health care

MEDICAL TOURISM
The next big thing

AYURVEDA
Does this ancient science hold the key to our future?

ELIXIR 2.0
India's original biomedical design challenge in its new avatar

WEB 3.0
A dream come true or our worst nightmare?

PERSPECTIVE
Technology transfer: Where does IITB stand?
Modern times may have changed mankind's priorities from mere survival to knowledge accumulation and understanding the Universe, but the single most important thing that has remained unaltered all these centuries is his need for basic healthcare. Changing times may have brought in new advances, however his frailties and helplessness in the face of newer challenges have been well documented in history, the most recent being the Swine flu pandemic. Be it developing newer technologies or providing impoverished third world countries access to cheap healthcare, the path is replete with unaccustomed pitfalls. Innovation is the need of the hour and as IITians, there is no better way for us to give back to the society than act as leading contributors to this burgeoning sector. Keeping this in mind, we have chosen healthcare as our theme. Going by this theme, we have a wide assortment of articles for you ranging from Ayurveda to medical tourism to orthopedic reconstruction.

Taking your feedback into account, we have also increased the number of R&D articles and introduced sub-sections. The R&D subsection deals specifically with projects done by the students only, whereas the in-depth analysis subsection deals with a particular research topic with great detail. We have covered the research on Pratham, India's first student satellite and research on computational photography by Vision and Image Processing lab (VIP) respectively in these sub-sections. Some of you had asked for more information on the latest projects that have been delegated to IITB from various agencies, which we have covered in IRCC News.

Another important topic that we have covered this issue is the process of technology transfer. Although significant research is going on in IITB, very few of these path-breaking technologies are finding their way into the public domain. IRCC is still improving its technology transfer protocols and its various pros and cons have been explored in the Perspective article. Elixir 2.0, the hugely successful biomedical competition at Techfest 2009 features in our events section. The article also documents some of the innovative solutions that the students presented at the competition which were thereafter funded by reputed agencies like J&J and TePP.

Although it's a new issue with a new set of articles and different presentation, the objective is the same: presenting science and technology in an informative yet informal manner to the students. It's your magazine and we urge you to come forward and give your valuable contributions. For further queries and feedback, contact us at feedback.pulse@gmail.com.
# IRCC news

## RnD at IIT Bombay

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## FunZone

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<td>Indian Nano electronics Users Programmes (INUP)</td>
<td>Electrical Engineering</td>
<td>Department of Information Technology</td>
<td>Ministry of Communications and Information Technology has sanctioned a project entitled “Indian Nano electronics Users Programmes (INUP)” with an outlay of Rs. 12.4 crore over a period of five years. It also released an amount of Rs. 3.4 crore towards first year installment. The projects aims to facilitate and support the generation of expertise and knowledge in Nanoelectronics through participation and utilization of the existing facilities at the Nanoelectronics Centre at the Institute by external users.</td>
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<tr>
<td>Rural Connectivity and applications, Wireless Communications and Networking</td>
<td>Computer Science &amp; Engineering</td>
<td>Tata Teleservices Ltd., Mumbai</td>
<td>To undertake research in telecommunication. Tata Teleservices Limited, Mumbai and Department of Telecommunication, Ministry of Communications and Information Technology jointly sanctioned a project with an outlay of Rs. 12 crores over a period of five years, to set up a center of excellence in telecommunication domain in the institute called Tata Teleservices – IITB Centre of Excellence in Telecommunications (TICET). The center will focus on rural connectivity and applications, Wireless communications and networking among others. This will be funded and functioned on a Public Private Partnership model in which 90% will be funded by Tata Teleservices Limited and 10% by the Department of Telecommunication through infrastructure support and cash contribution (Rs. 50 Lakhs).</td>
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<td>National Programme on Perception Engineering</td>
<td>Electrical Engineering</td>
<td>Department of Information Technology</td>
<td>The project objective is to carry out research related to human perception based models and algorithms for signal processing and presentation, leading to systems for improving speech, audio, and visual perception and for improving man-machine interaction.</td>
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<td>Fabrication and submicron tailoring of materials for photonics application with ultrafast lasers.</td>
<td>Physics</td>
<td>Department of Science &amp; Technology</td>
<td>The project aims at advanced optical studies related to emission and nonlinearity in photonic crystals for device applications</td>
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<td>A lab on chip of Cardiac Diagnostics</td>
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<td>To develop a complete lab-on-chip using a low-cost sensing platform for detecting Myoglobin &amp; one or two other cardiac markers (Troponin or CK-MB) for early diagnosis/screening of patients suffering from acute myocardial infarction (AMI).</td>
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Some Technology Transfers/ Commercialisations

1. Hindi word net software package was transferred to an international internet company
2. Design of V-trough concentrated module was transferred to a Mumbai based company
3. Technology on extraction of natural sweetener from leaves was transferred to an Indian company

Some Major facilities

1. Department of Science and Technology sanctioned a financial outlay of Rs. 5.4652 crores over a period of 5 years towards establishing a 'National Facility of 40Ar - 39Ar Geo-thermochronology' in the Institute. It also released an amount of Rs. 4.9 crore as a first installment in this year.
2. Department of Science and Technology sanctioned a project with a financial outlay of Rs. 4.6 crores to augment the research facility in the Chemistry department under the FIST program over a period of 5 years. The project received an amount of Rs. 2.7 Crores towards first installment in this year. Some of the research facilities that are to be augmented by this project are Gas Sorption Analyser, Vibrating Sample Magnetometer, CD Spectrometer, GC-MS system, EPR Spectrometer and Liquid Nitrogen Plant.
Recent Patents accepted
A method of depositing an amorphous-SiC:H barrier layer on a low dielectric material layer
R O Dusane, S K Singh, A Kumbhar
4/MUM/2006, January 02, 2006
Assigned Indian Patent No.223221
Abstract: A method of depositing an amorphous SiC:H barrier layer on a low k dielectric material layer coated on a Si substrate, the method comprises of exposing the low k dielectric material layer to hot wire chemical vapour deposition (HWCVD) using a mixture of silane (SiH4) and acetylene (C2H2) gases at a temperature of 200 to 300°C and pressure of 100 to 200 mTorr

Sterling Coolers
S L Bapat
Mechanical Engg
299/MUM/2006, March 02, 2006
Assigned Indian Patent No.225128
Abstract: A stirling cooler consisting of a compressor comprising of a compressor piston reciprocally disposed in a cylinder. An expander comprises of an expander piston rotably and reciprocally disposed in an expanded cylinder. A regenerator is located within a cavity formed in an extension at the top of the expander piston. A circumferential groove is formed on the extension adjoining the bottom wall of the cavity and the top end of the expander piston. Gas passages are formed in the top wall and the bottom wall of the cavity. A pair of helical grooves are provided along the length of the expander piston with their ends meeting each other. The pitch of the helix formed by the helical grooves is twice the expander piston stroke. The compressor cylinder is connected to the expander cylinder through a connecting tube and the helical grooves provided along the length of the expander piston and circumferential groove. At least one seal is provided between the sidewall of the cavity and expander cylinder to prevent gas leakage there. A conductor material cap is provided over the top of the expander cylinder corresponding to the expansion space formed within the cylinder between the top end of the extension and the closed end of the cap.

Head mounted device for semantic representation of the user surroundings
S Chaudhuri, Rajashekkar, Amit B Prabhudesai
Electrical engg
133/MUM/2006, January 27, 2006
Assigned Indian Patent No.225370
Abstract: Mounted on the cap, a computing platform connected to the image capturing means, a feature data store connected to the computing platform and an output module connected to the computing platform. The feature data store comprises reference features which represent different entities existing in the surroundings and are associated with semantic description of the entities in the surrounding represented by them. The computing platform is designed to extract at least one feature from the images of the entities in the surroundings captured by the image capturing means, compare the extracted feature of the captured image with the reference features data store, identify the reference feature in the data store closest to the extracted feature of the captured image and provide an output i.e the semantic description of the entities in the surroundings associated with the identified feature of the output module.
The modern times have been incessantly laced with ghastly acts of terrorism which have shaken our very faith in humanity. Time and time again we have been made to realize that our very existence can be blasted off by the whim of maniacs. This madness of manslaughter reached a crescendo when terrorists figuratively hijacked Mumbai itself on 26/11/2009. Their audacity to inflict such pain has left behind many questions on our capability and attitude towards tackling these demons. One always ponders on such questions- Are we so incapable of defending ourselves? Don’t we have the technology to combat terrorists and our neighbors? Isn’t the government doing anything? But the most important question that we felt as students and engineers should ask ourselves is - How can we as engineers contribute to the defence technology of the nation? To answer a few of these questions and many more, we talked to a few experts and students about the technologies that exist, that are being worked upon and also about some unexplored terrains where major breakthroughs are possible:

**Bulletproof materials**

Bulletproof vests are must for soldiers and police personnel. The current stock of bulletproof material is not good enough both in terms of quality and quantity. The distinct characteristics of advanced ceramics - light weight, high hardness, wear and corrosion resistant, low friction and special electrical properties, offer major advantages over conventional materials such as plastics and metals. Advanced technical ceramics provide the lightest, most durable body armor available for small to medium caliber protection. Boron carbide, silicon carbide and alumina materials are the best materials to provide advanced protection for vulnerable body areas.

A unique plate pressing process allows for cost effective body armor production along with custom molding in massive quantities. These materials are light and have high strength to weight ratio and achieve the highest level of durability with no sacrifice to performance hit after hit.

**Sensors for landmines/vapour emission:**

Limited but uncontrolled release of trace vapours takes place when explosive-laden landmines (anti-tank/anti-personnel) are deployed in fields. Development of chemical vapour sensors is based on specific explosive signature, pertaining to poly-nitro-aromatic compound of explosive charges. Critical Factors of this application
are very low detection limits, short detector response time for operations, involving moving platforms, good baseline stability, and minimum interference from environmental conditions. Several polymers have been used to detect nitroaromatic explosives by a variety of transduction schemes. Quenching of luminescent polymers by electron deficient nitroaromatic explosives, such as trinitrotoluene, may be monitored to detect explosives. Resistive sensing using carbon black particles that have been coated with different organic polymers and deposited across metallic leads can also be used to detect nitroaromatic vapors in an electronic nose approach. Luminescent polymetalloses have recently been investigated for sensing explosives in aqueous-based solutions and for improved visual detection of trace particulates on surfaces.

**Missile Fuel**

Nanotechnology can be used for rocket and missile propellants. Nanoparticulate material are used for gellants(hydrocarbon alkoxides). Gellants increase safety, fuel density and energy. Gellants reduce fuel slosh and reduce the vehicle dry mass with higher fuel density. Nanophase aluminium particles are added to missile and rocket fuels to form metalled gellants. Along with the benefits of gellants, metalled gellants can increase engine exhaust velocity and fuel density. Powder particle properties can be used to make better fuels.

**Camouflage materials**

Camouflaging is very essential for aircrafts. Stainless steel fibers in the camouflage material absorb some of the radar signal and reflect most of the remaining signal in all directions. The result is a small percentage of signal return to the radar for detection.

