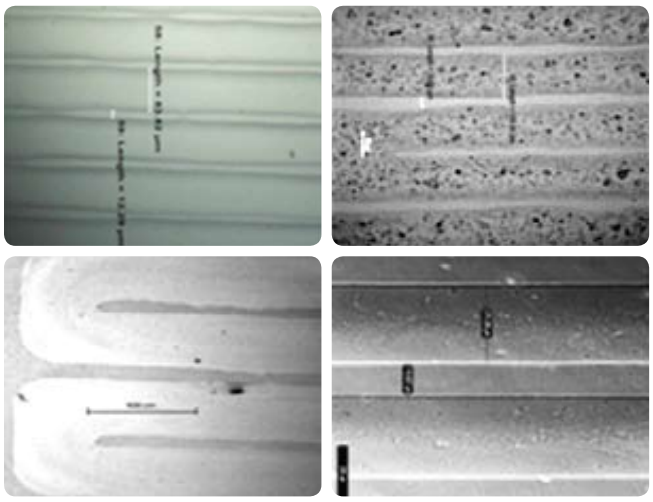


Bioreactor Prototype

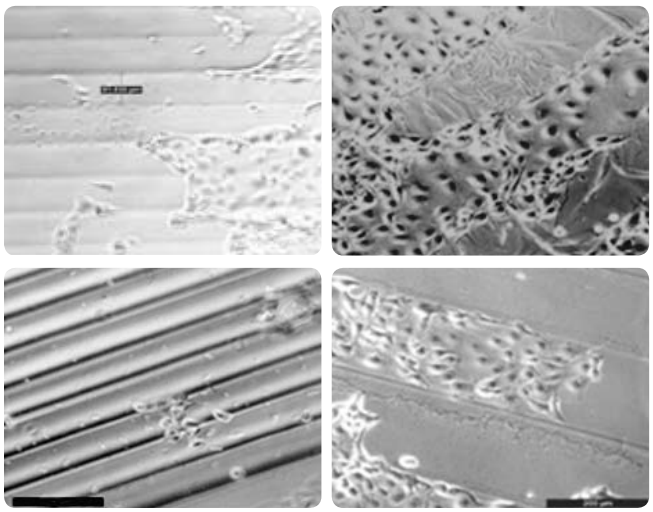


Human Corneal Cells: A. Epithelial B. Stromal C. Endothelial.

Also the use of enzymes causes the cells to get disrupted, hence the present work mainly focuses on developing artificial cornea based on cell-sheet engineering approach that incorporates temperature responsive polymers (PolyNIPAAm) to obtain intact monolayers without the use of proteolytic enzymes. To achieve that, patterned scaffolds (mixtures of PolyNIPAAm with silk and gelatin) have been developed for growing human corneal cells in a specific orientation equivalent to normal human cornea. Furthermore, the process of developing microreactor (that will work on perdusion culture mechanism) which will facilitate proper alignment of constructed cell sheets while maintaining cells orientation is in progress.



Developed patterned scaffolds



Cultured cells on patterned scaffolds

Production of High Value Therapeutics in *Pichia Pastoris*

Prof S Mishra, DBEB; Prof A Rathore, ChemE;
Dr V Sahai (Retired), DBEB; Prof AK Srivastava, DBEB;
Prof J Gomes, KSBS; Dr V Rebeiro, CSE

The Pharmaceutical market worldwide is estimated to grow to $1.3 trillion by the year 2020 [Agres, 2007]. While conventional chemical methods will continue for manufacturing drugs, the bio- based market is estimated to grow significantly and is expected to account for 15% of the overall world pharma market [Walsh, 1999]. Some major pharma companies have acquired technologies or invested in manufacturing facilities based on their confidence in biopharmaceuticals. For instance, Merck has bought RNAi developer, Sirna Therapeutics for $1.1 billion (RNAi being short interfering molecules to inhibit any gene of interest in any cells) [Dove, 2007]. Genentech has invested $140 million to set-up microbial-based manufacturing operations for bio-therapeutics in Asia. Amongst the microbial systems, the yeast *Pichia pastoris* enjoys a good position as a large number of therapeutics have been produced in this organism [Ayed *et al*, 2008; Potgieter *et al*, 2009]. This success can be contributed to its being culturable to high cell densities, a glycosylation pattern most akin to the human pathway and well worked out molecular biological techniques. The products made from *P. pastoris* have been found to be immuno-compatible.

In this project, it was proposed to develop *P. pastoris* system as a strong platform for production of high value therapeutics. The platform envisioned included all key aspects: cloning, fermentation, harvest, purification, analytics and process control. It is believed that such a holistic platform will be of great interest to both academia and industry. Two model proteins have been selected for this work which are Human Granulocyte Colony Stimulating Factor (GCSF) and Human Serum Albumin (HSA) for expression in *P. pastoris*. GCSF (Figure1) has many therapeutic uses especially in cancer therapies. During exposure to chemicals used in chemotherapy, the bone marrow's ability to produce white blood cells is damaged. This condition is known as neutropenia and it increases the patient's risk of contracting infection. Fever combined with a low white blood cell count, or febrile neutropenia, can be a life-threatening complication of chemotherapy. GCSF is a natural hormone produced by the body which stimulates the bone marrow to produce more white blood cells. Studies have found that GCSF injections can reduce the severity and duration of neutropenia in such patients. The commercially available GCSF sequences used for therapeutic purposes are expressed in higher eukaryotic cells using animal cell cultures. The major disadvantage of using animal cell cultures is that these are expensive to cultivate and are prone to contamination.

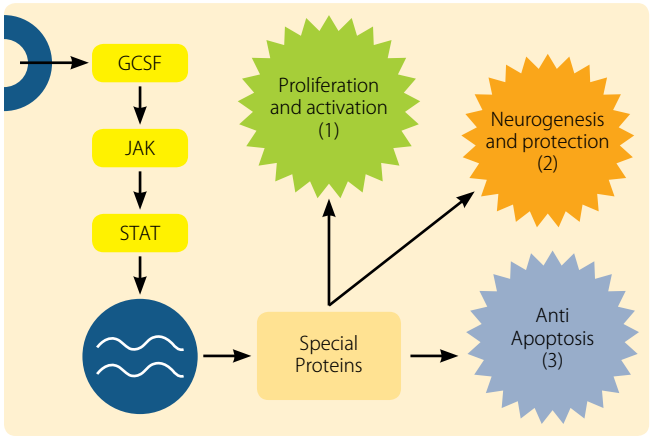


Figure 1: GCSF binds to special receptors and activates signaling pathways (JAK, STAT). This has different effect on different types of cells. (1) Bone marrow (2) Brain cells and (3) Neural cells (From Adusumilli et al 2012).

The approach was to use a synthetic GCSF gene in which the codon optimization chart for *P. pastoris* was used. A series of overlapping 50 bp primers were synthesized to span the entire 564 bp sequence. These primers are alternating forward and reverse sequences, with each primer overlapping the

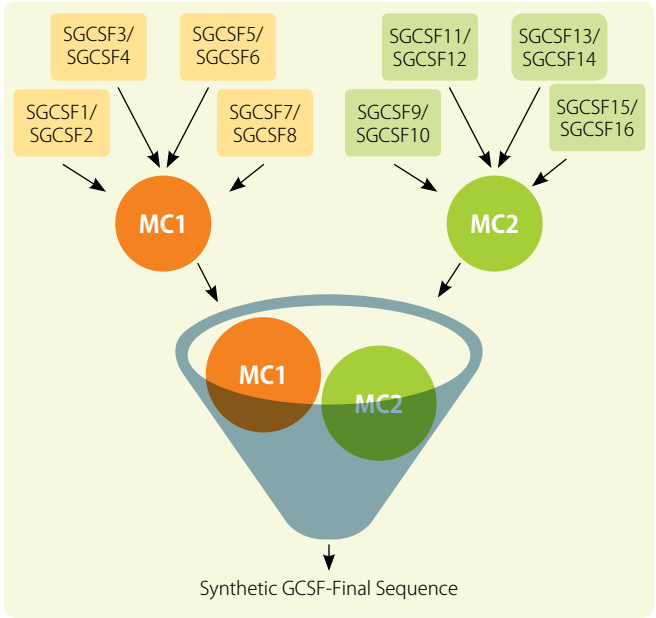


Figure 2: Process flow sheet for GCSF construction.

previous one by 15 bp. The entire process was carried out in two parts by constructing megaconstruct1 (MC1) and MC2 as shown in Figure 2. Suitable restriction sites were included at the 5′ and 3′ terminal primers, respectively, for cloning into the *Pichia* expression vectors.

Two type of vectors were used, one where in the expression of GCSF was under the control of Glyceraldehyde 3-phosphate Dehydrogenase (GAP) promoter and the other under Alcohol Oxidase 1 (AOX1) promoter. It is expected that under the GAP promoter, the expression will be constitutive while under AOX1 inducible expression is achieved in the presence of methanol. In the first case, low expression was observed and the growth was highly compromised indicating that the expressed product was deleterious for growth. Several clones were obtained that produced good levels of extracellular GCSF. In one of the transformants, extracellular proteins of 100-150 μg/ml were obtained and GCSF was detected as a 18 kDa protein product (Figure 3). The levels of GCSF were higher than what has been reported so far in the *Pichia* system. All the producer clones are being analyzed. The chosen construct will be modified for increasing the yield of the product.

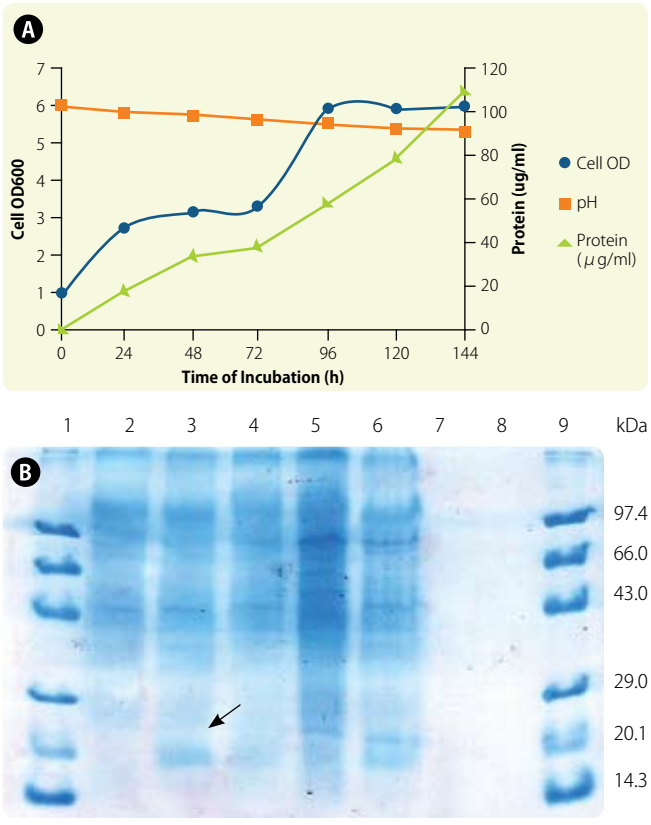


Figure 3: (A) Cell O.D., extracellular protein and pH profile of transformant # 1 in BMMY medium and (B) 12% SDS-PAGE analysis of concentrated culture supernatant of some clones: Lanes 1 & 9: mol wt markers; Lanes 2 and 5: controls (only vector) 100 x conc sample was loaded; Lanes 3,4 and 6: clone # 1, 3 and 6; Lanes 7 and 8: blank lanes. Arrow indicates the position of GCSF.