There is also a need for materials which provide both visual camouflage and infra-red camouflage against night vision goggles, I-R goggles etc. The main requirements of an infra-red camouflage material are that it must be able to reflect radiant heat incident on the material, have a low emissivity and be able to re-emit conducted heat at a specific level in keeping with the surroundings. A method of manufacturing a thermal camouflage fabric is by weaving metal-coated flat tapes to form the fabric. The tapes may comprise two layers of aluminium sandwiched between two layers of high density polyethylene or may comprise a single layer of high density polyethylene sandwiched between aluminium layers. These 'metallised' tapes are woven either with similarly metallised tapes or with non-metallised tapes of polyethylene to make up the fabric. The fabric is then overcoated (usually by an extrusion coating method) with polyethylene which may contain pigments that absorb radiation in the visible region of the electromagnetic spectrum.

**LASERS and Imaging:**

Lasers have a variety of applications in defence and security. In battle they can be used to guide missiles and bombs, as firearms for destroying tanks, radars and even satellites; for target ranging and for Dazzling: Dazzling the enemies or impairing their vision for a short duration can have a myriad of applications. In the recent 26/11 attacks and the siege of the Oberoi hotel, our commandos been equipped with lasers, rescue operations could have been carried out sooner. Lasers are also used as sensors. Pathogens in large water bodies can be detected using lasers, making them a shield against chemical and biological warfare.

In the recent 26/11 attacks and the siege of the Oberoi hotel, had our commandos been equipped with lasers, rescue operations could have been carried out sooner.

Gaseous ionization detectors are particle detectors used in high energy physics experiments. However, the same technology can be used in imaging for detecting explosives, metals, etc. Laser technology also has applications in infrared imaging and explosives. Such systems would have a greater range than existing metal detectors.

**MAV (mini aerial vehicles) & unmanned airships:**

MAV’s are unmanned robots which can fly over a certain range with their motion being controlled by a remote device. These vehicles are of the size of a small schoolbag. If you would have observed the 26/11 attacks, the terrorists were in rooms with windows. MAV’s mounted with image processors and snipers could have been used to shoot the terrorists from the window. These machines cost around Rs. 10k-20k. Unmanned airships can send picture of good resolution over a range of 3 km in a straight line. Taking into account their angular range, a region of 30 km can be monitored by an airship.

Unmanned airships can send picture of good resolution over a range of 3 km in a straight line. Taking into account their angular range, a region of 30 km can be monitored by an airship.

A thermal camera which can detect motion through image processing can be mounted on the airship which can send updated pictures. Thus the entire border can be kept under surveillance irrespective of the terrain and season. This can nip intrusion right in the bud.

Credit: Prof Arya, Saptarishi Bandhopadhyay

*Aerospace Engineering.*

**IIT Bombay**

Credit: Prof P. Bhargava,

*Metallurgical and Material Science Engineering.*

**IIT Bombay**

Credit: Prof B.P. Singh, Prof R Varma

**IIT Bombay**
GPS

GPS (Global Positioning System) can be used to safely navigate airplanes from a secure ground station. This can prove immensely helpful in situations such as plane hijacking, in which the pilot control can be blocked, and will then be handled by a base station. The immediate effect is the prevention of attacks similar to 9/11. An aircraft can do without a pilot except during unfriendly conditions like turbulence. Thus, it is very well possible to use GPS as an auto-pilot and land the plane at a destination of our choice.

Credit: Saptarishi Bandhopadhyay
IIT Bombay

Language Processing, Machine translation and Cross-lingual information retrieval

Machine translation, as the name suggests, is a technique that is used to translate from one language to another. This technology can be used to discover potential security threats from communications, internal and external. Extensive monitoring would not be required, and surveillance can be carried out with minimal man power.

A lot of the recent terror attacks were planned on the internet. Cross-lingual information retrieval is a technology using which one can place a query on the internet in one language, and get results in various others. Something like the Babel fish from The Hitchhikers guide to the galaxy. This technology would be very useful in searching various regional blogs and forums, including those with potential to disrupt national security, which are there in languages other than English.

Credit: Prof. P. Bhattacharya,
Center for Indian Languages Technology,
IIT Bombay

Robotics

Robots can be used for surveillance. The whole city can be manned by mobile and miniature robots which can send constant images of various locations. Such robots can also be designed to sense explosives, fires, etc.

The whole city can be manned by mobile and miniature robots which can send constant images of various locations. Such robots can also be designed to sense explosives, fires, etc.

Research is being carried out in IITB itself to make a robot which can automatically diffuse bombs. Such technology would surely be a boon for our defences.

Credit: Mechanical Dept.
IIT Bombay

The few technologies and materials mentioned here are not a piece of our imagination but are for real. Most of these technologies also exist while research is being carried out in others at IITB and other institutes. But in the end it comes down to the defence establishment to come down to researchers and extract the best result of their knowledge and for us as engineers, biologists and students to come up with innovative solutions to face the crisis.

The battlefield is ready Samurai, it’s time to rise and fight for pride!
Reconstructing step-by-step

Recent advances in orthopedic reconstruction have made it much cheaper and affordable for common man. A look at its basics and India's growing involvement in its research

Prof. B. Ravi
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Since the time of Pharaohs, when the rich re-implanted their teeth from slaves who would sell it to them, implants have been consistently used by man for reconstruction purposes. Be it for cosmetic purposes or treatment of life-threatening ailments like trauma (accidents), genetic disorders (birth defects) and malignant tumors (cancer), orthopedic implants have been in huge demand. These implants range from standard plates for stabilizing fractured bones (costing a few thousand rupees) to customized mega-prostheses (costing several lakh rupees) for reconstructing large gaps left after surgical removal of bone tumors. As a result of these innovative medical devices developed by engineers and intervention protocols perfected by surgeons, several thousand patients affected every year are provided a new lease of near-normal life. In India, the number of knee and hip replacements alone is estimated to be around 40,000 per year, most of them using imported implants. The number is nearly doubling every year, owing to better awareness and increasing affordability.

Medical Implants - Development Life Cycle

The process of developing an implant is an elaborate one and can be divided into several phases, which are:

Conceptualization: The most basic and initial phase consists of identification of the target population of patients and the consulting surgeons. Depending upon the need and nature of the problem, the implants may be standard (suitable for a large population), modular (for intra-operative flexibility) or customized (patient-specific). For this purpose, anatomical measurements of
the target group or individual are carried out to establish the geometric requirements through different imaging techniques like X-ray, CT and MRI. Various conceptual designs for the implant are evolved and the most suitable one is developed in consultation with the surgeon.

**Material selection:** Next up on the radar is the selection of appropriate biomaterials considering the requirements of the patient and economic viability. This may include metals (e.g., titanium, cobalt-chromium, stainless steel), polymers (e.g., ultra high molecular weight polyethylene), ceramics (e.g., hydroxyapatite) or a combination of these.

**Rapid prototyping:** The detailed design is validated through rapid prototyping for checking the function, and through computer simulation for checking failure, which may be caused by various reasons like loosening, deformation, fatigue and wear.

**Manufacturing:** The route taken is optimized so as to get the desired quality (shape fidelity, surface finish and properties) while incurring minimal costs. This includes an array of casting, forging and machining processes. In order to ensure its proper integration with our body tissues and environment, several specialized surface engineering methods, treatments and coatings are used. Advanced implants incorporate tissue grafts, fillers, scaffolds, growth factors and infection inhibitors.

**Testing and packaging:** Several mechanical, metallurgical and biological tests are carried out and only after obtaining satisfactory results are these implants certified for clinical use. Finally, it is laser marked, sterilized and packaged.

Standard or customized armamentarium (surgical instruments) required for implantation are developed using a similar process. Appropriate documents and training material are created to facilitate the implantation protocol. Computer-aided surgery planning, navigation, guidance and robotics further enhance the speed and quality of surgical intervention.

**Implants Technology – Indian Scenario**

Simple implants and basic surgical instruments do not need the elaborate development protocol mentioned above and thus are now economically manufactured in India with the desired quality and quantity. Other implants and instruments that require a higher degree of functionality, bio-compatibility and reliability are imported at exorbitant costs from Western countries, since there is no national facility for developing them here. For example, a local stainless steel single-hinge tumor knee prosthesis (TKP) costs about 10% of a rotating-hinge titanium TKP imported from USA, but the imported one is preferred by surgeons owing to its better functionality, modularity, and integration with the body tissues.

Development of medical devices requires in-depth knowledge of the specific medical domain coupled with an inter-disciplinary approach which includes designing, biomechanics, biomaterials, manufacturing, testing, imaging (radiology), electronics, computer, robotics and other technologies. Individual expertise in the above fields is available, though dispersed, in India. Almost all IITs and top engineering institutes have bio-engineering departments, and several researchers in metallurgical/material departments are shifting their attention to biomaterials. However, till date there has been no cohesive and sustained attempt to shape these biomaterials into innovative medical devices for catering to our requirements in a scientific manner. Indian medical device manufacturers are tiny compared to their global counterparts, and mostly rely on reverse engineering instead of R&D and innovation. As a part of an initial attempt to better this situation, we have set up an OrthoCAD research network cell at IITB.

**OrthoCAD Network Research Cell**

The OrthoCAD project at IIT Bombay integrated the expertise of CAD/CAM engineers at the institute with orthopedic oncologists (tumor specialists) at Tata Memorial Hospital, Mumbai, and material scientists at NFTDC, Hyderabad to develop a tumor knee prosthesis system. A great amount of work has been done in the past 3 years which includes

1. Development of an innovative rotating hinge TKP that combines axle and ball joints.
2. Evolution of a novel manufacturing process by combining investment casting, machining and surface engineering techniques.
3. Development of novel instruments (tibial and femoral jigs) to increase the speed and accuracy of implantation.

![Fig. 2: Tumour knee prosthesis, testing machine, instruments and software developed at IITB](image)
4. Creation of a 3D virtual surgery software to determine the position of the implant in a virtual anatomy of the patient reconstructed from CT images.

The team is now preparing for clinical trials. The entire TKP system (including testing machines, surgical instruments and softwares) was developed by using advanced CAD/CAM technologies and web-based video conferencing between the team members.

The experience clearly shows that medical device development is an inter-disciplinary knowledge-intensive process. Developing different implants within a short time, with high quality and affordable cost suitable for the majority of the population is a very challenging task. There is a clear need to enable large scale development of implants, instruments and human resources. There are several research issues that need our attention, some of which are outlined here.

**Medical Imaging:** This includes radiography, CT, MRI and other imaging modalities for visualisation of anatomy and defects. Research issues include fusion of multi-modal images for better accuracy of evaluation, and automatic image processing, anatomical reconstruction and 3D model evaluation.

**Biomechanics / Ergonomics:** This includes studying the kinematics and forces related to limbs of both normal and post-operative patients. Research issues include scientific evaluation of the gait of patients and various forces on implants, and developing an indigenous database useful for development of implants suitable to local patients.

**Bio-Materials and Tissue Engineering:** This includes developing and characterizing different bio-compatible materials, and evolving novel solutions to use them in implants. This requires evaluation and improvement of implant-tissue integration, and development of hybrid scaffold-implants that support growth of natural tissues.

**Computer-Aided Design and Prototyping:** This includes computer-aided design, evaluation and rapid prototyping in close collaboration with surgeons to rapidly develop novel concepts for medical implants. Research issues include better visualization (using virtual reality tools) and faster evaluation (using standardized finite element method software tools).

**Computer-Aided Manufacturing:** This includes novel and hybrid manufacturing routes to achieve the desired dimensional fidelity, surface finish and internal properties in an economical manner, so that the implants are affordable to the majority of the population.

**Testing and Certification:** This includes mechanical, metallurgical and biocompatibility tests (the last one requires animal facilities). Research issues involve development of standard test protocols for custom implants using a combination of virtual and physical test methods.

The success of these efforts should be measured by the innovative medical solutions developed for the 'common man' by leveraging advanced technologies available today, and catalyzing similar work in other organizations and industry by developing appropriate human resources.

**Surgery Planning and Navigation:** This includes computer-aided surgery planning, navigation, guidance and robotic assistance. Research issues include position sensing of anatomical landmarks and surgical instruments, registration of these with respect to the virtual models reconstructed in computer, and intelligent guidance to the surgeon driven by intra-operative imaging and sensing.

The success of these efforts should be measured by the innovative medical solutions developed for the 'common man' by leveraging advanced technologies available today, and catalyzing similar work in other organizations and industry by developing appropriate human resources. Bio-medical reconstruction provides immense opportunities for immediate application with concomitant social benefit, but comes with considerable technical and collaboration challenges, since this is an inter-disciplinary and knowledge-intensive field, and it is not easy to bring together the right combination of experts to solve a specific problem. The OrthoCAD network is a tiny step in this direction.
Advent of modern algorithms for modifying digital photographs has made computational photography a sought-after field. An in-depth analysis of the work being done in this field at our own backyard.

Digital Photography has overtaken conventional film photography over the past 2 decades. This is due to the fact that digital images can be manipulated very easily using computers as compared to the analog images. With the advent of a wide range of digital cameras, need for computational techniques to process them also became vital. Computational Photography refers to the collection of techniques which comprise of changes performed using software as well as changes in the camera internals (such as lens, sensor, shutter etc). These techniques make the digital cameras more intelligent and enable the user to capture digital photographs of complex scenes.

Background

Common applications in Computational Photography for digital cameras, dubbed as Epsilon Photography, require one to capture multiple images by varying the camera settings such as shutter speed, aperture, focus, and sensor sensitivity. These images can then be combined to obtain the image of our interest. This technique of combining multiple images is popularly known as Digital Compositing and has been used widely in recent times. In this article, we shall discuss an application which requires one to capture multiple images by varying only the shutter speed while keeping all other camera settings fixed. This can be achieved in most of the digital cameras using a mode called Auto-Exposure Bracketing (AEB).

We know that the real world scenes can have a wide range of brightness levels. Analog (film) cameras can capture all the brightness levels of such scenes in a single image. However, common digital cameras have a very less number of intensity levels (normally 256 i.e. 8 bit) to represent the entire scene. When one varies the shutter speed of the camera and captures multiple images of the scene, the entire brightness levels are spanned by these images. For example as in the given images, fig 1.1 is a low exposed image hence, one is able to observe the details of the brighter objects like wall clock whereas if you consider image 1.5, a highly exposed image, one can observe the details in the darker regions in the river; the wooden logs. The technique which combines these multiple differently exposed images to generate a single image which has all the real world intensity levels is called High Dynamic Range Imaging (HDRI). In other words, a High Dynamic Range (HDR) image seen in fig 1.6 is a faithful reproduction of the real world scene.
Though HDR image looks stunning on an HDR display (which are very costly), HDR image generation and its display on monitors that we have is a challenging problem. There is a characteristic function of every digital camera called the Camera Response Function (CRF) which the manufacturer does not provide the user. This function is used to compress and digitize the sensor signals and has to be estimated from the differently exposed images and their corresponding exposure settings in order to generate HDR images. Thus generated HDR images are encoded in formats such as OpenEXR and Radiance RGBE which are not compatible with common displays and printers. One needs to perform another operation called HDR compression to encode the HDR image in compatible formats like JPEG, PNG, etc. The images encoded in such a manner are called Low Dynamic Range (LDR) images and can be displayed using common displays and printed using common printers.

Research at IIT Bombay

At Vision and Image Processing (VIP) Laboratory, we have done work on the HDRI problem directly in the LDR domain. We have developed two algorithms which can composite multiple differently exposed images to generate an LDR image (analogous to HDR image). Our algorithms do not require the camera exposure settings and the estimation of CRF. The LDR image generated using our algorithms can be encoded in common image formats like JPEG, PNG, etc and therefore are compatible with common displays and printers. An explanation of the algorithms, which have been presented at IEEE

$$f(x, y) = \sum_{m=1}^{K} \alpha_m(x, y)g_m(x, y), \sum_{m=1}^{K} \alpha_m(x, y) = 1$$

The weighting function $\alpha_m(x, y)$ is modelled as a data dependent term (related to the local contrast computed from the image) and hence not estimated explicitly. Solving this optimization problem helps us to get an iterative solution which converges to the LDR image. In this equation, $\lambda$ is an appropriate weight for the smoothness term.

$$\hat{f}(x, y) = \arg\min \left[ \int \left( f(x, y) - \sum_{m=1}^{K} \alpha_m(x, y)g_m(x, y) \right)^2 + \lambda (f^2_x + f^2_y) \right] dx dy$$

The second algorithm employs a non-linear edge preserving filter called bilateral filter. This filter, when applied to an image, preserves the edges while removing the small textures. We use the difference between the image and the bilateral filtered image, which has details regarding small textures, as the measure of weighting function. C is an appropriate real valued constant which provides numerical stability.

$$\alpha_m(x, y) = \frac{\left( C + |f_m(x, y) - f_m^{BP}(x, y)| \right)}{\sum_{n=1}^{K} \left( C + |f_m(x, y) - f_m^{BP}(x, y)| \right)}$$

The bilateral filter for an image $f(x,y)$ is as shown below.

$$f^{BP}(x, y) = \sum_{x} \sum_{y} G_{\sigma_x}(x-x', y-y')G_{\sigma_y}(f(x, y) - f(x', y'))$$

where $G_{\sigma_x}$ is a 2-D spatial Gaussian function, $G_{\sigma_y}(x, y) = e^{-\frac{x^2+y^2}{2\sigma^2}}$

and $G_{\sigma_y}$ is the 1-D range Gaussian function $G_{\sigma_y}(a) = e^{-\frac{a^2}{2\sigma^2}}$
The first method, being an optimization based technique, provides an overall better contrast. However, the edges may not be sharp due to the imposition of the smoothness term. The second method retains the sharpness of the edges and is much faster than the first method.

Apart from the HDRI problem, we have developed an innovative application using a similar compositing technique explained above, LightBrush, which would find use in explorations and surveillance in a dark environment.

Future Challenges
At VIP laboratory, we work on more challenging problems related to exposure and illumination. Our objective is to make the digital imaging process more effective by providing the user facilities to capture images of complex scenes which were considered impossible before. We, in particular, tackle problems which come up in digital photography while capturing dynamic scenes. We have plans to extend our research and start work on coded imaging and other techniques which require one to redesign the camera internals.

Generate your own HDR Image
- Get a digital camera whose exposure settings can be varied.
- Select a static scene which consists of both the darker and the brighter regions.
- Take around 5 images using a tripod, exposure varying from low to high.
- Note down the corresponding exposure times.
- Vary the exposure in such a manner that the details of the brighter regions are well captured in the lowly exposed image and the details in the darker regions are well captured in the highly exposed image.
- Combine the 5 images to an HDR image using Adobe® Photoshop® CS3 function: File-> Automate -> Merge to HDR.
- If not happy with the results from commercial packages, do contact the authors.
Cooling hot chips

As miniaturization takes over, over-heating of electronic components is becoming a major issue. Can synthetic jets be the answer researchers are looking for?

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High performance electronic systems are fast becoming part and parcel of our day-to-day lives. Typical examples of such systems are desktop/laptop computers, mobile phones, and similar electronic gadgets that a large number of people use on a routine basis. Other examples of these systems are large servers, internet backbone routers, supercomputers, data centers, etc. that influence our lives perhaps in an indirect manner. The name of the game is miniaturization while maintaining/increasing the speed of performance. As a result of this trend, enormous amount of heat is generated in the electronic components and integrated circuits that form the essential parts of these systems. For example, a next generation computer processor is expected to generate in excess of 100 watts inside a chip size of less than 10 mm x 10 mm x 1 mm. In order for an electronic component and a system to perform its function in an uninterrupted manner and for a long time, effective heat dissipation strategies are required to be incorporated right from the beginning of the product development cycle. It is generally accepted that a large percentage of disastrous failures (as large as 75%) of electronic systems is due to poor thermal management, and hence this aspect of the design of today’s high performance electronic systems is extremely important. Typically this job, popularly called Electronics Cooling, is entrusted to a mechanical engineer.

Background

Conventionally, in most cases fans in conjunction with devices called heat sinks have been used to dissipate heat. A heat sink is essentially an array of fins attached to the heat-generating component. Heat sinks are typically made of aluminum or copper, and provide an enlarged surface area for increasing the heat dissipation. The airflow provided by the fans eventually carries away the heat. Heat sinks have been popular primarily because of economical reasons. They work well for standard systems such as desktop computers. However, for space-constrained systems such as laptop computers, heat sinks are difficult to use because of their relatively large size. In such applications, devices called the heat pipes have been used extensively. Heat pipes work...
on the principle of evaporating a fluid at one end of an enclosed tube thereby removing heat from a hot component and rejecting it to a cooler ambient through the other end of the tube. After heat rejection, the vapor condenses and is pumped back to the evaporating end through a wick due to capillary action. In a handful of cases, liquid cold plates have been employed for cooling of processors. Liquid cold plates are nothing but simple heat exchangers in which cooler liquid flowing inside tubes machined within a base plate remove heat from components that are attached to the base plate. Other than these conventional approaches, a liquid immersion type of cooling system has been tried with a supercomputing application. A couple of other approaches under research and development stage are spray impingement cooling and employment of micro-channel heat sinks.

What & Why

Electronics cooling with synthetic jets is a relatively new concept. The interest in synthetic jets has seen a great increase in the last decade or so. A synthetic jet is a flow that is synthesized directly from the fluid in the system in which it is embedded. A simple schematic of the operation of a synthetic jet is shown in Fig. 1.

![Schematic of operation of a synthetic jet](image)

A synthetic jet assembly consists of a cavity that is bounded on one side by an actuator (piezoelectric or electromagnetic) and on the other side by a cover plate with a small orifice at the center. The actuator is made to vibrate or oscillate about a mean position by providing external power. Figure 1(a) shows the “suction” stroke of the actuator during which fluid from the ambient is sucked into the cavity of the synthetic jet assembly, while Fig. 1(b) shows the “ejection” stroke during which the fluid is thrown out of the cavity. A jet is found to form beyond a certain frequency of actuation. Thusline a synthetic jet is formed when fluid is alternately sucked into and ejected from a small cavity by the motion of an actuator bounding the cavity, so that there is no net mass addition to the system. This is a particularly attractive feature since this implies that input piping, pumping, etc. are eliminated altogether. Depending on the frequency of the vibrating actuator, the jet flow can be “laminar” or “turbulent”. Laminar jet flow exists for lower values of the frequency of operation, and is characterized by the presence of a series of flow structures called “vortex rings” that emerge from the orifice; see Fig. 1(b). With an increase in the frequency of actuation, these vortex rings coalesce or merge into one another, eventually forming a turbulent jet. Figure 2 shows an experimental flow visualization image of a turbulent synthetic jet.