In addition to this, fermentation strategies and filtration studies have been optimized for HSA being produced in *P. pastoris* system. With an existing HSA producing yeast transformant, strategy was developed for continuous methanol feed based on pH monitoring (Figure 4). Glycerol was used in the batch growth. The culture was induced with methanol and the protein expressed under the control of the AOX1 promoter. A total extracellular protein level of 2.42 g/L was achieved with a cell optical density of 336. The strategy will also be applied to GCSF producing clones. Harvesting strategies were also developed for HSA producing *Pichia* clones based on combination of anion exchange chromatography.

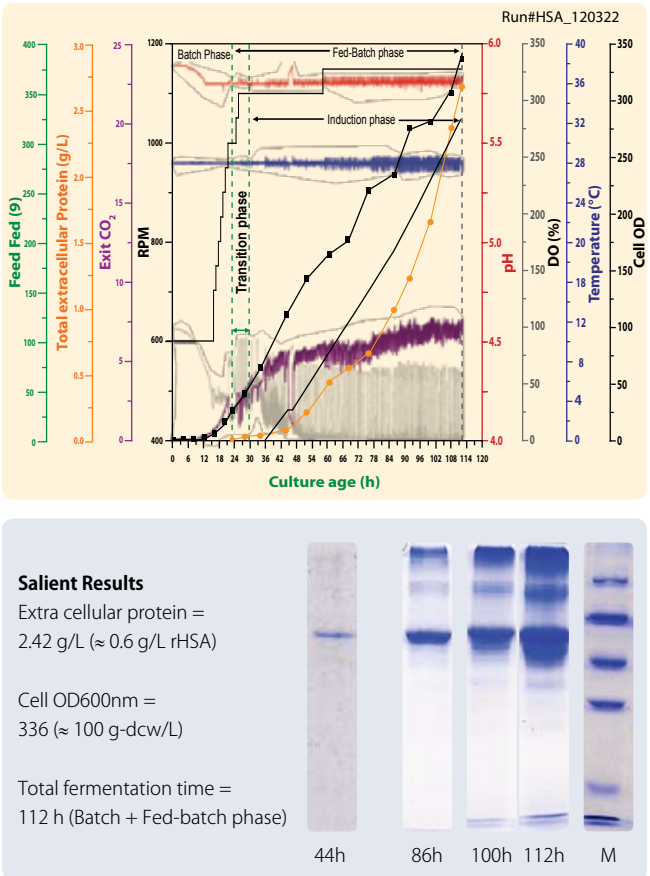


Figure 4: Production of HSA in complex medium in a 3 L bioreactor. Methanol feed was based on pH control. The gel pictures show production of HSA in the extracellular broth of *P. pastoris.*

References:

- Adusumilli S *et al* (2012) Asia J Biomed Sci Pharm Sci 2,1.
- Agres T. (2007) PharmaAsia Sept-Oct Issue, 12.
- Ayed A *et al* (2008) Enzyme Microb Technol 42,173.
- Dove A (2007) PharmaAsia. July-Aug Issue, 22.
- Potgieter *et al* (2009) J Biotechnol 139,318.
- Walsh G (1999). In: Biopharmaceuticals an Industrial Perspective. Walsh G, Murphy B, editors. Kluwer Academic Publishers, Massachusetts. pp. 1–34.

Technology Development for Synthetic Liquid Fuels through Process Intensification

Prof AN Bhaskarwar, ChemE; Dr V V Buwa, ChemE;
Prof KK Pant, ChemE; Prof S Roy, ChemE;
Dr A Shukla, ChemE; Dr S Upaadhyalyu, ChemE

This project concerns itself with technology enabling elements for producing synthetic liquid fuels, such as petrol and diesel, from solid carbon sources that are abundant in our country (such as coal and biomass). The project takes significance in light of the current poor quality of coal, the challenges with breaking down complex constituents of secondary biomass, and the fact that conventional technology in this area is largely inefficient because of both chemistry and transport phenomena considerations. While being of great relevance to India economically, the technology platform has unique technical challenges, many of which are of fundamental nature and best addressed by an academic team.

Renewed interest in CTL/BTL (coal-to-liquids/biomass-to-liquids) technologies (collectively referred to at XTL technologies) all across the world in recent years has been primarily fuelled by the rising oil prices, the isolation of large oils reserves in politically sensitive regions of the world – directly affecting the energy security issue, and the desire to have long term sustainability from an environmental standpoint. For India, these are all very relevant and topical issues. What makes the technical and economic situation with this crucial technology more challenging is the wide patent coverage that it enjoys with existing players, hence it is difficult for beginners like India to enter this market or develop indigenous technology that are free to practice. It should also be recognized that the IP protection enjoyed by multinationals is so wide-ranging that unless disruptive technology or know-how is developed in sufficiently large number of key enabling elements in the XTL canvas, negotiating a fair price even if the technology or parts of it were to be imported would become very difficult for India.

With that general motivation, effort has been channelized to focus on those parts of the XTL flow sheet (Figure 1) which are relatively poorly understood at the present or are bottlenecks for future development. Specifically, the present work focuses on high resolution experiments and modeling of some of the important reactor vessels, on characterizing and developing catalysts for the process, and on some alternate electrochemical paths to the syn-gas cleanup effort. Figure 1 summarizes the basic "stations" in the "XTL route" and the main sub-projects that are being undertaken in the current effort.

Figure 2 shows pictures some typical catalysts developed in this project for Fischer-Tropsch (FT) synthesis, one with a promoter and one without. Amongst various catalysts developed and tested, favorable reaction conditions for selective C5 - C28 range of hydrocarbons were identified for a Rhodium promoted catalyst (Rh-Fe/Co/SiO_2 catalyst). It was found that higher pressure favored higher chain growth probability. Rhodium was found to be a very effective promoter, optimum composition being around 2% Rh loading for the Fe/Co bimetallic catalyst for FT synthesis. The amount of coke/wax deposited on Rh-promoted catalyst after a run time of 100 h was ~ 1.8%, compared to 14-18% over Fe/Co catalyst. The impact the promoter has on the catalyst surface morphology following the reaction is clearly seen in Figure 2. The key objective of this research is to make "designer catalysts" which would be able to control the branching of the hydrocarbons in the FT reactions, as well as minimize catalyst deactivation due to coke and wax deposition.

Figures 3 and 4 provide an overview of hydrodynamic investigations. Figure 3 shows some of the ongoing development of better computational tools based on discrete bubble modeling for predicting flow patterns in gas-liquid reactors called bubble columns, which are the principal reactor environment employed for the highly exothermic FT reactors. Development of such sophisticated tools, for reactor design and scale-up, demands non-invasive experimentation at resolutions comparable to the numerical predictions. Figure 4 shows some such sophisticated facilities, in which IIT Delhi is rather uniquely positioned, being employed for this research. Current day design methods for complex multiphase reactors such as those employed in XTL are limited by very poor understanding of flow patterns, as well as their limited incorporation in the design and scale-up protocols. This research is focused both on developing fundamental enabling tools as well as their application in developing better scale-up tools.

Figures 5 and 6 provide an overview of this unique strategy for syn-gas cleanup, which is a crucial step in the XTL chain

owing to the requirement of removing H_2S post the gasifier, so that it does not poison the FT catalyst. The work revolves around a combination of gas purification using novel clay membranes, and a specially designed electrochemical cell. Obviating the use of polymer membranes for gas-cleanup raises the possibility of enabling the process at high temperatures that exist at the exit of the gasifier and required at the inlet of the FT reactor, so the overall process becomes energetically more favorable.

In summary, the ongoing project is on its way to develop several enabling pieces in the rather complex XTL landscape, and hopefully develop an IP portfolio that can be deployed, with industrial partnership, in the national interest.

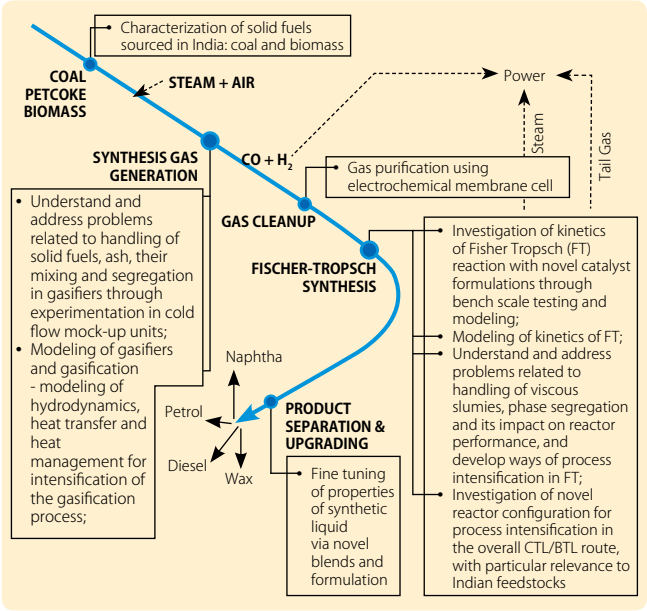


Figure 1: Overall work plan of the current XTL initiative showing the process flowsheet (in blue) and important sub-projects under investigation (bulleted list)

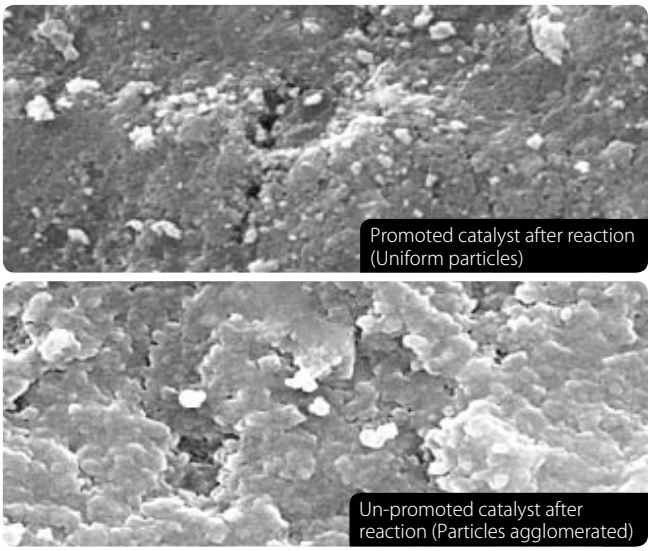


Figure 2: Composition and properties of some typical catalysts developed

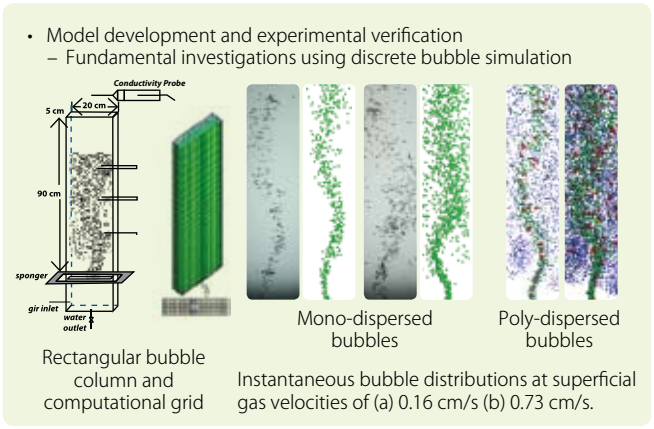


Figure 3: Development and verification of CFD models for reactor design and scale-up