Research done at IITB

To that end, we have undertaken several activities at IITB. From the fluid flow perspective, a detailed experimental work characterizing the jet velocity as a function of the cavity geometric parameters and actuating frequency has been performed and published. Furthermore, the characteristics of a direct impingement mode of heat transfer using a synthetic jet have been extensively studied, and will appear soon in a publication. These two studies have generated useful engineering data. In addition, several parametric studies, both experimental and using computational fluid dynamics (CFD) simulations, have been done to investigate the effect of various geometrical and operational parameters relevant to direct impingement cooling, cooling of a component situated in a flow duct, enhancement of heat transfer by a combined use of a synthetic jet and a heat sink, etc. A patent has been filed for a novel concept of manipulation of geometry of the synthetic jet assembly to obtain enhanced heat transfer within space-constrained systems. Such large amounts of data are expected to provide insights into the working of this device that will eventually be used to design an innovative product.

In the future, we would like to continue these investigations with more sophisticated measurement techniques and computer simulations to gain better insights into the fluid flow and heat transfer behavior. Finally acoustic, ergonomic and economical viability of a synthetic jet based cooling system remains to be ascertained.
We often encounter staunch believers in the curative powers of alternative medicinal systems. Some of us may be believers ourselves, whether openly or not. Equally, there are many of us who are skeptics or even staunch disbelievers who ridicule the believers. So how does one attempt to bring rationality to this belief or lack thereof (if indeed one wants to do that at all)? To convincingly prove to those subscribing to the school of modern medicine that these medicines work, one should ideally employ the currently accepted standard of testing the medicinal prowess of a purported medicine by performing a multi-center, double-blind study of the medicine against a placebo. To a layman, these tests may seem hard to be done because of these medicinal systems' holistic viewpoint and the elaborate nature of prescribing most traditional medicines. Moreover, such a study is expensive and it may not immediately yield results that can be commercialized.

However, those trained in the scientific approach find that there is much scope for understanding these medicines from a basic modern science viewpoint. It is important to realize that herbs and minerals, which are integral parts of traditional systems of medicine in many countries, have led to many allopathic medicines (aspirin is a simple example). Hence, a small group of us at IITB thought it would be worthwhile to explore this ourselves by applying the tools of modern science to traditional and alternative medicine.

**Background**

Ayurveda or the 'Knowledge (Veda) of Life (Ayu)' represents one of the outstanding examples of science and technology development in ancient India and is a precious part of our heritage. The three primary treatises by Charaka, Sushruta, and Vagbhata are more than a thousand years old. These and the Laghu Trayaü provide an elaborate description of symptoms, diseases, diagnostics and therapeutic advice. They also describe the properties and uses of a large number of plants and formulations. There are compilations that cover food technology and describe the preparation and therapeutic properties of a wide variety of general and special foods. Special books even deal with Ashwa (horse)-ayurveda, Hasti (elephant)-ayurveda and Vruksha (tree)-ayurveda. We chose to study one class of products called Bhasma, of which there are many types.

Bhasmas are herbo-mineral medicinal preparations unique to the Ayurvedic and Siddha systems of Indian
Traditional Medicine. The word Bhasma loosely translates to “ash” and this word arises from the heat treatment that the herbo-mineral precursor is subjected to, several times, along with a quenching step in-between. These preparations have been used for quite some time and are claimed to be a very effective and potent dosage form. However, there is a dearth of scientific analytical studies carried out on Bhasmas, and even the existing studies suffer from incomplete analysis.

Ayurveda: Pros and Cons
Modern medicinal science has made enormous strides in the fundamental sciences of biochemistry, pharmacology, molecular & cell biology, and genetics. This has enabled us to target specific diseases even at the gene level, and to offer customized medicines. Ayurveda in a sense appears to have had a head start in many areas. An Ayurvedic practitioner has always talked of medicine combinations specific to an individual. Modern medicine places greater emphasis on the curative over the preventive, and allopathic medicines do have specific performance problems. Yet, both systems are not without their own sets of concerns. Apart from drug resistance, side effects and efficacy, major issues are cost and national capability, a fact that becomes significant in today’s patent regime. This is something which should be of concern in designing an effective and affordable healthcare policy in a country like ours. One important aspect is using traditional medicines to lead to new drug discovery in modern medicinal chemistry.

Despite its ancient origins, Ayurveda is not really one of the first choice therapies for many, the most important reason being the lack of user-friendly features for today’s lifestyle. Many formulations are cumbersome to take and are not readily portable. Dosages are often large and bitter, and medicines need to be taken with specific anupan such as milk, honey and ghee at specific times. There is a definite perception among many that Ayurvedic medicines work slowly and are therefore not suitable for acute problems. Most importantly, regulatory systems on chemical and biological quality control which are applied de rigueur for allopathic medicines are not yet developed for herbo-mineral and multi-herbal finished products. Also, the molecular mechanism of action is not explained or is not known.

In order that Ayurveda be developed as a more widespread system, it is necessary to study that system with the rules of modern medicinal chemistry. This is a technological challenge. In addition, systematic work needs to be done to establish chemical quality criteria for raw materials and finished drugs. Finally, there is an urgent need to develop a wide range of bioassays to assess the toxicity and efficacy of multi-herbal and herbo-mineral formulations. With these aims in mind, we embarked on our research of this fascinating world.

Research at IIT Bombay
Though the term Bhasma appears to signify plain ash obtained by burning a variety of substances, Bhasma production is actually a complex multi-step, multi-option process with a diverse array of base materials, process steps, products, and applications. Now, if the desired finished product composition (its chemistry) and the ideal particle size and crystallinity (its materials science) could be identified, it should be possible to develop a modern technology (via chemical engineering) which will take us directly to just the desired finished product, without the use of potentially toxic mercury and arsenic compounds which may be present in some Bhasma products. That is the objective of the work we have undertaken at IIT Bombay.

![Figure 1. Growth curve of yeast cells with and without treatment with JB.](image)

The first aim was to develop and establish physicochemical and biological methods of characterization. Such a study would enable the development of a radically different process technology to achieve a greater than 100-fold reduction in dosage. To begin with, methods to determine the elemental composition of the Jasada Bhasma, the phases, shape and size distribution of particles, and assessment of the coating on these particles needed to be established (Jasada Bhasma is a unique preparation of zinc which has been successfully used by traditional practitioners for the treatment of diabetes and age-related eye diseases). This required the use of sophisticated tools of nanotechnology like spectroscopy and microscopy and their variants such as X-Ray Diffraction, X-Ray Fluorimetry, Transmission Electron Micrography, XPS, EDS, Micro-Raman spectroscopy and also other methods such as Atomic Absorption Spectroscopy, and Dynamic Light Scattering, all of which are available at IIT Bombay. Starting with one type of Bhasma, we have now developed a method for the complete estimation of the elemental composition, which has been the first and main mystery in stating what these materials are. We have also made progress in defining the size and the nature of particles: they have nanoparticles!
The second aim of this work has been to understand their biological mode of action. This is useful in two ways: Firstly to develop bioassays (mostly stains of algae) which can be used for batch quality control as well as to test toxicity, and secondly to explain in simplistic terms their biological activity, and how this is linked to the activation/inhibition of specific enzymes and other biochemical markers. We have shown some elementary mechanisms at a molecular level involving free-radicals.

Our analysis shows that the Jasada Bhasma particles are in an oxygen deficient state and a clearly identifiable fraction of particles are in the nanometer size range. These properties like oxygen deficiency and nanosize particles in Jasada Bhasma might impart the therapeutic property of this particular type of medicine.

Our work is but a small beginning towards understanding of traditional medicines with the tools of modern science. It needs to be expanded to many more systems, higher organisms including humans. The work needs to be further extended to pharmacology, bio-dynamics and efficacy, and also to efficient manufacturing that would lead to better healthcare for all.

Figure 2. TEM image of the yeast cells (a) without treatment with JB. cell loses its rounded structure owing to the thin cell wall. A few organelles are visible in the cell. (b) After treatment with JB. Prominent nucleus in the cell is seen

Fig. 3 Particle size distribution result of Jasada Bhasma by DLS. (a) Bulk particle size distribution; (b) particle size distribution of Jasada Bhasma after filtration through 0.5 μm filter. Particle size analysis with transmission electron microscope; (c) TEM photograph of bulk particles of Jasada Bhasma; (d) TEM photograph of Jasada Bhasma particles present in the filtrate after filtration through 0.5 μm filter. Mean particle size of Jasada Bhasma is showing ~ 1 μm. After filtration through 0.5 μm filter we can observe significant number of small particles of 10-25 nm size present in the sample.
The IIT Bombay Student Satellite Project is a landmark project taken up by IIT Bombay students. The major objective of this project is to make IIT Bombay a respected centre for advancement in satellite and space technology in the world. The project aims at launching at least 5 satellites within the next few years. These satellites will be test-beds for new technology that is being developed in the institute and need space qualification.

‘Pratham’ is the first satellite under this project. The plan is to build a fully functional microsatellite which would then be launched by ISRO. This is entirely a student initiative with mentorship provided by ISRO scientists and IIT Bombay Faculty. As per the present timeline, the flight model of Pratham will be ready by end of 2009, which caters for some delays due to unforeseen reasons. Hence they wish to launch Pratham within the 4th quarter of 2009 or the 1st quarter of 2010.

Since the past few months a lot of research and development has gone into the satellite project leading to path-breaking achievements which have been done entirely by the students of IIT Bombay. A couple of noteworthy ones are given below.

1. **Attitude Determination and Controls Sub-System**

   The Satellite project uses 3 sensors; i.e. magnetometer, sun-sensor and GPS in order to get the required data for attitude determination and correction. The satellite would get information about the attitude (orientation of the satellite w.r.t. a fixed reference system) from the sun-sensor and magnetometer and the position from the GPS. The control systems would then combine this sensor data with position using a Kalman Filter (a recursive filter that estimates the state of a dynamic system from a series of measurements) to then get the desired outputs, i.e. quaternions and rates.

   Now this system works perfectly in an illuminated region, however in the dark region (when the satellite is eclipsed by earth) the sun-sensors are rendered ineffective thus causing the original Kalman Filter to fail. This is a common problem that most satellites face and hence to resolve this most international satellites use other systems such as the INS (Inertial Navigation System) or gyroscopes. This method, though effective, has three major drawbacks. Firstly these systems take a lot of computational power and as a consequence drain the energy of the satellite. Secondly an INS system weighs a lot. And thirdly the cost of an INS system can be anywhere from 60 lakhs to a couple of crores. To address this problem, the controls subsystem team of the satellite project has hence developed a new Kalman Filter which gives the required outputs using only the
magnetometer data in the eclipsed phase, which itself is in RnD phase in few places in the world. The control algorithm and control strategy is completely new and has been created by the controls team from scratch.

The controls subsystem team of the satellite project has hence developed a new Kalman Filter which gives the required outputs using only the magnetometer data in the eclipsed phase, which itself is in RnD phase in few places in the world. The control algorithm and control strategy is completely new and has been created by the controls team from scratch.

2. Payload Sub-System
The task of the satellite is to measure the Total Electron Count (TEC) of the ionosphere and to give a tomographical (section wise) representation of the same in co-ordination with ground stations. The satellite does this using information from the electron counter and accordingly meshing this information with the data received from the ground stations.

Now this can be done by using a variety of algorithms. However it has been found that these algorithms work very well in theory but give disastrous results when applied in practice. This happens because there is an excess of data available, and selecting the correct data takes tremendous amount of computational power. The payload team has hence devised an entirely new algorithm that works on the fact that the electron distribution would be continuous through the different layers of the ionosphere. This method helps the system to choose the correct data values for their equations and hence can now successfully determine the tomographical distribution of the ionosphere with accuracy levels greater than ever received.

The satellite team of IIT Bombay has helped a lot of other student satellite projects across the county. The team puts tremendous emphasis on the documentation of the entire project and believes to keep their data “open-sourced” so that others can learn and benefit from the same.

accurate and well designed antenna. The key to a well designed antenna is the polarization that can be produced across the antenna. The main quest of the communications team of the satellite project was to design a low cost antenna for all ground stations across the country and they have achieved the same by designing a two crossed Yagi antenna for their communication systems. A Yagi antenna is like your standard TV antenna with some minor modifications. The intuitive, simple and yet robust designs of the antenna that the communications team has developed entirely by themselves has been applauded by the scientific community and the team will be presenting a few results on the same at the IEEE conference in December 2009.

Apart from the above mentioned projects, the satellite team of IIT Bombay has helped a lot of other student satellite projects across the county. The team puts tremendous emphasis on the documentation of the entire project and believes to keep their data “open-sourced” so that others can learn and benefit from the same. Of the 10 sub systems of the satellite project, work on 3 Sub-Systems has been completed and the satellite is all set to launch by late 2009 – early 2010. We wish them all the best for their foray into the orbit.

3. Communication and Ground Station Sub-Systems
In order to transfer data the satellite requires a highly
Background

Prosthodontics is a branch of dentistry dealing with the restoration of damaged teeth structure. Apart from replacement of missing teeth and related mouth or jaw structures, it's also a common cosmetic treatment utilized by personalities in the entertainment industry for a pleasant 'engineered' smile. In ancient times, people mostly used gold and porcelain for replacing lost tooth structure since they could be custom fabricated to fit the needs of individual tooth requirements as far as form and aesthetics were concerned. Since gold was very expensive, other metal alloys were also being used for restoration.

The material that became popular next to gold was silver amalgam which was easily produced and relatively inexpensive. This material, popularized by an American dentist G. V. Black in the 1890's, was widely used as a cheap and effective replacement for tooth structure lost through decay. But eventually it was discarded as a safe option since it used toxic mercury and also lacked aesthetic appeal. Then other metal alloys like Ni-Cr with acrylic facing/composite facing were tried but most of the above materials were accepted only as an aesthetic compromise until superior options became available with introduction of complete ceramic restorations.

Ceramic Materials have been in heavy demand in Prosthodontic industry. A look at their current status and challenges

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Why Ceramics?
As recently as 20 years ago, ceramics were ignored as potential biomaterials. However, since then, especially in the past decade, interest in bio-ceramics has increased dramatically owing to their excellent color matching features coupled with durable chemical composition. It is necessary to look for suitable ceramic materials that can sustain average stresses during chewing of food. Some of the ceramic materials developed such as glass infiltrated Alumina, popularized by various companies all over, do satisfy most of the specifications. Thus they have a superior lifetime and score high on aesthetics too.

Global vis a vis Indian scenario
While all-ceramic restorations are pretty commonly used in the developed world, they are still to make headway into the Indian market. The most popular material used here is porcelain fused to metal despite the fact that porcelain based materials exhibit a chalky, opaque or gray appearance, thus limiting the final aesthetic result. This limited use of all-ceramic restorations is a resultant of their high costs as all of the materials are imported and in some cases even the fabrication is outsourced to companies abroad. This heavy dependence of dentistry in India on imported materials and technology is primarily because of limited amount of interdisciplinary work involving collaborative efforts among dentists and technologists/engineers in India.

Among the recent products the most common ceramic materials in use have been alumina Al2O3) or zirconia (ZrO2) or a combination of the two. The most successful commercial products developed abroad and also in limited use in India are the following:

> In-Ceram (www.inlab.com)
> Noble biocare – Procera (www.imperius.com)
> Degussa - Cercon (www.ceramco.com)

Challenges
Inspite of their versatility, there are several challenges faced by dentists and material scientists. These include improvement of their ability to resist crack growth during use involving cyclic stresses during chewing, achieving best fit for specific patients and matching the properties of natural tooth together with aesthetics.

To overcome these, two approaches have been popularized. One of them involves fabrication of a porous ceramic crown to the exact dimensional specifications followed by infiltration of the porosity with glass. The other approach was based on fabrication of the ceramic crown of appropriately enlarged dimensions such that following densification and accompanying shrinkage the dimensions match those specific to the patient’s requirements.

On-going work at Powder Metallurgy lab, IIT
While the focus of the work being carried out at IIT...
(glaze) with suitable coloring agents to match it with natural tooth color.

> The glass is powdered and its slurry (suspension) is applied on the porous alumina crown (SEM).

> The porous alumina crown coated with glass powder is heated to promote infiltration of glass into the pores forming a impervious (pore free) ceramic crown

> The crowns are then coated with another layer of glass (glaze) with suitable coloring agents to match it with natural tooth color.

> This fully prepared crown is now implanted into the patient to cap the broken tooth using cement at the interface.

Efforts are also being put on improving the mechanical properties (strength, fracture resistance) of the materials used for making dental crowns by incorporating nanoparticles of zirconia, which are being prepared by co-precipitation techniques.

In conclusion, although all-ceramic materials seem to fulfill the necessary criteria, they are very costly and thus not that popular in developing countries. The first step towards this would be setting up an extensive collaboration between the various inter-disciplinary links so as to develop cheaper fabrication techniques and materials which can be easily adopted by practicing dental technicians, making it affordable for the common man too.
Some of the hottest tourist destinations of the world are turning out to be the ones providing cheap healthcare. How can budding entrepreneurs take advantage of this?

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Way back in 4000 B.C., the Sumerians built the first known health complexes around hot water springs, visited by people from nearby areas. A thousand years later, India started having visitors from around the world to discover the novel art of healing that India had developed in the form of Ayurveda and Yoga. 5000 years later, a truck driver from the US travels all the way to Malaysia's Bumrungrad hospital for a hip replacement. The cost incurred by him is about a tenth of the cost in the US. However, the quality of treatment that he gets is comparable, if not better, than what he would have got in the US. Healthcare experts identify this phenomenon as medical tourism. Medical Tourism is where people from one country travel to another country to receive medical, dental and surgical care while at the same time receiving equal to or greater care than they would have in their own country.

Why Medical Tourism?
To understand why something like medical tourism is occupying the minds of healthcare experts, let us see where the flux of medical tourism comes from. In developed countries like the US, the UK and Canada, there are certain elective medical procedures which are very costly. There are these other bunch of processes such as cardiac processes (remember the movie Seven Pounds?) for which patients have to wait for years to get them done. Some of you, who followed the US elections, must have noticed that there is a big burden of ageing population on the western world. For example, in 2005, 13% of US citizens were aged at 65 years or above. This indeed puts an extra burden on their healthcare infrastructure, due to which patients look for offshore treatment options; creating medical tourism opportunities. 2007 census data revealed that 45.7 MM people in the US had no health insurance and 120 MM had no dental insurance.

All the numbers above say out one thing aloud; “there is definitely a buyer for economical and timely health services”; the question is where the sellers, if at all are? The answer lies in table 1. Asia, South America and recently, Middle East have become centers of medical tourism. Seeing that the maximum chunk of medical travelers comes from North America and Europe, it is not surprising that the medical tourism market has been growing at a 22.5% growth rate. In fact in 2007 alone, more than 750,000 Americans traveled abroad.

*see page no.
In fact in 2007 alone, more than 750,000 Americans traveled abroad for medical procedures. If things go the way they are, medical tourism will touch USD 100 Bn by next year.

**Evolution and impact of economic slowdown**

If we go back about 10 years in time, we will see how the medical hubs of the world have changed. Before 1997, wealthy consumers from developing countries traveled to industrialized countries for getting high-end medical treatment. This resulted in the US and Europe becoming centers of medical tourism for wealthy consumers. Between 1997 and 2001, price became an important factor for patients, partly because of the Asian economic crisis. The increased price sensitivity led to the emergence of alternatives players in South America and the Middle East. Between 2001 and 2006, The Middle East Boom, coupled with the cosmetic surgery boom led to a shift in consumer perception. People from the US, Europe, Middle East, South East Asia and South Asia began seeking treatment in Asia. The economic slowdown has not affected the number of medical tourists. However, the choices of destinations have changed. Medical travelers prefer cheaper destinations now compared to expensive ones. A classic example of this can be seen in Singapore, where the number of medical travelers came down after the economic slowdown, whereas, in Malaysia, the number went up.

**What's in it for aspiring entrepreneurs?**

A careful look at how medical tourism operates shows us that there are three key areas to fit in. The first and the most important role is that of the health providers. A list of key medical tourism hospitals is given in table 3. Talking of provider groups it becomes important here to explain the role of accreditations. Accreditations are certificates of quality, issued by organizations in the developed countries to ensure their medical travelers that the quality standards in the foreign countries will be same as that in the home country. The Joint Commission International (JCI), a nonprofit organization, has emerged as the sole leader in accreditations space. Over 220 health care organizations in 33 countries have received JCI accreditations. A more important group, from the point of entrepre-

neural ventures is that of the intermediaries. Intermediaries include hotel groups, travel agencies and medical travel planners. Intermediaries help medical travelers in identifying the destination and arrange for travel. They also help patients in working out the insurance plans that would suit their medical travel needs.

If there is any single factor that will impact medical tourism drastically, it has to be the insurance companies. The first insurance plan for medical tourists was launched by Health Net of California and the Consulate of Mexico. They introduced the first medical tourism insurance product called Mexi-Plan in 2006. This was followed by other companies such as Blue Cross and

**Chronicles of a medical tourist**

- **Knee replacement** Mexico
- **Cancer** Bangalore
- **Angioplasty** UAE
- **By-pass surgery** Malaysia

proper legal procedures in case of bad outcomes is an area to watch for. Secondly, getting insurance companies to pay for medical travel is another impediment that we are facing. The silver lining in this dark cloud is the government's role. Governments of third world countries have been trying hard to promote the medical tourism sector with increased funds and growth opportunities (table 5). And this might be your chance to get in the picture and get some American insurers to pay for medical travel. Any takers?
Geographies of origin and destination for medical travelers

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Key Medical Tourist Hospital Groups

**Bumrungrad Hospital, Thailand**
- Bumrungrad is the largest private hospital in Southeast Asia, with over 550 beds and over 30 specialty centers.
- The hospital has treated over 1 million international patients and has JCI accreditation.

**American Hospital, U.S.A.**
- American Hospital in Dubai is a 400-bed, private hospital with 40 U.S. Board-certificated physicians for multispecialty group practice.
- It was the first hospital in the Middle East to be awarded JCI accreditation.

**SPL USA Medical Center, Philippines**
- SPL USA Medical Center is a 650-bed hospital, which is a part of the three facilities, 13 departments, and 700 beds.
- It includes an affiliation agreement with Memorial Sloan-Kettering Cancer Center.
- It also has JCI accreditation.

**Apollo Hospitals, India**
- Apollo Hospital is the largest private hospital in India, with over 8,000 beds in more than 41 hospitals.
- Apollo was the first hospital in India to receive JCI accreditation.
- The Apollo Group and Johns Hopkins Medicine International have partnered to undertake a study on heart disease in India.