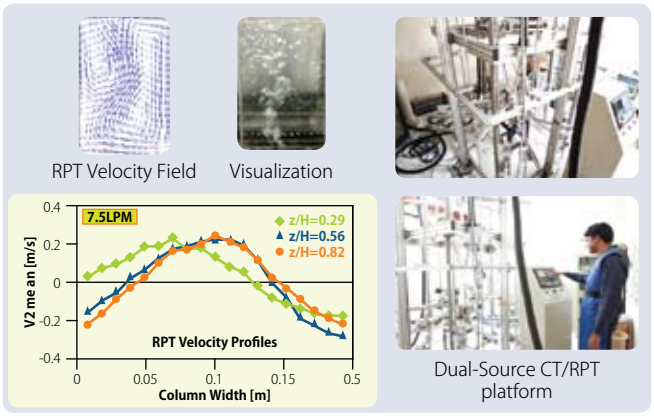


Figure 4: Hydrodynamic investigations using Radioactive Particle Tracking (RPT) and Gamma-Ray Tomography (CT)

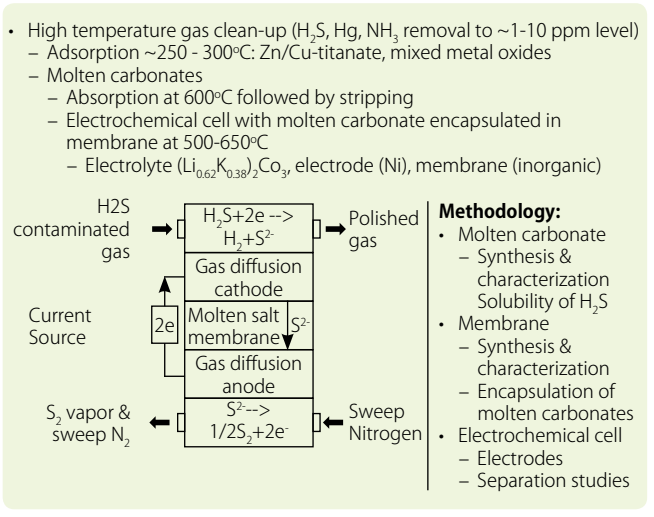


Figure 5: Strategy for clean-up of H_2S from syn-gas at high temperature

Figure 6: Synthesized clay membranes for syn-gas cleanup

Design and Development of Light Weight Ballistic Armour Protection System for Body, Vehicle and Structures

Prof N Bhatnagar, ME; Prof P Mahajan, AM;
Prof R Alagirusamy, TT; Prof AK Ghosh, CPSE;
Prof S Ahmed, AM; Dr BP Patel, AM; Prof DR Kumar, ME;
Dr MK Singha, AM; Dr BK Satpathy, CPSE;
Prof VK Kothari, TT

The failure of all varieties of non-metallic armour worldwide has led to a serious void in protection systems for security forces especially in South Asia where there is a dire need of light weight body armour system due to adverse security situation. Thus, there is an imperative need to develop indigenous technology of ballistic armour which should be light weight, effective, comfortable and cost effective. Keeping the technological challenges and the urgency of the need in mind, an interdisciplinary team drawn from Applied Mechanics, Polymer Science, Textile and Mechanical Engineering streams was formed.

A holistic approach was taken to design and develop light weight composite armour using a mix of technologies. The complexities of high velocity ballistic impact phenomenon were modelled and an in-depth analysis was carried out to bring out a unique combination of various high performance materials to develop a composite panel for the body armour. The developed panels were tested under live firing conditions and were able to withstand 9 mm at 450 m/s and 5.56 mm projectiles from point blank range at a velocity of 900 m/s, as seen in the computed tomographic (CT) images below:

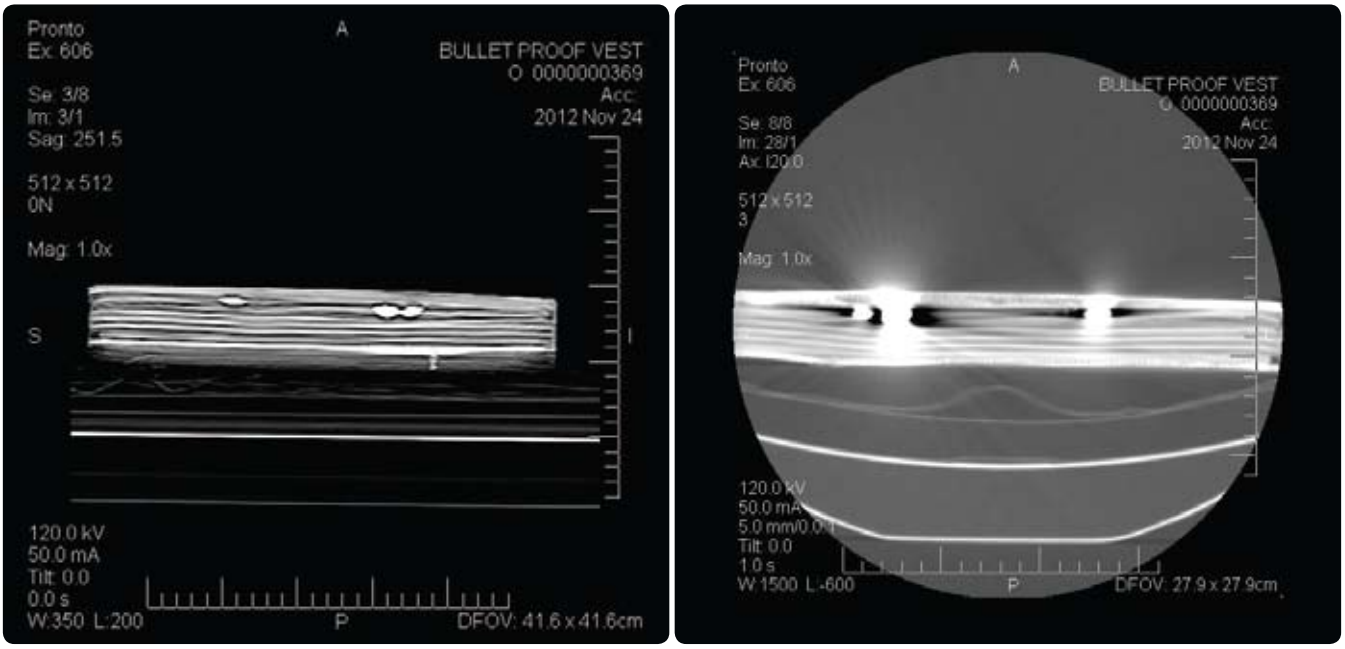


Figure: Computed Tomographic images of bullet proof vests

Further research and experiments are under process to extend this novel technology to blast resistance and other high impact applications.

Abbreviations:
AM: Department of Applied Mechanics, ChemE: Department of Chemical Engineering, CPSE: Centre for Polymer Science and Engineering, CSE: Department of Computer Science and Engineering, DBEB: Department of Biochemical Engineering and Biotechnology, KSBS: Kusuma School of Biological Sciences, ME: Department of Mechanical Engineering, TT: Department of Textile Technology, BSTTM: Bharti School of Telecommunication Technology and Management, CARE: Centre for Applied Research in Electronics, CAS: Centre for Atmospheric Sciences, CBME: Centre for Biomedical Engineering, CE: Department of Civil Engineering, CES: Centre for Energy Studies, Chy: Department of Chemistry, CRDT: Centre for Rural Development and Technology, DMS: Department of Management Studies, EE: Department of Electrical Engineering, HUSS: Department of Humanities and Social Sciences, IDDC: Instrument Design Development Centre, Phy: Department of Physics

Invited Articles

Nanostructured Carbon: The Wonder Material

Prof VD Vankar
Department of Physics
Indian Institute of Technology Delhi

The advent of C_{60} Buckminsterfullerene in 1985 stimulated the imaginations of scientists into a new direction of research. Soon after fullerene, the discovery of carbon nanotubes (CNTs) by Iijima created the boom in the scientific world. Recently, the discovery of graphene by Novoselov and Geim made it a flagship material harbingering the age of nanotechnology. Carbon nanotubes and recently revealed graphene, shown in Figure 1 are the prototype one and two dimensional carbon nanostructures (CNs) that are excellent contenders for nano-electronics, gas-sensing, solar-cell and field emission display device applications.

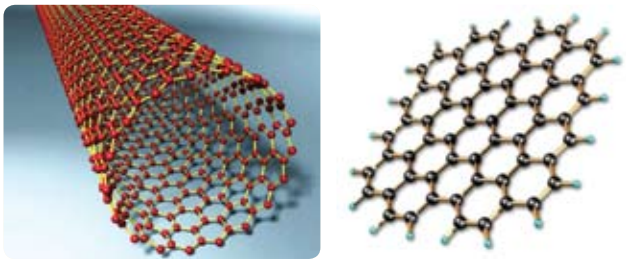


Figure 1: Left and the right panel show the single walled CNT and monolayer of graphene, respectively.

These structures show extreme physical strength and high electron mobility resulting from extensive electron conjugation and delocalization. The crystal perfection in CNTs and graphene causes the ballistic transport of charge carriers at sub micrometer distances. Hence, apart from the exciting possibilities in discovering new physics from these 1D and 2D structures, they offer tantalizing opportunities for the development of high speed (and even flexible) molecular electronics. However, one of the major barriers impeding their progress on this front relates to difficulties in their fabrication. In order to integrate them into electronics they need to be fabricated in large areas in a manner suited to device-based technology. This latter point is important because the semiconducting industry has invested billions in its current technology and so its use for the large-scale manufacture of CNTs and graphene based high speed electronic devices and circuitry will make it economically viable. The state-of-the-art carbon nanostructures (CNs) production encompasses numerous methods and new routes are continuously being developed. These are arc-discharge, laser-ablation and chemical vapour deposition (CVD) techniques. Out of these methods, the most attractive and commercially used is chemical vapour deposition (CVD) method. As compared to arc-discharge and laser-ablation methods, CVD is a simple and economic technique for synthesizing CNs at low temperature and ambient pressure. The crystalline quality of CNs grown by arc discharge and laser ablation method is superior to the CVD-grown CNs. However, in yield and purity, CVD overcomes the arc and laser methods and provides better control over CNs.

In the Thin Film and Nanoscience & Nanotechnology Laboratory of Physics Department, IIT Delhi three methods namely thermal CVD, microwave plasma enhanced CVD and laser ablation are being used for the processing of CNs. In Figure 2 photographs of the equipment used are shown.

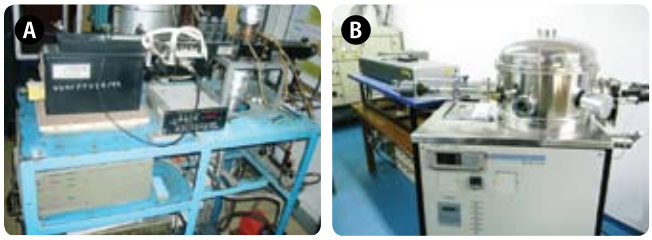


Figure 2: Various deposition systems (a) microwave plasma enhanced CVD system, and (b) laser ablation system equipped with CO_2 laser used for the growth of CNTs and graphene in our laboratory.

The CVD technique is versatile in the sense that it offers harnessing plenty of hydrocarbons in any state (solid, liquid or gas), enables the use of various substrates, and allows CNT growth in a variety of forms, such as powder, thin or thick films, aligned or entangled, straight or coiled nanotubes, or a desired architecture of nanotubes on predefined sites of a patterned substrate. It also offers better control on the growth parameters. The relative ease with which one can set up a CVD system also makes of it the most promising route for the mass production of CNs. In order to use CNs in novel devices, it is necessary to produce these materials with a high crystallinity in large-scale at economic costs. Figure 3 shows the Transmission electron micrographs of CNTs and graphene deposited by MPECVD system.

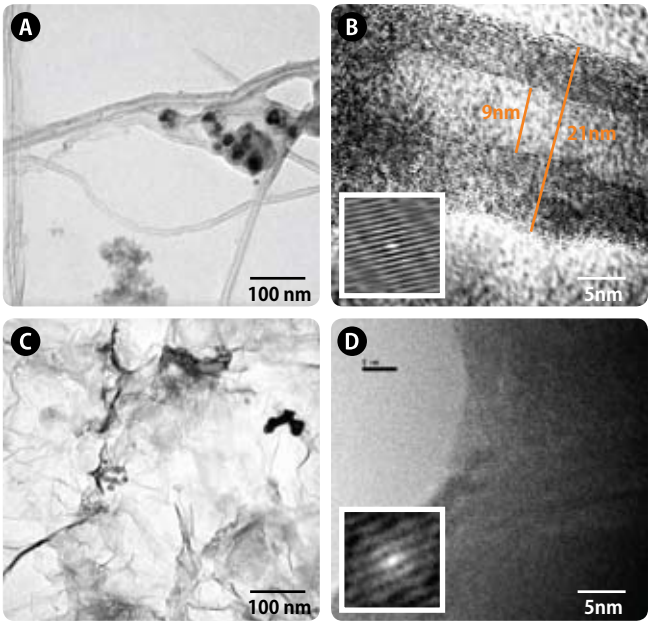


Figure 3: Microstructures of CNTs and few layers of graphene synthesized by MPECVD system.

The HRTEM image of CNTs and its corresponding lattice planes are seen in Figure 3(a) and (b), respectively. From these images, it is seen that for small catalyst film thickness, the CNTs are hollow with inner and outer diameter of 9 nm and 21 nm, respectively. The number of graphitic walls in CNTs is about 12. Figure 3(c) and (d) are the micrographs of few layers of graphene showing folding in the structure with the lattice spacing of 3.4Å.

These CNs structures show extremely good electron field emission properties, which is defined as a quantum-mechanical tunneling effect where under a sufficiently high electric field (of the order of 10^9 V/m), electrons near the Fermi level can tunnel through the energy barrier and escape to the vacuum level. The field emission current from a metal surface is given by Fowler- Nordheim (F-N) equation, $I = aV^2 \exp(-b\ \varphi^{3/2}/\beta\ V)$ where, I is the emission current, V is the applied voltage, φ is the work function and β is the field enhancement factor, a and b are constants. The emission of electrons from carbon based nanostructures is explained on the basis of F-N model. CNs exhibit excellent electron emission properties as the electrons are emitted from the tips which are of nanometer dimension. The tunneling of electrons from carbon based structures is accounted in terms of field enhancement factor (β) which is an important parameter for electron emission investigations. The value of β depends on the shape and also on the height and diameter of emitter. β is also related with the geometrical enhancement which is given in terms of (h/r) for carbon based emitters. Figure 4 shows a typical image pattern from CNTs using phosphor coated ITO glass as an anode material. CNTs are used as cathode. CNTs have been demonstrated to be very efficient electron emitters and are being explored for making display devices, microwave tubes etc.

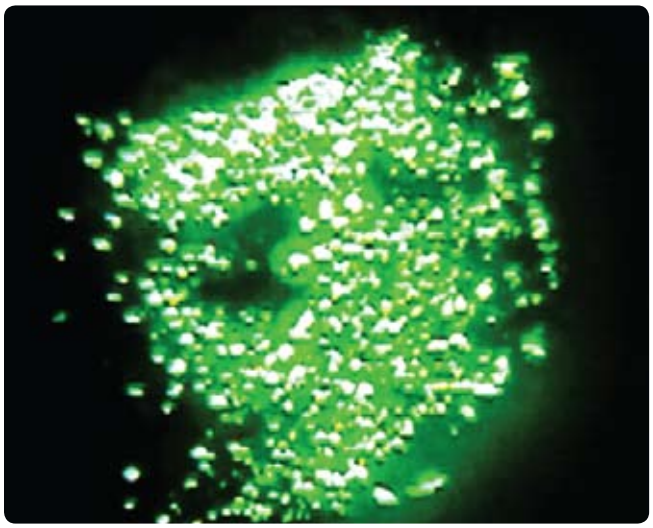


Figure 4: Field emission pattern from CNTs at 2 kV.

References

- Himani Sharma, AK Shukla, VD Vankar, J. Appl. Phys. 110 (2011) 033726.
- Vishakha Kaushik, H Sharma, P Girdhar, AK Shukla, VD Vankar, Mat. Chem. Phy. 130 (2011) 986.
- Himani Sharma, V Kaushik, P Girdhar, VN Singh, AK Shukla, VD Vankar, Thin Solid Films 518 (2010) 6915.
- Sangeeta Handuja, P Srivastava,VD Vankar, Nanoscale Res. Lett. 9 (2009) 9315.
- Sanjay K Srivastava, AK Shukla, VD Vankar, V Kumar, Thin Solid Films 492 (2005) 124.

Proteins and Facebook: What's the Connection?

Dr S Agarwal
Department of Electrical Engineering
Indian Institute of Technology Delhi

In some senses, the cell is to biology what the atom is to physics: a basic unit, a fundamental building block of the objects one is studying (living organisms for biologists, material objects in general for physicists). Cells are wonderful creatures: they can do an amazingly wide variety of things. Think of heart cells, which work to pump blood to different parts of the body; or blood cells themselves, which carry oxygen and fight infections; or muscle cells, which allow us to move our arms and legs by stretching and contracting; or brain cells (neurons), which form complicated circuits that carry out all sort of calculations, and ultimately underlie our thoughts, memories and emotions. And yet the amazing thing is that all of these cells contain the same 'recipe book', the sequences of DNA (or genes) that are the 'blueprint for life'. So how is it that cells that all have the same recipe book, manage to behave so differently? The answer is that each cell is picking out its favourite recipes (genes) to put into practice. So if a gene is like a recipe, then what is it a recipe for? A protein, of course! Indeed, all cells contain big kitchens, or factories (technically called ribosomes), whose job is to read the recipes and use them to create new proteins. If cells are the building blocks of life, then proteins are the building blocks of cells; all the different parts and bits of machinery inside a cell are largely made of proteins- including the factories that make new proteins! (Think of a brick kiln, made of bricks that were themselves made in another brick kiln.)

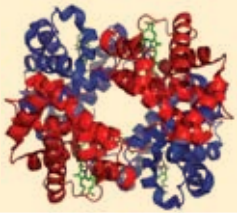


Figure 1: Haemoglobin, the protein which transports oxygen from the lungs to the rest of the body. (Image from Wikipedia)

Returning to the amazing versatility displayed by cells, we now know that the reason they are so varied is because they are producing different combinations of proteins. Proteins are a bit like lego pieces: they come in many different shapes and sizes, and they can join together to make all sorts of fancy structures that can do useful things. In fact, proteins are better than lego pieces: they can even wiggle about, and fold up in different ways, and change their shape altogether when they attach to something else!

But how exactly does a particular cocktail of proteins lead to a cell with a specific kind of structure and behaviour, such as a muscle or brain cell? We don't really understand this, and it is something many scientists are working on. Figuring out how the different parts fit together and what roles each of them plays is important for all sorts of reasons; for example, it can help to tell us what exactly has gone wrong when cells start to behave badly, as in cancer, when they begin growing too quickly. If we can pin down the rogue protein(s), it makes it much easier to try and design drugs to fix the problem. Unfortunately, biology is very complicated: we are not very good at understanding the structure and behaviour of even a single protein, and when lots of proteins interact and join up in complex ways, it becomes all the more bewildering!

Thankfully, there are techniques for coming up with simple representations of systems that are made up of many interacting parts. One way of doing this is to think of the system as a network. What is a network? It's just what you might expect; like we have computer networks, or railway networks, or Facebook networks, we can also have protein networks:

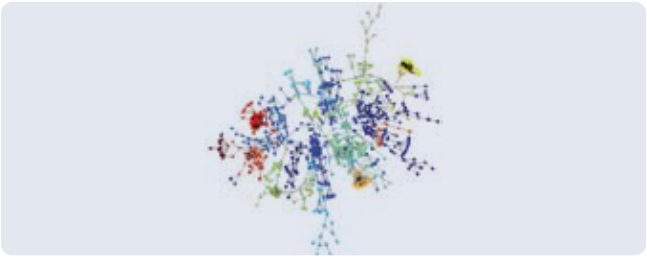


Figure 2: A network of proteins; two proteins are joined if they interact. The different colours are different 'communities' of proteins.

In the above picture, each dot is a protein, and two dots are joined by a line if we know that the two proteins can join up in some way (just like if two lego blocks can fit into each other). Also, we have coloured the proteins according to which 'community' they belong to. So what's a community? Basically, it's a group of things (computers, people, and proteins) that interact a lot more amongst themselves than they do with things outside their group. In the network above, we can clearly see such groups of proteins, and we've just assigned them different colours using a computer program.

Ok, so networks might look pretty, but how do they help us understand what's going on inside a cell? Well, for one thing, we know that a cell has lots of different things to do: producing energy to keep going, manufacturing proteins, sending signals to other cells and so on. Many of these things depend on what type of cell it is: a blood cell might need to carry oxygen, whilst a brain cell might need to process incoming signals (such as a signal form RED from the eyes) and send out a response (such as something corresponding to 'FIRE!' or 'DANGER!'). But whatever the type of cell, one might expect that there are certain kinds of proteins that specialise at certain kinds of tasks; and the proteins doing a particular thing probably tend to 'stick together', i.e., interact mostly amongst themselves. So the communities in the network above might correspond to groups of proteins that are involved in carrying out a particular task. Indeed, we do find that this is often the case: for example, some of the communities in the picture above are groups of proteins that make up the ribosome, the factory that manufactures new proteins. So by looking at where a protein sits in the network, and what other proteins it interacts with, we can usually get a pretty good idea of what the protein must be doing.