### Key Provider Groups

#### Mexico
- The government is supporting the setting up of health centers by an Indian hospital group, which will provide facility to medical tourists, especially from the US.

#### Costa Rica
- The government is developing a comprehensive program aimed at improving medical tourism.
- The government plan to provide more incentives to retiring Americans.

#### Brazil
- The Brazilian government is taking steps to improve the quality of care provided by its increasingly foreign standards.
- The Brazilian Ministry of Tourism is creating a group to help promote medical tourism in Brazil.

#### Singapore
- Various government bodies, the Singapore Tourism Board, Economic Development Board, and International Enterprise Singapore have formed an agency called SingaporeMed.
- This agency, comprising government and industry representatives, aims at promoting Singapore as a medical hub.

#### India
- In 2007 the Indian government launched plans to confer U.S. dollars to promote medical tourism industry.
- The government is working with groups such as the U.S.-based Taj Medical Group to support medical tourism in India.

#### Thailand
- The government has planned to invest THB 200 billion between 2010 and 2012 on the service sector, with a focus on medical tourism.
- Education of doctors and the purchase of quality hospital equipment will be the key focus.

#### Philippines
- The Department of Health in the Philippines is striving to become a medical tourism destination.
- The government is promoting the offering of services to convince local societies.

### Government Initiatives to Promote Medical Tourism

- **Mexico**
  - The government is supporting the setting up of health centers by an Indian hospital group.
  - The government plan to provide more incentives to retiring Americans.

- **Costa Rica**
  - The government is developing a comprehensive program aimed at improving medical tourism.
  - The government plan to provide more incentives to retiring Americans.

- **Brazil**
  - The Brazilian government is taking steps to improve the quality of care provided by its increasingly foreign standards.
  - The Brazilian Ministry of Tourism is creating a group to help promote medical tourism in Brazil.

- **Singapore**
  - Various government bodies, the Singapore Tourism Board, Economic Development Board, and International Enterprise Singapore have formed an agency called SingaporeMed.
  - This agency, comprising government and industry representatives, aims at promoting Singapore as a medical hub.

- **India**
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### Cost Comparison

#### Angioplasty/Arterial Treatment Costs in Major Destinations

### Heart Valve Replacement Treatment Costs in Major Destinations

### Knee Replacement Treatment Costs in Major Destinations

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TECHNICAL
Merging innovative technology and business is the need of the hour; what better place than IIT Bombay? A look at a couple of them.

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“To generate huge money by implementation of all ideas in energy and power sector” pat comes the candid reply from Ankit Mehta, MD of ideaForge, when asked about his ultimate vision. Like most IITians, he too always wanted to be an entrepreneur. He had implemented several ideas during his stay in IITB, together with setting up of the Innovation Cell, commonly known as UMIC. So, when the opportunity came by in 2006, he didn’t have the slightest indisposition to leave behind his well paying six-figure job, and this is where the story of ideaForge starts.

The seeds of the start-up were sown in his IIT days, when he had filed a patent for an alternative energy device which generated energy using human movements. Based on this IP, the company initially concentrated on developing mobile chargers harnessing energy from various sources like human movement, bike, car and USB. The primary motive of this product line is to give the user “walls free” charging. Although the prototypes were ready in a short time, funding proved to be a major obstruction. Ankit enumerates the reasons, saying, “Firstly we were targeting mobile sector, which is as such pretty competitive. Secondly our IP was just an incremental one; it wasn’t a new one altogether. So justifying the numbers to prospective investors was painful”. They convinced SINE to provide them with initial funds together with an office-space. Extra funds came from Ankit’s savings together with the consultancy and events work which he and his team-mates did for TRI and Techfest respectively. Finally their hard-work paid dividends when, in 2008, they were able to attract angel funding from an NRI investor, who was interested in clean-tech technologies in India. A major breakthrough came this year when they received micro-funding from Govt. of India under the TePP scheme of DSIR.

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Recognizing security as a paramount contemporary need and the lucraviveness of this sector, the company is
Currently working on developing Micro Unmanned Aerial Vehicles (MAVs) for various purpuses like aerial surveillance, aerial security, aerial imagery and reconnaissance. They have already come up with two models, namely Fireball and Zepellin IV. Fireball is an autonomous fixed wing flying platform ideal for aerial surveillance of short range missions. On the other hand, Zepellin IV is an autonomous hovering platform suited for constant monitoring & surveillance of areas from a fixed perspective. They are currently working on improving the design and packaging aspects. According to Ankit, they have approached a few prospective buyers in the form of defense labs and already have a few orders. They are looking at the year-end for introducing the product on retail level.

Although they have started slowly, they have made steady progress over the years. With the government giving them due recognition through funding means and their major foray into the crucial defense sector, ideaForge is set to scale unprecedented peaks. For further information, please visit www.ideaforge.co.in

Most businesses follow the pattern of alphabet “J”, i.e., in the beginning, it goes down, which could be in the form of effort, time, money, etc. The bottom of the “J” is the most painful period. This is the time, when we need to have patience and courage as R&D, packaging, branding of products, etc. takes several years. However, brain by itself cannot do everything. Similarly, product development is only 10 to 20% of business activity. Development of finished products, manufacturing, testing, packaging, marketing/selling, distribution, etc. account for remaining 80 to 90% of business activity. This I would say was one of our toughest periods. Most businesses follow the pattern of alphabet “J”, i.e., in the beginning, it goes down, which could be in the form of effort, time, money, etc. The bottom of the “J” is the most painful period. This is the time, when we need to have patience and courage as R&D, packaging, branding of products, etc. takes several years. One must have passion for their enterprise and guts for taking risks, followed by the will to succeed in any circumstance while maintaining moral and ethical values. However, we were able to convince the external investors for additional funds, and again, IIT brand was very helpful.

We have developed large number of products such as, Mobile Phone Jammers, Signal Enhancers, Radiation Shield (to absorb undesired radiation from towers, mobile phones, computers, microwave oven, etc.), Antennas, Amplifiers, Filters, etc. This was possible because of technical knowledge acquired over the last 25 years. These products are useful for Telecom Sector, Defense and Space communication, Security, etc.

As a part of our future projects, we are also developing several products for 3G and WiMax Communication. Rural communication is extremely important for the growth of the country; we are developing low cost solution using non-conventional energy sources. We will soon be launching products such as GPS Tracking for vehicle and human movement, Mobile Phone Detector, RFID for Electronic Toll Collection and Inventory management, Receivers and Transmitters for wireless communication and security applications. In addition, many new and innovative radiation shield products are being developed to safeguard human health from undesired microwave radiation, such as, pocket radiation shield, collar/locket/belt/bag/cloth radiation shield and notebook/school book wrapper radiation shield.

In conclusion, we have developed large range of products and will be launching very soon several innovative products. We are ready for scaling up the operation and talking to investors for further expansion. For further information, please visit www.wilcom.co.in
Technology Transfer and IIT Bombay

In today’s world, where economies are moving towards knowledge based ones, availability of technology to common man is as important as its creation. Let’s delve into the various aspects of technology transfer at IIT Bombay

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Every year we see thousands of BTPs, DDPs and various other Mtech & Ph.D projects being done. Apart from these, professors in various departments receive funding from an assortment of agencies, both government and private, to work on a multitude of research topics. Ever wondered how these researches, some of them path breaking in their own right, actually end up being used in the industry? How these are transformed from a lab scale project to a product of mass use? How do the professors and the institute stand to benefit from these transactions? We will try to answer these questions in the course of the article. But before that, we must know as to what exactly technology transfer is.

The IITs were founded with the aim of being fountainheads of new ideas and innovations in the field of science and technology. Keeping this motive in mind, Industrial Research & Consultancy Centre (IRCC) was established as an initiative to promote innovations and to facilitate protection of Intellectual Property (IP) thus generated at IIT Bombay. However, the most important objective of IRCC was public notification by making these pioneering technologies available to the common man. This is precisely what is known as technology transfer. Simply put, technology transfer is the movement of knowledge and discoveries to the general public. It can occur through publications, educated students entering the workforce, exchanges at conferences, and relationships with industry. For the purpose of this article, however, technology transfer refers to the formal licensing of technology to third parties, under the guidance of professionals employed by universities, research foundations and businesses, in departments focused on these activities.

To achieve the aforementioned goals, IRCC at IIT Bombay follows a defined path to facilitate a successful technology transfer, which is specially designed to make it easier for the researcher to file a patent and license his/her technology. These basic steps are as follows:

Research
The whole process starts off with a thorough analysis of the problem’s background. Based on this, various experiments and surveys are designed and carried out, which lead to a set of observations and inferences. These activities often lead to new innovations and inventions. An invention is any useful process, machine, composition of matter, or any new or useful improvement of the same.
Invention Disclosure

It is also referred to as Technology Disclosure, the written notice of invention to the IRCC that initiates the formal technology transfer process. An invention disclosure remains a confidential document, and should fully document invention so that the options for commercialization can be evaluated and pursued. To file a Technology Disclosure one has to fill up a disclosure form, which is available on www.ircc.iitb.ac.in/IDF/idf-iitb-modified.doc.

Assessment

This is the period in which the concerned IRCC official reviews (with your input) the invention disclosure, conducts patent searches (if applicable), and analyses the market and competitive technologies to determine the invention’s commercialization potential. There are two basic models to assess the disclosure – Cost based analysis and Market based analysis. IRCC largely follows cost based analysis; market based analysis is still absent in their workflow.

Protection

Protection is the process in which protection for an invention is pursued to encourage third party interest in commercialization. Patent protection, a common legal protection method, begins with the filing of a patent application within India. Some of the Technology Disclosures have the uniqueness and potential of being a patent. A patent is a set of exclusive rights granted by a state to an inventor or his/her assignee for a limited period of time in exchange for the disclosure of an invention. According to the Indian patent rules and regulations, the inventor should file the patent before its publication. In India a patent lasts for 14 years from the date of filing the complete specification. However, for food, drug and insecticide patents, the life is seven years from the date of complete specification, or five years from date of sealing of the patent, whichever is shorter. At IIT Bombay IRCC takes up the whole job of documenting and legalities involved in filing the patent. In normal cases a patent is granted after 24 months of submission of the final documents. Other protection options include copyright and trademark.

According to the terms and conditions of IIT Bombay, any innovation taking place inside the campus of IIT Bombay, using the facilities of IIT Bombay is a property of IIT Bombay. Any patent coming out of the research is patented in the name of IIT Bombay.

Marketing to find a Licensee

With sufficient involvement of the researcher, the IRCC identifies candidate companies that have the expertise, resources, and business networks to bring the technology to the market. It has been statistically proven at various universities that 70% of the time the licensee is already known to the researcher; hence involvement of researcher in the licensing process forms the cornerstone of a successful technology transfer.

Licensing

A license agreement is a contract between IIT Bombay and a third party in which IIT Bombay’s rights to the technology are licensed (without relinquishing ownership) for financial and other benefits. A license agreement is used with both a new start-up business and an established company. An optional agreement is sometimes made to enable a third party to evaluate the technology and its market potential for a limited time before licensing. The decision as to whether the technology has to be transferred exclusively or given out in the form of multiple licenses is taken by IRCC and the researcher together and depends on the following key aspects
1. Market share of the company
2. Type of the product
3. Licensing amount offered by the licensee

According to the terms and conditions of IIT Bombay, once the technology has been transferred, the licensee bears all the liabilities related to the patent. IIT Bombay never shares liabilities related to the technology.