So far, we've been thinking of individual cells as somewhat static, boring creatures: unceasingly, unchangingly doing their job, whether it is carrying oxygen or stretching and contracting. But, the fact is that cells keep changing; they have a life-cycle, just like us, and they go through different stages: growing, responding to the environment, dividing into daughter cells, wearing out, dying. Often it is the way in which these changes happen that we are particularly interested in understanding; for instance, cancer happens when for some reason the growing and dividing stages go into overdrive. From the protein network point-of-view, what is happening as the cell goes through these different stages? One way to think of it is that at each stage, only part of the network is 'switched on'; the cell is making only those proteins it needs for that stage. So the network shown above is not really static, but dynamic: imagine different parts of it lighting up at different times. If we take this into account, can it help us to better understand what roles the different actors (proteins) are playing in the great cellular drama? One interesting idea that was suggested by scientists some years ago was that if we focus on the seemingly important proteins, the ones that have many interactions (these are called 'hub' proteins), may be by looking at when these interactions light up we can say something about what kind of protein it is.

Supposing I am hub protein in the network, and I have five 'partners', proteins that I can attach to. One might imagine two opposing scenarios: may be all my partners get produced by the cell at the same time, and so all the interactions get switched on at once. In this case, it's like me and my 5 partners all coming together for a big party; hence according to the scientists, I would be called a 'party hub'. On the other hand, it could be that my 5 partners get switched on by the cell at different times, as they are needed in different life stages. In this case, my interactions don't happen all at once, but one by one: they're like going on a sequence of dates with different partners, and so I would be called a 'date hub'.

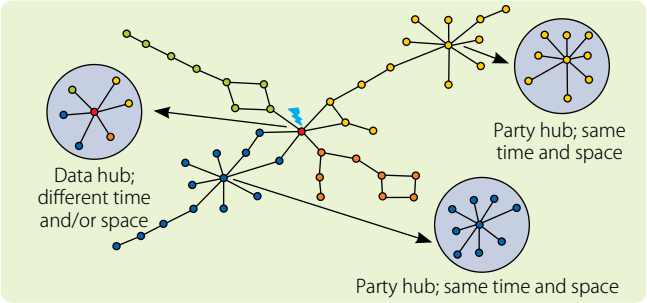


Figure 3: A small part of the protein network; the different colours are now used to show proteins that are produced at different stages of the cell's life. So for instance all the blue proteins are produced in one stage, whereas the green ones would be produced in another stage. (Taken from Han et al., Nature 2004 [2])

The idea that hub proteins came in two flavours, date and party, was quite exciting to scientists: the article that first came up with it was published in Nature, perhaps the most prestigious scientific journal. The reason for this was that the two types of hubs appeared to have distinct, important roles in how the protein network as a whole was organised. It appeared that the party hubs were like local, low-level coordinators: they helped to bring together many proteins that all had the same purpose, and were thus produced at the same time. For example, a party hub might attach to many other proteins to form a big protein factory, or ribosome. On the other hand, date hubs looked more like high-level, global organisers; they could help the different parts and stages of the network to communicate with each other, by for instance transmitting signals from one type of protein to another. Knowledge of what specifically date and party hubs were doing could be a major step forward in our goal of understanding how the complicated protein cocktail produces specific kinds of cells and behaviours.

Unfortunately, things turn out be not so simple. Several other scientists disputed the idea that the hub proteins could be categorized into 'date' and 'party' types, presenting evidence

that there was no consistent relationship between the pattern in which the interactions light up and the sort of role the protein has in organizing the network. In our article [1] in the journal *PLoS Computational Biology*, we establish this more clearly, showing that the so-called date hubs are not really any more likely to be global network coordinators than the party hubs. Moreover, protein hubs seem to display a wide variety of 'lighting up' patterns for their interactions, and classifying the hubs into just two types appears too simplistic.

However, it is not all a bad news. So far, we have been thinking of individual proteins as the actors to whom we want to assign roles, in order to see how they fit into the bigger picture. But what if we instead think of *interactions* between proteins as the actors? In other words, what if we try to assign roles to the *lines* in the networks pictured above, rather than the dots? What kind of role could a line, or link, in the network have? Well, one way of thinking of it is to imagine that the links are roads, joining up a bunch of cities (the dots). In this case, if I want to drive from one city to another, I will naturally try to find the shortest path, i.e., the one with the smallest number of links or roads (let us say that all the roads have the same length). For any given pair of cities, I can come up with a shortest path between them. Now, suppose I remove one of the links; one road suddenly gets destroyed. How many of those shortest paths between cities have to be re-routed? If the answer is lots, then it means that the link we removed was very important to efficiently connecting up different points in the network. So, for each road or link, we can say that one way of measuring its importance is how many paths have to be re-rerouted if that link gets removed: this is technically called the *betweenness* of the link.

How is betweenness relevant to the network of proteins? What we found was that there is a strong relationship between how important a link is (in the sense just described), and how similar the two proteins joined by that link are: **the links with the highest betweenness tend to be interactions joining the most dissimilar proteins**. Hang on a minute, you may be thinking: how do I decide how 'similar' two proteins are? Well, we know quite a lot about proteins from experiments: for many of them we know about their structures, and about what parts of the cell they are found in, and about what sorts of tasks they seem to be involved in. We can use a database of such information to measure how much two proteins match up in these terms. Our results seem fairly consistent across different protein networks. So why is this interesting?

One reason is that it seems to mirror something sociologists have long known about social networks (which are made up of people joined by relations like friendship or kinship; Facebook is just a giant online social network). In social networks, there is often a distinction made between 'weak' ties (or links) and 'strong' ties. Strong ties are close relations or friends; weak ties may be colleagues or acquaintances with whom one has less frequent interaction.

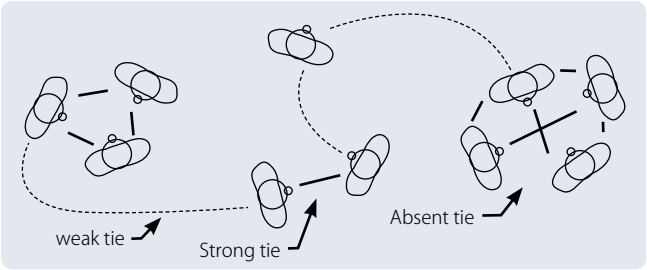


Figure 4: An example network of social interactions, depicting strong and weak ties. People tend to form into clusters of close relationships, with the clusters linked to each other by weaker relationships. (Image from Wikipedia)

The interesting thing is that the weak ties turn out to be the most important ones for communicating information across the network: for example, if you are looking for a job, then it is more likely that someone outside your immediate social circle (say, a friend's colleague) will be able to provide a useful tip than someone whom you know very well. This simply reflects the fact that your nearest and dearest are most likely to share your own connections and information sources, whereas an outsider is more likely to know something novel. Coming back to protein networks, if we think of the betweenness of a link as a way of measuring its importance for information flows between proteins, then we see that here too the most important or central links are 'weak', in the sense that they are between dissimilar proteins that have different functions and are not part of the same group. This suggests that a deeper understanding of the roles played by specific links in protein networks, along the lines of things like weak and strong ties, may help us to unravel the tangled webs of proteins that comprise and control cells, and thus ultimately, life itself.

References:

- Sumeet Agarwal, Charlotte M. Deane, Mason A. Porter, and Nick S. Jones. Revisiting date and party hubs: Novel approaches to role assignment in protein interaction networks. *PLoS Comput Biol*,6(6):e1000817, June 2010.
- Jing-Dong J.Han, Nicolas Bertin, Tong Hao, Debra S. Goldberg, Gabriel F. Berriz, Lan V. Zhang, Denis Dupuy, Albertha J. Walhout, Michael E. Cusick, Frederick P. Roth, and Marc Vidal. Evidence for dynamically organized modularity in the yeast protein-protein interaction network. *Nature, 430(6995):88–93, July 2004.*

Jobless Growth in Indian Manufacturing

Dr JJ Thomas
Department of Humanities and Social Sciences
Indian Institute of Technology Delhi

Manufacturing has not emerged as the leading sector in the Indian economy at any stage of its development so far. This is quite unlike the experiences of countries that have made successful economic transitions – such as Britain during the 18th century or East Asia and China during the 20th. The small size of manufacturing in the economy is a major reason for the development paradox in India – of fast economic growth occurring along with slow employment generation and poor advances in human development.

In 2006, the share of manufacturing in gross domestic product (GDP) was only 16.1 per cent in India compared to 30.9 per cent in China. And manufacturing employs only 52 million or less than 12 per cent of India's total workforce (of 459 million: all figures for 2009-10). It is notable that close to 57 per cent of India's GDP is created in the services sector. At the same time, the largest employer in India is still agriculture and related activities, which account for 52 per cent of the country's workforce, although their share in India's GDP is less than 15 per cent (indicating the low productivity nature of agriculture in India).

India's manufacturing sector consists of the organized and unorganized segments. The organized sector comprise factories that employ more than ten workers and operate with the aid of electric power as well as factories that employ more than 20 workers without the aid of electric power. In 2009-10, manufacturing workers belonging to the factory or the organised sector numbered 11.3 million. The rest of the manufacturing workers in India, 40.7 million in number, were engaged in small, informal enterprises in the unorganized or unregistered sector.

The growth of Indian manufacturing since the 1980s has been characterized as 'jobless': that is, relatively fast growth of manufacturing incomes but slow or stagnant growth of manufacturing employment. During the two decades between 1981-82 and 2003-04, only less than one million new jobs were created in the organized-sector manufacturing in India.

One of the reasons is the changes that occurred in India's industrial structure. During the 1980s, the factory-based production of cotton and jute textiles and also food products suffered major declines, and thousands of workers lost jobs in Mumbai, Kolkata, Ahmedabad, and other industrial centres. The new industries that emerged in the country subsequently – chemicals and petrochemicals, for instance – were highly capital-intensive in nature. Since the 1980s, India has built several world-class refineries and steel plants, which contribute handsomely to GDP numbers, but add very little to employment creation.

Divergences between the organized and unorganized sectors

However, during the 2000s, and especially after 2003-04, there has been a welcome change in the growth of employment in India's organized manufacturing. Despite the global economic slowdown, India's organized-manufacturing employment increased by an impressive 3.2 million between 2004-05 and 2009-10. The automobile industry has witnessed a phenomenal growth in the country during the 2000s. India is increasingly gaining a reputation for 'service-based manufacturing': providing engineering services to automotive, telecom, and other high-technology sectors. Large numbers of jobs were generated in the country during the 2000s in the manufacture of machinery and equipments, metals (such as steel and aluminium) and automobiles.

Quite in contrast has been the growth experience of the unorganized sector. Between 2004-05 and 2009-10, job losses in India's unorganized sector amounted to a massive 6.9 million. Large numbers of jobs have been lost in small enterprises in a wide range of industries including textiles, garments, food products, wood products, furniture-making, chemicals, and machinery.

Thus, with job gains in the organized sector and much larger job losses in the unorganized sector, the overall employment in Indian manufacturing fell from 56 million in 2004-05 to 52 million in 2009-10.

What could possibly explain such divergent trends within Indian manufacturing? How could the vast numbers of tiny, unorganized industrial units stagnate and lose jobs even

while the bigger enterprises in select industries perform well and also recruit more workers?

Evidence from Coimbatore

A study was conducted in Coimbatore, Tamil Nadu to understand the decline of small-scale industrial units in recent times. Coimbatore has long been an important centre for textile and engineering industries in India, the latter including the manufacture of pumps, automobile-ancillaries and textile machinery. The study involved interviews with leaders of industry associations, trade union leaders, entrepreneurs and workers in Coimbatore over a period between December 2008 and July 2012. Some estimates show that Coimbatore district accounts for approximately 2.5% of all factories (organized sector) and possibly a much larger share of all micro and small industrial units (largely belonging to the unorganized sector) in the country.

Power Shortages

The study suggests that power shortages have been the most severe constraint facing industrial units in Coimbatore. After 2007, there have been acute power shortages in this industrial city every year during the months between October and May. For instance, in January 2012, industrial units in Coimbatore suffered from six hours of power cuts on a daily basis. In addition, they were required to observe one 'power holiday' in a week. According to the owner of a leading pump manufacturer in Coimbatore, the schedule of power cuts in their area (in January 2012) – 10 am to 12 noon, 4 pm to 6 pm, 7.30 pm to 8.15 pm, and 9.45 pm to 10.30 pm – did not allow the economic operation of machines including induction furnaces in his unit.

Thus micro, small and medium industrial units in Coimbatore were paying around Rs. 4.30 per unit (or per kilo Watt hour) of electricity and still had to endure 50 per cent or even more of production losses due to power interruptions. At the same time, however, multinational companies such as Hyundai located in Chennai were being offered uninterrupted power supply at cheaper rates, as part of the agreement they had signed with the State government.

Clearly, the poor state of power generation and infrastructure in India is hitting the growth prospects of micro, small and medium industries much more than those of large industries. And this is a problem affecting industries all over the country, not just those in Coimbatore alone. The average annual growth of power-generation capacity in India decelerated from 8.6 per cent during the 1980s, to 6.8 per cent during the 1990s, and to 5.7 per cent during the 2000s. In recent years, power demand-supply deficits have been reported in almost all Indian States, including economically advanced ones such as Tamil Nadu, Punjab, Maharashtra and Gujarat.

Bank Credit

The second major issue that affects the performance of micro and small industries in India has been the virtual unavailability and high cost of bank credit. In Coimbatore, according to some estimates, more than 80 per cent of micro enterprises did not even have a bank account in a nationalized bank (during the period of my study). Therefore, the owners of these enterprises depended largely on their own personal savings or on private banks and private-finance companies. The interest rates charged by nationalized banks on micro and small units were considerably higher than the rates at which they gave loans to bigger units and large corporates (15 per cent compared to less than 10 per cent for the latter). Some entrepreneurs noted that the interest rates charged by private banks on micro and small units were as high as 36 per cent.

The share of the priority sector – including agriculture and small-scale industry – in total bank credit in India has declined after 1991, along with the introduction of economic reforms. The share of the small-scale industry in total outstanding bank credit in the country fell from 15 per cent in 1991-92 to 6 per cent in 2011-12. On the other hand, there was considerable increase during these years in the share of personal loans, including housing loans, and professional services, in India's total outstanding bank credit.

The third important factor that constrained the growth of Indian manufacturing has been the fluctuations in exchange rates and in the prices of key raw material. During 2007-08, the Indian Rupee had appreciated sharply against the US Dollar, due to which export-oriented industries such as textiles, garments, leather, and engineering suffered declines in their export demand. However, with the onset of the global financial crisis, Indian Rupee depreciated equally sharply: from Rs. 39-40 a dollar during April 2008 to Rs. 48.6 a dollar by October 2008. Indian exporters did not benefit much from Rupee depreciation because the demand from Western countries remained low. Another reason was that

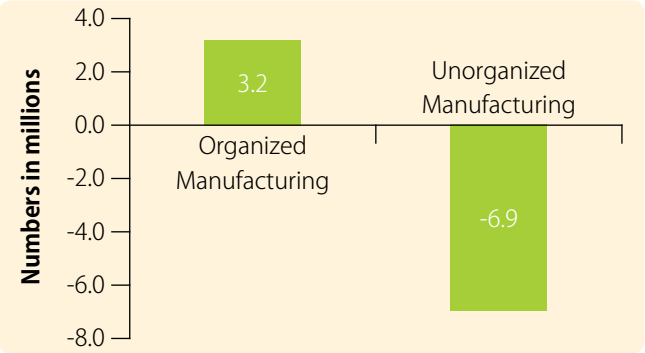
many exporters had already entered into contracts in forward exchange markets, at exchange rates prior to the Rupee depreciation. At the same time, imports and foreign currency loans became costlier with the currency depreciation

Engineering and textile firms in Coimbatore suffered from high volatility in the prices of raw material such as steel, cast iron and cotton. According to an association of spinning mills in Coimbatore, the marked rise in prices of cotton from 2007-08, despite a reasonably good cotton-crop production in the country that year was due to the export of and speculative trading in cotton. A small entrepreneur who manufactured gear boxes and supplied them to larger firms opined that the bigger units would hardly compensate him for any changes in the prices of steel or other raw material that occur later, after the supply rates were fixed.

Finally, there has been a continuous rise in imports as a proportion of the domestic output of machinery and transport-equipment industries in India through the 2000s: from 26 per cent in 2001-02 to 50.5 per cent in 2008-09. This imply that the fast growth of these industries in the organized-sector have increasingly been based on imported components. Clearly, such a pattern of growth limits the opportunities for the small-scale, unorganized units manufacturing ancillaries and components.

It is clear that India cannot ensure equitable and inclusive economic growth by relying on the services sector alone. Rapid expansion of manufacturing activities, particularly in the rural areas, will be a necessary step to create better jobs and living conditions to millions of poor Indians.

Net increase in Manufacturing Employment in India, 2004-05 to 2009-10, numbers in millions



Source: Calculations based on Annual Survey of Industries and National Sample Surveys on Employment and Unemployment.

Short term training on Solar Radiation and Solar Thermal Technologies - April, 2013

Research delegation from SAFRAN - April, 2013

Faculty Profiles

Prof CS Dey
Kusuma School of Biological Sciences
Indian Institute of Technology Delhi

Professor Chinmoy Sankar Dey has done his Ph D from the Indian Institute of Chemical Biology, Kolkata. In 1988, he proceeded for Post Doctoral Research at the California Institute of Technology, California, USA, and then at the Baylor College of Medicine, Texas, USA. After returning from abroad, in 1994 he joined the National Institute of Pharmaceutical Education and Research (NIPER), Punjab, as an Assistant Professor of the Department of Biotechnology. In 1999 he was promoted to the post of Associate Professor. In the year 2002 he became a Professor and from 2004 to 2010 he was the Head of the Department of Biotechnology, NIPER. In 2010 he joined the School of Biological Sciences, at IIT Delhi as a Professor.

Professor Dey has been teaching for the last 18 years. He has been teaching subjects like Cell Biology, Molecular Biology, Eukaryotic Signal Transduction etc. At IIT Delhi he has developed courses like Kinetoplastid Parasites and Novel Targets, Signal Transduction and Drug Target Identification, Chemical and Molecular Foundations of Cell (with other colleagues). Professor Dey has supervised a large number of Ph D and Masters students. Most of his students are settled abroad or working in Indian industries.

Professor Dey's research interests are insulin resistant diabetes and Leishmanial drug resistance. One of his primary contributions in diabetes research is that his group has created insulin resistant diabetic skeletal muscle and neuronal cells in the laboratory. Professor Dey's research group has demonstrated a linkage between insulin resistant diabetes and Alzheimer's disease (AD). Dr Dey's research has also suggested that Metformin, a clinically used anti-diabetic drug, could be useful for the treatment of neuronal diabetes as well as AD. On the occasion of "Sixty years of DNA structure" held at the University of California, Los Angeles, USA, Professor Dey's work has recently been cited by Professor James Watson, the discoverer of DNA structure and a Nobel Laureate.

In the pursuit of Leishmaniasis, one of the most significant contributions of Professor Dey's research demonstrated the mechanism of Miltefosine (first oral anti-leishmanial wonder drug) mediated killing of drug resistant Leishmania by the novel way of programmed cell death. One of his research works on Leishmania has been published as the Cover Page of the journal, Molecular and Biochemical Parasitology, (2005,141: 1). One of his papers, BMC Cell Biology, 2008, 9: 48, has been downloaded as 1408 pdf reprints within 3 months of publication. Professor Dey has over 60 primary research publications in reputed international journals. He has also published 6 reviews in international journals, one US patent and 3 book chapters.

Because of his significant contributions in science Professor Dey has been awarded:

1. Shanti Swarup Bhatnagar Award in 2003 by the Hon'ble Prime Minister of India,

2. National BioScience Award-2003 from the Department of Biotechnology, India

3. Organization of Pharmaceutical Producers of India (OPPI) award-2005 in "Pharmaceutical Biotechnology" by Hon'ble Minister Shri Kapil Sibal

4. Central Drug Research Institute (CDRI) Award-2008 for Excellence in Drug Research.

5. The prestigious J.C. Bose Fellowship from the Department of Science and Technology in 2009.

Prof Dey is a Fellow of the Indian National Science Academy, (FNA) and a Fellow of the National Academy of Sciences (FNASc.). He is a Visiting Scientist, at the Diabetes Research Foundation, Madras, and an Adjunct Professor of the Institute of Life Sciences, Hyderabad.

Professor Dey has been invited to deliver several invited lectures in various Universities, Research Institutions and Conferences in India and abroad. He has been acting as member of several committees of CSIR, DST, DBT, ICMR, and in academic and advisory committees of the National

Institutes and Universities of the country. He has served in the Scientific Advisory Board and also acted as Consultant to some of the pharmaceutical industries. He was a Regional Associate Editor, Journal of Biopharmaceutics and Biotechnology, USA. He is a Member, Editorial Board, Open Parasitology Journal, Bentham Publisher. *Prof Dey's website: www.csdey.org*

Prof PK Jain
Department of Management Studies
Indian Institute of Technology Delhi

Prof PK Jain completed his M Com in 1972 and Ph D in 1979 from Delhi School of Economics, University of Delhi. He started his academic career as a Lecturer at Shri Ram College of Commerce (University of Delhi) in 1972, before joining as Assistant Professor at Indian Institute of Technology, Delhi in 1984 and subsequently rose to the position of Professor in 1990.

At present, Dr Jain is Professor of Finance at Department of Management Studies, IIT, Delhi. He earlier served as the Head of Department of Management Studies and Co-ordinator of Dalmia Research Programme on Management in Asia. He is the Chair Professor Modi Foundation. Earlier, he was Dalmia Chair Professor.

He has a teaching experience of more than 40 years in subjects related to Management Accounting, Financial Management, Financial Analysis, Cost Analysis and Cost Control.

He had taught at the Foundation for Technical Institute, Basrah, University of Basrah, Iraq. He was visiting faculty at the University of Paris School of Management, Asian Institute of Technology, Bangkok and Howe School of Technology Management, Stevens Institute of Technology, New Jersey. He has been visiting faculty at International Centre for Promotion of Enterprises Ljubljana, Slovenia to teach Finance in its MBA (International) programe for more than a decade. He has been nominated as Honorary Visiting Professor by the Faculty of Economics, Ljubljana, Slovenia. He has been conferred best teacher award by IIT Delhi in January 2012. In July 2012, he has also been conferred 3rd Asia's Best B-School Awards entitled 'Best Professor in Financial Management' (Singapore) by World Education Congress and CMO Asia as well as 'Best Teacher in Financial Management' (Mumbai) by Amar Ujjalla (November, 2012).