Revenue

Once licensing is done, the payment received is shared between the researcher and IIT Bombay. Researcher is entitled to get 70% of the revenue and IIT Bombay the remaining 30%. This 30% is shared between the institute and the department with which the researcher is associated. This ratio is applicable up to an amount of ‘Q’ which is fixed at INR 10 million, above which the ratio varies as the following:

<table>
<thead>
<tr>
<th>Case</th>
<th>Net earnings</th>
<th>Inventor(s) share</th>
<th>IITB’s share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>For the first amount Q</td>
<td>70%</td>
<td>30%</td>
</tr>
<tr>
<td>2</td>
<td>For the next amount Q</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>3</td>
<td>For amounts more than Q</td>
<td>30%</td>
<td>70%</td>
</tr>
</tbody>
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Need for a Change?

The officials at IRCC have been able to take care of the technology transfer work very efficiently, with IIT Bombay being able to get an average of 30 patents annually. However, this figure is far less as compared to that of Stanford University or MIT, which get an average of 200 patents annually. There is a need to revamp the whole process and include some new steps so as to actively promote patenting as this is the first step towards transferring knowledge for the public good. For the same a group of students working for IRCC under a tag-name of “Technology Transfer Group” (TTG) are thoroughly studying and evaluating various technology transfer models and Technology Licensing Office (TLO) present across the world and proposing a final structure to IIT Bombay.

TTG was able to find out two basic problems present in the process at IIT Bombay and thus based on them proposed changes comprising of the following:

1. Pre-Disclosure: All the researchers at IIT Bombay can voluntarily send the first draft of their publications to IRCC. By the time they finalize their publication, a group of students (M. Techs, RAs) will study the publication and, with the help of the researcher, will try to find out if a patent is possible out of that publication. They will also do an initial patent search to find out if it will infringe on anyone else’s patent. If a successful patent is possible, IRCC will propose the researcher to delay his/her publication for a month by which they are able to file a patent on the same. The students thus hired to do the said work, will be in lieu of their Teaching Assistant work, thus not hampering their academic commitments. This proposal was given after it was found that researchers don’t have enough time to do documentation and patent search required to be done before filing the patent.

2. Outsourcing: Another issue crippling IRCC at the moment is the absence of a Marketing Officer who can do evaluation of the patent and then market the same. TTG proposed an outsourcing model for the same. It was proposed to hire a big firm from the field of patenting to whom IRCC will outsource the work of evaluation and selling the patent in the market.

There is a strong need for linkages to be developed and maintained between industry and research organizations. Many people perceive the process of technology transfer as a mode of commercializing research and thus making these academic/research institutions a marketplace, but more importantly it’s the process which makes it possible for the innovations to be used for the greater good of society. For this to happen, industry needs to be involved at an early stage of research, so as to be able to participate even in the research definition stage. At the same time, public sector/academic research organizations need to be prepared to support industry in the commercialization process. Efforts to erase preconceptions that build barriers to successful technology transfer should also be taken.

Many people perceive the process of technology transfer as a mode of commercializing research and thus making these academic/research institutions a marketplace, but more importantly it’s the process which makes it possible for the innovations to be used for the greater good of society.

Although it remains to be seen exactly how much of the proposal will be actually implemented, the setting up of TTG and more importantly, involving students in it has been a step in the right direction. A good technology transfer unit and necessary awareness in the research fraternity will definitely go a long way in fulfilling Nehru’s dream of IITs being “the leaders in march of science”.

Patent infringement consists of unauthorised making, using, offering for sale or selling any patented invention within the territory where the patent has been filed, without the confidence of the patent holder.

In this case a patent holder can sue the company or person infringing on his/her patent. Patent infringement and litigation on the same has become one of the biggest markets in the current scenario. One of the leading software companies in the world generates almost 40% of its revenue from litigating against companies in infringing on its patents and hence continues investing huge money on R&D and then patenting the same, but hardly ever uses them directly in its product field.

One of the most famous examples of Patent Infringement is the most notorious Freeny Patent. The patent, originally issued to the late Charles Freeny Jr in 1983, covers virtually all the E-commerce. The patent was awarded much before the rise of personal computers, CD’s and mp3 players (iPod). It was later bought in 1988 by E-Data, a company formed just around this patent. In 2000, E-Data suddenly came into the limelight and sued almost all the most powerful and successful e-commerce players, which included Amazon, Apple’s iTunes store, Microsoft, iTunes, Hallmark greetings and many more. Each litigation ended into an undisclosed royalty to E-Data for all the usage in the future. The patent period ended in 2003 in US and in 2004 in Europe, but till then E-Data made handsome amount of money from litigations. These kind of companies which have no intention to manufacture or market their patented invention, but generate revenues by collecting royalties and further companies who allegedly infringe on their patents are known as patent trolls.
Implementing Life

A look at the healthcare event Elixir 2.0 organized by Techfest 2009

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Health care is a field extremely important to humanity and one in which there is a lot of scope for innovation. Developing cheap and sustainable/reliable health-care technologies is the need of the hour. Techfest 2009 tried to address this need through the first of its kind initiative by a student organization, ‘Prayaas’. Prayaas aimed at getting implementable solutions for the pressing energy crisis problem and in the field of health-care technologies. The initiative was a grand success and achieved the objective of getting practical solutions, some of which have already been implemented and some are on their way to implementation. There were 2 events under Prayaas; Energize and Elixir 2.0. Energize, as the name suggests, was designed for getting energy efficient solutions for the society whereas Elixir 2.0 focused on getting implementable health-care solutions for the society. With this noble goal of getting innovative solutions to the problems encountered in the field of life sciences and health-care Elixir 2.0 was launched in the second week of July, 2008.

Under Elixir 2.0, there were 4 specific problem statements dealing with issues ranging from creating a portable low cost ventilator, detection of heart failure and critical monitoring, ultrasonic vein finder to automatic detection of falls in the elderly. A fifth section was also added which was kept open ended along with a few examples in order to encourage students to identify various health-care problems in rural and urban sector and come up with creative and innovative solutions.

Initial Stages
To help the students in various aspects of their prototypes and increase the quality of solutions, a stage-wise mentorship programme was put in place. There were 3 main stages; the abstract submission stage, the video submission and the technical report stage followed by the finals at the festival. The abstracts were evaluated by a panel of biomedical experts and the purpose of the abstract was to know about the concept of the solution proposed and to get a brief insight into their plan for implementation. At the abstract submission stage there were around 120 abstracts
out of which 48 were provided with mentorship. The event was still open for those who hadn’t been shortlisted for mentorship. After a 45 day period there was a technical report submission stage in which the participants had to submit a detailed technical report and a video to show the working of the basic concepts involved in the prototype. At this stage there were a total of 80 entries out of which 24 were shortlisted for the finals at Techfest 2009. The judging criteria for these selections (as well as the final event) were as follows:

- Practicality of the idea
- Implementability of the product
- Cost efficiency
- User friendliness of the product
- Conditions and the feasibility of solution implementability
- Marketability of the product

**Final Event**

The final event was held on 25th Jan, 09. The judging panel for the event comprised of Mr Youseph Yazdi (Corporate Director, J&J), Dr A S Rao (Head, TePP), Prof S Mukherjee (Professor, IITB) and Prof C Amarnath (Professor, IITB). Visitors were amazed at the compendium of solutions on display which included innovative solutions like a setup for detecting and preventing elderly people from falling by using sensors for various purposes like wet floor detection and obstacle detection (this entry won the third prize).

The first and second solutions were a low cost anaesthetic ventilator (this entry was from Dubai) and NIR (Near Infra-red Imaging) vein finder respectively. The judges were duly impressed. Remarked Mr. Yazdi; “This is an outstanding idea for the event. Academic Institutions around the world struggle with the 'Ivory Tower' mentality. Your Prayaas theme will hopefully help drive a shift in the culture at IIT and other schools away from this by encouraging student and professors to feel a greater sense of responsibility and entrepreneurship.”

**Implementation**

Two solutions (the first and the third) were adopted by Johnson and Johnson and are being worked upon in their R&D Department. Eight of the solutions were recommended for Micro TePP funding.

With these achievements, Elixir at Techfest 2009 was a grand success and it met its objective of getting implementable solutions in the field of life sciences and healthcare. Carrying forward the good work, Team Techfest 2010 has also floated Elixir with the same objective of getting implementable solutions in the field of life sciences and healthcare. For further details please visit www.techfest.org/initiatives/prayaas/elixir
The story of Web 3.0

As web-sites move towards web-services and providing personalized information becomes the need of the hour, has the era of Web 3.0 already started?

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"...It is the best of the times; it is the worst of the times...

In the year 2014 people have access to a breadth and depth of information unimaginable in an earlier age. Everyone contributes and participates to create a living, breathing mediascape. However, the Press, as you know it, has ceased to exist. 20th Century news organizations are an after-thought, a lonely remnant of a not too distant past.

Welcome to our world. Welcome to the world of Epic.

EPIC is a summary of the world – deeper, broader and more nuanced than anything ever available before. The ‘Evolving Personalized Information Construct’ is the system by which our sprawling, chaotic mediascape is filtered, ordered and delivered. Everyone contributes now – from blog entries, to phone-cam images, to video reports, to full investigations. Many people get paid too – a tiny cut of Googlezon’s immense advertising revenue, proportional to the popularity of their contributions.”

This futuristic story tells us about the notional merger of Google and Amazon to form Googlezon, and its repercussions. While the idea of Googlezon and Epic might seem to be extrapolated but this is what web 3.0 is supposed to be. It’s a linked information space in which data is being enriched and added. It lets users engage in the sort of serendipitous reuse and discovery of related information that’s been a hallmark of viral Web uptake.

Web 1.0 in plain words was static and non interactive. The limitations attached with this version of web made it extremely easy to differentiate from the web that we use today.

There’s something quite brilliant, from a corporate-consumer-marketing perspective, about the term Web 2.0. Its very name – Web 2.0 – embodies new-and-improperness: a new version, a new stage, a new paradigm, a new Web, a new way of living. Web 2.0 represents a blurring of the boundaries between Web users and producers, consump
tion and participation, authority and amateurism, data and the network, reality and virtuality. The rhetoric surrounding Web 2.0 infrastructures allowed everybody to use new Internet technologies to organize and share information, to interact within communities, empowering the users while also relishing the power of collaboration and social networks.

Web 2.0 represents a blurring of the boundaries between Web users and producers, consumption and participation, authority and amateurism, data and the network, reality and virtuality.

And just as we’re getting used to the term Web 2.0, Web 3.0 is making its way to the front seat of many a conversation. The boundaries between Web 2.0 and its version have already started to merge but the ques-

tion does remain - what exactly is or would be Web 3.0? There is much debate about what the term Web 3.0 means today, and even more about what it will come to mean tomorrow. Some people do believe that Web 3.0 is round the corner but as the transition from static web to Web 2.0 has taken well over 10 years, it may take just as long for the next fundamental change to reshape the web.

As the experts predict, this version of web would come along with technologies like 4G that would bring Gigabytes of bandwidth to the users, hardware like the Techcrunch Web Tablet browse simplifying web surfing, Project Natal that would enable virtual reality, platforms like Google Wave that would redefine Email, frameworks like Silverlight that would bring tons of interactivity features, hence providing users with unimaginable flexibility.