He has Authored/Co-authored near a dozen Text Books (some of them have run more than two dozen reprints and five editions and two books have more than 60 reprints). Apart from these, there are 12 Research Books/Monographs. The select list includes Financial Management, Management Accounting, Cost Accounting (All from TMH), International Financial Management (MacMillan), Financial Management Practices in select Private Corporate Enterprises – A Comparative Study of India, Thailand and Singapore, IFCI – A Study in Financial Management Practices: Economic Crisis in South East Asia, A Study in Financial Management Practices: An Empirical Study of Indian Corporate (Springer). He has guided eighteen Ph D students; at present his work is in progress with six students on various important themes of finance.

He has published Research Papers (155) in Journals of national and international repute such as Chartered Accountant, Management Accountant, Pranjnan, Journal of Financial Management and Research, Indian Management, South Asian Journal of Management, Vikalpa, International Journal of Development Banking, Long Range Planning (UK), Journal of Derivatives and Hedge Funds (U K) Public Enterprise (Yugoslavia), Journal of Development Finance (Philippines), Systems research and Information System (USA), Decision Support System (USA), Journal of Technology Transfer and Commercialization (UK) and Journal of Applied Finance (USA), International Journal of Commerce and management (USA). He has presented research papers in nearly three dozen conferences held in India and abroad; more than a dozen research papers have been published in the conference proceedings. He is on the Board of various academic institutions. He is reviewer for journals like, Vision, Abhigyan, Vikalp, Finance India, Management and Change.

He has been invited by several institutions as visiting professor to deliver lectures. The select list includes Indian Institute of Foreign Trade, Department of Financial Studies,

FITT FORUM

University of Delhi, Institute of Chartered Accountants of India, All India Management Association, National Productivity Council, National Institute of Educational Planning and Administration, Management Development Institute, Indian Oil Institute of Petroleum Management, National Institute of Financial Management, Indian Institute of Information Technology and Management, National Thermal Power Corporation, IIM Lucknow, IIM Indore and Administrative Staff College of India, Hyderabad.

He has organized several Management Development Programmes (MDPs)/Continuing Education Programmes (CEPs) both for public and private sector executives.

He has been organizing Online Executive Development Programmes on Finance for Non-Finance executives. These Programmes are being conducted in e-learning mode in collaboration with Macmillan India Ltd. Since its launch, more than 400 senior executives from organizations such as, IBM, TCS, American Express, Larson and Tubro Ltd., NTPC, BHEL, Indian Oil Corporation, Engineers India, ASCI have participated.

He has been invited as an expert member to revise syllabus of Commerce by UPSC for conducting its preliminary and main Civil Service Examination. He was an expert member to interview candidates for the posts of Civil Services and of IFS (Government of India). He was appointed as a member of Academic Advisory Committee by Government of India to restructure National Institute of Financial Management, Faridabad.

His contributions in the field of Finance have been recognized at national and international levels and several awards and recognition have been conferred on him. He has been associated with several research projects and consultancy in the field of Finance.

Training Program on Polymer Materials and Processing PVC-Technology & Knowledge Management - June, 2013

National Technology Day at IIT Delhi - May, 2013

We Value Your Feedback

FITT seeks to explore various avenues to enhance the quantum of interaction between industrial units/end-users and IIT Delhi. Therefore, we keenly look forward to your feedback and suggestions on various issues that can help meet our objectives.

Write: mdfitt@gmail.com

Happenings

Technology Transfer to Industry under Stanford India Biodesign Program

Stanford India Biodesign (SIB) is a collaborative program between AIIMS, IIT Delhi and Stanford University supported by the Department of Biotechnology, Govt of India to nurture and train the next generation of Medical Device Innovators in India. Interns are mentored by the Faculty and Fellows of the SIB program to work on solution for unmet clinical needs.

Limb Immobilization Device or (LID)

"Limb Immobilization Device" developed under Stanford India Biodesign Program has been licensed to M/s. HLL Life Care Limited, Thiruvananthapuram, India on November 5, 2011. The device has been developed under the mentorship of Prof Alok Ray, Centre for Biomedical Engineering, IIT Delhi, in collaboration with AIIMS and Stanford University USA under 'Stanford - India Biodesign Program. This new Limb Immobilization Device (LID) is intended for pre-hospital emergency care use. Manufactured from moulded cardboard with ideal structural characteristics the innovative design makes the LID very light, low cost, and allows eco-friendly disposal. This device is ideal for storage in ambulances in rural and urban areas. Currently, the product is used in ambulances in Kerala, Karnataka and Tamil Nadu.

Novel, low cost - Patient Transfer Device

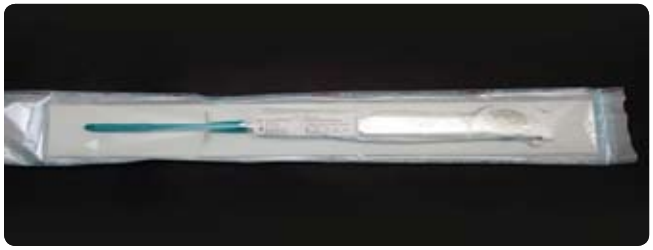
"Patient Transfer Device" is another innovation towards transferring patient from one bed to other with ease. It is a disposable fabric based solution that requires only one to two caregivers and reduces transfer time directly by half. It also prevents injuries to the caretakers and patients. The device as compared to the existing devices is user friendly, low cost and can be used by untrained human resources. This project is also a result of the collaborative program under mentorship of Professor Alok R Ray, Dr Mansi Agrawal, Mr Shitij Malhotra, Ms Pooja Singh, Mr Nishith Chasmawala, Mr Amit Sharma, Dr Praveen Agarwal, Dr Shiv Chowdhary, Dr Mahesh Chandra Mishra, and Dr Chandralekha are inventors of this device.

A better way to transfer patients in hospitals

Fecal Incontinence Device (FID)

This cost effective "Fecal Incontinence Device" has been developed for non-ambulatory patients under Professor A Ray. Nishith Chasmawala, Amit Sharma and Dr Sandeep Singh are the co-inventors of the technology. Fecal incontinence is the inability to control release of flatus and stool. This medical problem affects more than 32 million patients in India and the US annually. Globally there are close to 100 million patients that suffer from this problem.

Existing solutions to manage fecal incontinence are considered very inconvenient by patients. The product licensed to Consure Medical Pvt Ltd has an innovative design that is much more comfortable and acceptable to users at a much lower cost than currently available products. Currently the product is undergoing efficacy studies in target patients and will be commercially available after establishing regulatory compliance by the end of this year.



FITT Footprint

Innovations

Opportunities for IP Licensing

Sl No	Title	PI/Dept
1	A method and assembly for bidirectional data flow through an optical vortex network (P)	Prof V Chandra, EE
2	Pollution preventing microemulsion ink	Prof AN Bhaskarwar, ChemE
3	Process for purification of MBP or MBP tagged proteins	Prof MN Gupta, Chy
4	A novel variant of L-Asparaginase and its use thereof	Dr B Kundu, KSBS
5	High resolution microscope for 3D imaging of Live Biological Cells	Dr KB Khare, Phy
6	Clubfoot deformity measuring device	Dr PM Pandey, ME
7	A small Chaperone (C)	Dr B Kundu, KSBS
8	An ecological sanitation toilet pan	Dr VM Chariar, CRDT
9	A hybrid passive energy dissipation device for multipurpose vibration control of tall buildings	Prof A Madan, CE
10	A wheeled walker with braking system	Prof SN Singh, AM

Technology Profiles

A Novel Small Molecular Chaperone

Dr B Kundu
Kusuma School of Biological Sciences
Indian Institute of Technology Delhi

The small molecular chaperones (small heat shock protein or sHsps) are ubiquitous proteins, having monomer size ranging from 12-43kDa. Usually they are induced by a variety of stresses and display considerable sequence similarity with vertebrate eye lens protein α-crystallin (α-C). These sHSPs and α-C acts as ATP-independent molecular chaperones which prevents irreversible protein aggregation and subsequently facilitate protein renaturation in co-operation with ATP-dependent chaperones. The present invention is about an isolated nucleic acid encoding recombinant protein N-PfA form *Pyrococcus furiosus* L-asparaginase, having property of preventing aggregation of thermal and chemically denatured protein as well as inhibition of amyloidogenesis, thereby acting as a novel small molecular chaperone

Multiple Purpose Wheel Chair

Prof SN Singh
Department of Applied Mechanics
Indian Institute of Technology Delhi

Ordinary wheel chair serves the purpose of navigation only and do not provide the user an easy access to the toilet. In other words, patient (or handicapped person) using the conventional wheel chair requires an assistance to access the toilets. Also, it is not feasible with the existing wheel chair to access things which are kept at certain height; for example, a book kept at a certain height in a bookshelf.

The present invention provides a wheel chair, which can conquer the above-mentioned problems of the existing wheel chairs. It helps the user navigate from one place to other and also provide easy access to toilets without any assistance. Further, this wheelchair also enables access things kept at height.

A lifting means mounted on the base and coupled with the auxiliary seat for moving the same from an engaged position at which auxiliary seat is accommodated inside the hole to a disengaged position defined by position at which auxiliary seat is removed from the hole of the seat. Additional accessories like a table board, a cleaning brush, an umbrella can be attached to the main frame with the provision on the main frame. These accessories make this innovation into a multiple-purpose wheel chair.