Fundamentally while there is logic attached to prediction regarding the evolution of web 3.0, leading professionals agree on 3 essential elements in the evolution of Web 3.0:

1. **The Data Web** - The Data Web is already in motion. Massive amounts of data are being published online every minute in reusable and remotely queryable format. Backed by the rise of the API culture and Mashups this would ultimately initiate the formulation of architecture for a more advanced categorization that will dictate the way both humans and crawlers seek and retrieve information.

2. **The Semantic Web/SOA** - The Semantic Web, as it is coined today, is based on formats for integration and combination of data drawn from diverse sources, partially on present data grouping capability and partially on yet to be realized machine reading and understanding capability. The semantic web will enable the interaction of the data with the computer more comprehensively, and this will eventually evolve into artificial intelligence that would have the capability to take decisions.

3. **Ubiquitous Connectivity** – With technologies like 3G and 4G we live in a hyper connected world where computers, television and mobile would become synonymous in the times to come. As we move towards the convergence on the horizon, ubiquitous connectivity as it’s called, appears to be an obvious backbone in the emergence of Web 3.0.

All said and done, the predictions and the reality are far apart. To name a few Google Wave, Chrome OS, Silverlight and HTML 5 are platforms that would mark the beginning of the merger. However the evolution of this version of web brings its own set of cons. Web 3.0 embodies a set of unintended consequences, including the unprecedented flow of personal information across networks, the diffusion of one’s identity across fractured spaces, and some crucial insights over Deep Web.

And as bill gates said –
"Today, you always know whether you are on the Internet or on your PC’s hard drive. Tomorrow, you will not care and may not even know."
Seren
dipity

Seren
dipity is the effect by which one accidentally discovers something fortunate, especially while looking for something else entirely unrelated. Some of man’s greatest discoveries have been made entirely by accident. The amount of contribution of serendipitous discoveries has changed the way we look at life. From Viagra to Velcro, a whole set of discoveries were simply because a couple of smart people observed the right things at the right time and interpreted them in the correct way. Here we bring you a list of the more popular and daily use inventions.

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Popsicle

The Popsicle was invented by a 11 year who kept it secret for 18 years. The inventor was Frank Epperson who, in 1905, left a mixture of powdered soda and water out on the porch, which contained a stir stick. That night, temperatures in San Francisco reached a record low. When he woke the next morning, he discovered that the fruit soda had frozen to the stir stick, creating a fruit flavored ice treat that he humbly named the epsicle. Eighteen years later, in 1923, Epperson introduced the Epsicle to the public for the first time at an amusement park. In 1924, Epperson applied for a patent for his “frozen confectionery” called the Epsicle ice pop. He renamed it the Popsicle, allegedly at the insistence of his children. It was originally available in seven flavors and marketed as a “frozen drink on a stick.”

Microwave

The microwave oven did not come about as a result of someone trying to find a better, faster way to cook. During World War II, two scientists invented the magnetron, a tube that produces microwaves. Installing magnetrons in Britain’s radar system, the microwaves were able to spot Nazi warplanes on their way to bomb the British Isles.
By accident, several years later, it was discovered that microwaves also cook food. Called the Radar Range, the first microwave oven to go on the market was roughly as large and heavy as a refrigerator.
The idea of using microwave energy to cook food was accidentally discovered by Percy LeBaron Spencer of the Raytheon Company when he found that radar waves had melted a candy bar in his pocket. Experiments showed that microwave heating could raise the internal temperature of many foods far more rapidly than a conventional oven.

In the early brewery years wine was distilled as a preservation method and as a way to make the wine easier for merchants to transport. It was also thought that wine was originally distilled to lessen the tax which was assessed by volume. The intent was to add the water removed by distillation back to the brandy shortly before consumption. It was discovered that after having been stored in wooden casks, the resulting product had improved over the original distilled spirit. No one is sure who it was that discovered the delightful taste of this distilled liquor, but he was clearly guided by God in its discovery for the betterment of man.

Teflon was invented accidently by Roy Plunkett of Kinetic Chemicals in 1938. Plunkett was attempting to make a new CFC refrigerant, the perfluorohydrin polymerized in a pressurized storage container. In this original chemical reaction, iron from the inside of the container acted as a catalyst. In 1954, French engineer Marc Grégoire created the first pan coated with Teflon non-stick resin under the brand name of Tefal after his wife urged him to try the material, that he'd been using on fishing tackle, on her cooking pans. Teflon is inert to virtually all chemicals and is considered the most slippery material in existence.

In 1970, a chemist named Spencer Silver was working in the 3M research laboratories trying to develop strong glue. His work resulted instead in an adhesive that wasn't very sticky. When pulling apart two pieces of paper stuck together with that adhesive, Spencer discovered that the glue stuck either to one paper or the other. That seemed like a pretty useless invention. Four years later a colleague who was singing in the church choir was however hit by a brilliant idea. He used markers to keep his place in the hymn book, but they kept falling out. So he coated them with Spencer's glue. As if by magic, they stayed in place yet lifted off without damaging the pages. The Post-it note was born.

Today, it is one of the most popular office products available.

In 1928, Scottish Scientist Sir Alexander Fleming was studying Staphylococcus—the bacteria that causes food poisoning. He turned up at work one day and discovered a blue-green mould that seemed to be inhibiting growth of the bacteria. He grew a pure culture of the mould and discovered that it was a Penicillin mould. After further experiments, Fleming was convinced that penicillin could not last long enough in the human body to kill pathogenic bacteria, and stopped studying it after 1931, but restarted some clinical trials in 1934 and continued to try to get someone to purify it until 1940. The development of penicillin for use as a medicine is attributed to the Australian Nobel Laureate Howard Walter Florey—he shared the Nobel Prize with Fleming and Ernst Boris Chain.
ACROSS
4 Innovators
9 IIT Bombay’s attempt at developing a tumor knee prosthesis system.
11 A non-commutative number system; used for the calculating three-dim-

ional rotations.

DOWN
1 The branch of surgery concerned with conditions involving the musculoskel-

etal system.
2 Accidental discoveries.
3 IIT Bombay’s Student Satellite.
4 A sweet flavored liquid (usually containing alcohol) used in compounding

medicines.
5 A branch of dentistry dealing with the restoration of damaged teeth structure.
6 Knowledge of Life
7 Computational Photography.
8 Loosely translates to “ash”.
10 A spinning, turbulent flow of fluid.

1. You are one of 20 prisoners on death row with the execution date set for tomorrow. Your king is a ruthless man who

likes to toy with his people’s miseries. He comes to your cell today and tells you - “I’m gonna give you prisoners a

chance to go free tomorrow. You will all stand in a row (queue) before the executioner and we will put a hat on your

head, either red or a black one. Of course you will not be able to see the color of your own hat; you will only be able

to see the prisoners in front of you with their hats on; you will not be allowed to look back or communicate together

in any way (talking, touching...). The prisoner in the back will be able to see the 19 prisoners in front of him. The one

in front of him will be able to see 18... Starting with the last person in the row, the one who can see everybody in front

of him, he will be asked a simple question: WHAT IS THE COLOR OF YOUR HAT?

He will be only allowed to answer “BLACK” or “RED”. If he says anything else you will ALL be executed immediately.
If he guesses the right color of the hat on his head he is set free, otherwise he is put to death. And we move on to the

one in front of him and ask him the same question and so on...

Well, good luck tomorrow, HA HA HA HA HA HA!” Now since you all can communicate freely during the night, can

you find a way to guarantee the freedom of some prisoners tomorrow? How many?

2. Divide $289 (in whole $ increments) into a number of bags so that I can ask for any amount between $1 and $289,

and you can give me the proper amount by giving me a certain number of these bags without opening them. What is

the minimum number of bags you will require?

When I take your favorite CD and tell you I’ll make a scratch of 5 mm

long and 1 mm deep on it, you’ll freak out. But I give you some choices

on the position of the scratch. Which choice is the MOST dangerous for

your CD and should not be chosen (remember: the topside is the one

with the printing on it)?

Circumferential on the topside.
First of all, every scratch can be fatal (so don’t try this at home kids),
but scratches on the topside are the most dangerous. This doesn’t seem
logical, but there’s a good reason for that. The information on a CD is
‘stored’ on the downside of the CD and is read by a laser beam that is
reflected on a very thin (aluminium) oxide layer just under the surface
of the topside. When you damage the topside, you risk to damage this
layer, and the beam won’t be reflected and hence no information will
be read. When there’s only a small part missing (the radial scratch),
your CD might be able to handle that by oversampling. The scratch in
the circumferential direction causes a whole sequence of information

to be lost and there your CD player will fail.
People who tend to go out sometimes, may have noticed that the ice cubes you get in your drink are usually 'see-throughs'. They almost seem like glass, bright and shiny. Can you make the same ice cubes in your freezer?

You also may have noticed that they are hollow on the inside. This is the trick: you'll have to start the freezing process on the inside, allowing the air bubbles to migrate to the outside that is still fluid at that stage. The solubility of a gas in water (a fluid) is much higher than in ice (a solid), therefore you will get all the fine air bubbles in a regular ice cube (the outside is already solid and the gas has no way to escape anymore) and it becomes hazy or dull.

There is a simple trick to see if your fancy knives are really of a good quality stainless steel. What could you use on the spot to see if it is really good stainless steel?

Good knives are made of austenitic stainless steels (instead of ferritic or martensitic stainless steels). They are the only ones to be non-magnetic. So if the knife is attracted to the magnet, you're sure it's not the quality they tell you it should be. Take care, if you bend the knives a few times and deform it in the process, it can become magnetic nevertheless! This is known as 'transformation induced plasticity', the retained austenite (a small fraction of the austenite in the material) will gradually transform into martensite, and therefore become magnetic.

The amount of bubbles in a beer and the firmness of the foam is dependent on what factors?

Alcohol tends to have a negative impact on foam. If you pour pure alcohol on foam, it will disappear immediately (it has to do so with the 'surface stresses'). The amount of dissolved CO$_2$ gas in the beer will allow the bubbles to be formed. But, this may surprise some people, the glass is very important. A bubble of CO$_2$ gas forms at an impurity, or a scratch; so some of the glasses are purposely 'damaged' by putting some tiny scratches in them, hence allowing a constant amount of bubbles to be formed...

If you want to see what an iron crystal looks like, you could go to which European city to watch 'the Atomium'?

Brussels.

Build for the World Expo in 1958, the Atomium is a magnification (165 billion times) of an iron 'body-centered cubic' crystal... The height of the construction is 102 meters and six of the nine balls are open for the public (restaurants, congress rooms etc).

The Coriolis effect can be seen in toilet bowls when you flush. Thus, two identical toilet bowls should swirl in opposite directions when they are placed on opposite sides of the equator. Is this true?

The correct answer is no.

With all due respect to the Simpson's episode "down under", THIS IS PURE HOGWASH! Coriolis force is a very small force, and in order to see its effects on small scale bodies of water you have to make sure that the water is absolutely still (has sat for at least a few days) and that the hole in the bottom is absolutely centered and that the container is as round and symmetrical as possible. Any swirling effects that you see in toilet bowls are caused by the shape of the bowl and the location of the inflows and outflows. You can make your toilet swirl either clockwise or counter-clockwise with the proper arrangements.

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