R&D Projects

Sl No	Title	PI/Dept
1	Integrity analysis of pipeline weld joints using CTOD approach	Dr BP Patel, AM
2	Consultancy services for energy smart building for gas pipeline station	Prof A Sawhney, CE
3	Advice for development of long term monitoring techniques using underwater acoustic technology	Prof R Bahl, CARE
4	Development of an algorithm for scheduling patients on an MRI scanner that improves utilization of the equipment	Prof NB Bolia, ME
5	Development of a flexible freezer	Prof S Jain, ME
6	Estimation of sub-surface hydraulic parameters for dewartering design for construction of additional office complex for Supreme Court of India	Prof AK Keshari, CE
7	Investigations and root-cause analysis of LP turbine blades analysis of LP turbine blades failure of DCR thermal power plant, Yamuna Nagar	Prof K Gupta, ME
8	RF KIT consisting of 10 devices including manual for N9923A Handheld Network Analyzer	Prof SK Koul, CARE
9	Technical evaluation of effluent treatment plant	Prof TR Sreekrishan, DBEB
10	Development of mild hybrid drive using claw-pole wound filed synchronous machine with field oriented control for automotive application	Dr AK Jain, EE
11	Design of curriculum, experiments and laboratories for Mechanical Engineering UG course	Prof SR Kale, ME
12	Experimental investigation and machining parameter optimization for glass nano finishing using magnetorheological finishing process	Dr S Jha, ME
13	Evaluation of CEX and HIC process steps for purification of monoclonal antibody based therapeutics	Prof AS Rathore, ChemE
14	Production of rhizobium biofertilizer	Prof VS Bisaria, DBEB

15	Analysis of two – phase flow through fine channels of porous substrates (Phase-VII)	Prof S Roy, ChemE
16	Area drainage study for 1 GSTPP, Jharli, Jhajjar Distt., Haryana	Prof AK Gosain, CE
17	Optimization of chromatography process steps for purification of monoclonal antibody based therapeutics	Prof AS Rathore, ChemE
18	Engymatic Interesterification of Rice bran oil	Prof MN Gupta, Chy
19	Engagement of domain expert for technical due diligence of M/s. Solexel Inc., USA for Oil and Natural Gas Commission	Prof V Dutta, CES
20	Ukai Flood Modeling	Prof AK Gosain, CE
21	Technical advice on (i) IGBT based STACOM and (ii) DFIG Control	Dr AK Jain, EE
22	Microstructural modeling of Li-ion battery electrodes for electric vehicle application	Dr A Gupta, ME
23	HERCULES – Reckitt Mechanical Mosquito Repellent Disbursal	Dr J Kumar, IDDC
24	Recommendations for precision manufacturing process control and optimization	Dr S Jha, ME
25	Investigations on vibration and noise issues in top loader washing machine	Prof AK Darpe, ME
26	Political Economy of Low Carbon Investment (PELCI)	Prof AD Sagar, HUSS
27	Removal of acid and grit from high value carbon stream	Dr S Mohanty, ChemE
28	Functional testing and validation of sub-station monitoring system developed by BSES Yamuna Power Ltd.	Dr S Jha, ME
29	Analysis of lubricant technology	Dr S Mohanty, ChemE
30	Design of cooling fins for the electric motor employing heat pipe	Dr H Hirani, ME
31	In-Vitro binding study of bile acid salts to resin	Dr V Haridas, Chy
32	Disaster risk reduction including climate change adaptation of Guwahati in the context of dynamic growth	Prof SK Dash, CAS
33	To design Earth Air Heat Exchanger (EAHE) at Rajiv Gandhi National Institute of Youth Development (RGNIYD), Sriperumbudur, Tamil Nadu	Prof GN Tiwari, CES
34	Automated delineation/detection of a structure of interest in ultrasound images	Prof S Chaudhury, EE
35	Study on surface topology of pallets	Dr S Aravindan, ME

Professional Development Programmes

Forthcoming HRD Programmes

Sl No	Title	Date	Sponsored/Participation based	Faculty/Dept
1	Certificate Programme in Telecom Technology in Management	September, 2013 to February, 2014	Participation fees based	Dr M Sagar, BSTTM
2	Logistic and Supply Chain Management	September 14, 2013 to March 29, 2014	Frankfinn Aviation Services Pvt Ltd, New Delhi	Prof R Shankar; Dr SP Singh, DMS
3	One day workshop on Clean Coal Technology for Cleaner and Efficient Use of Coal	October 25, 2013	Participation fees based	Prof DK Sharma, CES
4	International Microwave and RF Conference 2013 (IMaRC)	December 14-16, 2013	Participation fees based	Prof SK Koul, CARE
5	SERC cum-Symposium on Rheology of Complex Fluids-2013	SERC School – 3 days – December 16-18, 2013 Symposium 2 days – December 19-20, 2013	Participation fees based	Dr SK Pattanayek, ChemE

Professional Candidate Registration Programme

Applications are invited from qualified professionals working in industry and research organizations for a unique knowledge augmentation and skill enhancement programmes at IIT Delhi. This involves a semester-long registration for a regular PG course. Course fees ranges from Rs. 15,000/- to Rs. 20,000/- (industry professionals) and Rs. 6,000/- to Rs. 8,000 (academic/ government personnel) for a 42 hour lecture course. In the case of a few selected courses, on-site course delivery using the two way audio-video link can be considered.

All major disciplines of Science and Engineering, and also relevant courses from the Humanities, Social Sciences and Management streams which are being conducted at IIT Delhi are covered. The course detail can be downloaded from FITT website www.fitt-iitd.org.

Eligibility: Degree in Engineering or Masters Degree in Science, Management or any other Post Graduate Degree with relevant industry experience. The two semester sessions in the academic year starts in the month of July and January, the exact dates being notified in advance.

Contact: uttamaswal@hotmail.com, kirityroy@yahoo.com.

Snippets

Corporate Membership of FITT

FITT invites the industry/industry associations/R&D organizations and financial institutions to become corporate members of FITT at a nominal annual subscription. A corporate client can participate in technology transfer and joint R&D programmes of the Institute on a priority basis with FITT providing the interface. Membership form can be mailed on request or can be downloaded from www.fitt-iitd.org.

Techno-entrepreneurship Supports

FITT extends supports for innovation/entrepreneurship under approved Government Schemes:

1. **Technological Incubation and Development of Entrepreneurs (TIDE), DIT**: to financially support technology ventures (IT and IT & ES) at incubators during early stages of their development. (www.mit.gov.in).

2. **Seed - Support to Incubatees, TDB:** for addressing the varied development needs of the start-ups at incubators up to Rs. 25 lakhs. (www.dsir.gov.in).

3. **Biotechnology Ignition Grant (BIG) scheme of BIRAC (DBT):** to establish and validate proof of concept through financial support/mentoring to incubatees and new startups up to Rs. 50 lakhs. (www.birapdbt.nic.in)

4. **Entrepreneurial and Managerial Development of SMEs through Incubators, MSME:** to nurture/promote technology/knowledge-based innovative ventures through financial support of up to Rs. 6.25 lakhs.

5. **Promoting Innovation in Individuals, Start-ups and MSMEs (PRISM):** aims to support Proof of Concept/ Prototypes/Models up to Rs. 2 lakhs and Fabrication of Working Model/Process Know-How/Testing & Trial/ Patenting/Technology Transfer up to Rs. 20/50 lakhs. (www.dsir.gov.in)

News and Views

Time right for research clusters to inject innovation into healthcare

Twelve years after the Government, unsuccessfully, rolled-out a fund to support the research and development of medicines – there is a renewed call for supporting innovation in health care. An innovative eco-system with an India perspective needs to be created so research can be focussed on problems on this side of the world, says Amit Chander, Partner with Baring India... *Source: Business Line, February 20, 2013*

Smart industry-institute linkages needed: Pallam Raju...

Source: Economic Times, April 9, 2013

Indian IT spending to reach $44.8 bn in 2014: IDC report

Information technology spending by companies across all sectors in India is projected to grow to $44.8 billion in 2014, according to a report published by technology researcher IDC.

The report said IT spending in India would expand by about $ 10 billion between 2012 and 2014. Most of the spending will be driven by a relaxation of foreign direct investment (FDI) rules in certain sectors, IDC said... *Source: Mint, June 10, 2013*

India's sub-standard engineering colleges

The world's top 50 universities in engineering and technology in 2013 do not include any Indian university/ college. The Higher Education World Reputation Ranking 2013 of top 100 institutions, has representation from all the BRIC countries, except India. We can conveniently blame it on bias, or simply ignore the global ranking. While the Government-run institutions have their share of challenges, the private institutes/universities, perceived to be a ray of hope, appear to be less interested in improving quality... *Source: Business Line, June 11, 2013*

Human Genome Project paid off in $966 billion life sciences boom

The $14.5 bn investment by the US in the Human Genome Project completed a decade ago has paid off more than 60-fold in new jobs, drugs and a rapidly and expanding genetics industry an analysis has found... *Source: Mint, June 13, 2013*

A technology that helps bridge the digital divide

Imagine being able to make international calls at the price of a local call, or for that matter, using a basic Rs.1,000 cellphone from a remote village to access information that would otherwise only be accessible to tech-savvy users in big cities who flaunt fancy, high-end smart phones or tablets.

Such a scenario is fast becoming a reality with an ambitious communications project called IVR Junction developed by two young Bangalore-based computer science researchers at Microsoft Research India, Bill Thies and Aditya Vashistha. Their mission is to bridge the digital divide between rural and urban India using what is called an interactive voice response (IVR) system... *Source: Mint, June 30, 2013*

New ventures that build technology-based solutions to boost agriculture

In turning his back on a coveted consulting job to launch a startup that brings technology to India's farm sector, Shashank Kumar was choosing the road less travelled.

But the 27-year-old graduate of Indian Institute of Technology, Delhi, was convinced that bigger rewards lie in harnessing the potential in the country's agriculture sector. Two years ago, he set up Farms and Farmers, a company which develops processes and technologies to help farmers evaluate soil quality and climatic conditions as well as choose crops and marketing for the produce... *Source: The Economic Times, June 21, 2013*

POSOCO Power System Award (PPSA-2013)

POSOCO - a subsidiary of Power Grid Corporation of India Ltd. (POWERGRID) in partnership with FITT, IIT Delhi organized the POSOCO Power System Awards (PPSA-2013) to recognize research excellence in power system at the technical institutes of IITs, NITs, ISM and IISc. As a nodal agency, FITT was entrusted with the execution of the project with the signing of the MoU in November, 2012. Accordingly, FITT planned out the modalities of the program for its implementation. On 18th February, 2013, the applications received for the program were evaluated by a six member expert panel which shortlisted 15 best projects in the Doctoral category and 20 in the Master category. The Doctoral projects received a cash price of Rs. 75,000/- each along with a certificate, while each Master category winner received a cash price of Rs. 35,000/- along with a certificate.

Biotechnology Ignition Grant Scheme

The third call for proposals under this scheme is on from July 1, 2013 to August 16, 2013. During the second call for proposals, 44 proposals seeking for support under this scheme were received at FITT, one of the three BIG partners of BIRAC. 17 proposals were shortlisted, out of which 8 have been recommended for support.

IIT Delhi Leadership

- Prof RK Shevgaonkar, Director
- Prof SN Singh, Deputy Director (Operations)
- Prof SK Koul, Deputy Director (Strategy & Planning)
- Prof Anurag Sharma, Dean (Academics)
- Prof S Tuli, Dean (Research & Development)
- Prof A Sagar, Dean (Alumni Affairs & Intl. Programmes)
- Prof A Gupta, Dean (Infrastructure)
- Prof Sushil, Dean (Faculty)
- Prof SK Gupta, Dean (Students Affairs)

FITT Team

Chairman: Prof RK Shevgaonkar

Managing Director: Dr A Wali

Executive Team: Mr KK Roy, Mr M Mahajan, Mr P Somarajan, Ms P Bhatia

Staff: Mrs S Lamba, Mr RK Mehta, Mr V Bhattacharya, Mr J Singh, Mr U Aswal, Mr MK Rajoriya

Consultant: Mr G Kumar

Associates: Ms T Jain, Mrs S Bhuyan

Editing Desk: anilwali@fitt.iitd.ac.in, surekha.bhuyan@iitd.ac.in

www.iitd.ac.in

Foundation for Innovation and Technology Transfer
Indian Institute of Technology Delhi
Hauz Khas, New Delhi 110016
Phone: +91 – 11 – 26857762, 26597289,
26597153, 26597285, 26581013
Fax: +91 – 11- 26851169
Website: www.fitt-iitd.org
Email: anilwali@fitt.iitd.ac.in, mdfitt@gmail.com