

Science Sustainable curriculum

THE NEED TO BE GREEN HAS MADE IT TO BUSINESS SCHOOLS, SAYS S ANANTHANARAYANAN

ast week, the Indian Institute of Management, Bengaluru, conducted a three-day symposium on "Advancing Sustainability Research and Education" in collaboration with the Kenan-Flagler Business School, University of North Carolina. It was funded by

firmed that heat-trapping gasses in the atmosphere, released by humans and industry, were causing the environ-ment grave damage. The same year, the Intergovernmental Panel on Climate Change was set up under the Uni-ted Nations and in 1992 governments

eloped nations, which included Australia, the European Union and some others. These were valid, in the first instance, from 2007 to 2012. The tar-gets have been refined and detailed at different conferences and at the next major international meet, to take place later this year in Paris, more specific, comprehensive measures to contain the global rise in temperature within two degrees Celsius may be decided.



Professor PD Jose, Devnath Tripathi, J Swaminathan and PS Narayanan, IIM, Bengaluru, dean

the Obama-Singh 21st Century Knowledge Initiative, Asim Premji's Wipro was a co-sponsor through Earthian, its sustainability engagement prog-ramme, and they hosted a part of the proceedings in their premises Global warming effects were dis-covered in the 19th century but it was in 1988 that scientists formally con-

Janeiro to decide on what was to be done. One of the first things decided was that all countries maintain National Greenhouse Gas Inventories to help monitor progress The next accord was the Kyoto Con-ference of 1995, where *emission con-trol targets* were set, at least for dev-

Technology non-transfer

One study that was presented at the symposium examined the Clean Development Mechanism, a device for implementing the carbon reduction targets fixed under the Kyoto protocol. Developed

countries have the option of reaching their targets by sponsoring an approved, emissionreducing project in a developing country. The scheme has an objective of creating efficient technology in developing countries, which would serve to limit future emissions from those countries.

There were three classes of technology transfer in these projects – where the technology is created by the host country in collaboration with the exporter, where the technology imported is adapted and improved by the host

country and where the export is of a finished product with only operational competence being

TAPAN KUMAR MAITRA

are anchored to protein complexes located

adjacent to one side of the membrane or the other. Particularly convincing evidence for

the mobility of at least some membrane pro-

teins has come from *cell fusion experiments*. In these studies, David Frye and Michael

Edidin took advantage of two powerful tech

niques, one that enabled them to fuse cells from two different species and another that made it possible for them to label, or tag, the

surfaces of cells with fluorescent dve mole

cules. Their approach was to fuse human and mouse cells and identify human-specific and mouse-specific membrane proteins on

the surface of the fused cells by tagging them with *fluorescent antibodies* that had

been complexed with either of two different

kinds of fluorescent dyes. They then ob-served the fused cells with a fluorescence

microscope to see what happened to the plasma membrane proteins that served as mark-

ers for the two different parent cell types. The mobility of membrane proteins can

be shown experimentally by the mixing of

membrane proteins that occurs when cells

from two different species (mouse and

human) are fused and the membrane pro-

teins are tagged with two sets of fluorescent antibodies, one specific for mouse mem-

brane proteins and linked to a green dye,

and the other specific for human membrane

proteins and linked to a red dye. Proteins begin to mix within a few minutes and are

embrane proteins are much more vari-M able than lipid molecules in their mobility and some appear to move freely within the lipid bi-layer whereas others are constrained, often because they

Developing countries Emission reduction activity Certified emission reductio Capital or Developed countries Reduction transferred as technology.

A first conclusion of the study of 1,000 approved projects was that 77 per cent were cornered by India, China, Brazil and Mexico, but these projects accounted for only 28 per cent of the reduction in emissions And then, out of the 1,000 projects ransfer. And of these, the technology transferred was of the

The antibodies needed for this kind of

experiment were prepared by injecting

small quantities of purified membrane pro-teins from either human or mouse cells into separate experimental animals. (Rabbits or

goats are commonly used for this purpose)

The animals responded immunologically to the foreign protein by producing *antibodies* that reacted specifically with the membrane

proteins used in the injections. After the antibodies had been isolated from the blood of the animal, fluorescent dyes were cova-

lently linked to them so that the prote in/antibody/dye complexes could be visu-

Frye and Edidin tagged human and mouse plasma membrane proteins with antibodies that had dyes of two different

colours linked to them so that the two types

of proteins could be distinguished by the colour of their fluorescence. The mouse cells were reacted with mouse-specific anti-

bodies linked to a green fluorescent dye called *fluorescein* whereas the human cells

were reacted with human-specific antibod-

ies linked to a red fluorescent dve. rho-

treated them with Sendai virus, an agent

known to cause fusion of eukarvotic cells

even those from different species. The fused cells were then exposed to the red and green

fluorescent antibodies and observed by fluo

rescence microscopy. When the fused cells were first exposed to the antibodies, the

green fluorescent membrane proteins from

the mouse cell were localised on one-half of

the hybrid cell surface, whereas the red fluo-

To fuse the human and mouse cells, they

alised with a microscope.

third — operating skills only -category in 259! Awareness and motivation of business to prefer sustainable avenues along with commercial ends is clearly a priority.

MEMBRANE PROTEINS VARY IN THEIR MOBILITY, WRITES

of the world came together in Rio de This limit is seen as the level of warming that people and the environment can accommodate, with reason

ble adaptation. But what is alarming is that for all but what is take imposite a state of the conferences, parleys and the mass of data collected by scientists, the gro-wth of CO_2 in the atmosphere is apa-ce. Much of the reductions reported by developed countries is misleading as they have reduced manufacture within their own borders but have shifted industry to other places, like China or India. Underdeveloped countries think the West has "recognized" their capability and is "investing", and manufacture and consumption are peaking. The earth is seen to have clearly breached three of the 10 plan*etary boundaries* set by the Stockholm Resilience Centre, and the last report of the IPCC is emphatic that the twodegree Celsius target is unrealistic, at best. It may be more optimism than reason to hold that there is still a *win*dow of opportunity till 2030 to get things under control.



cent proteins had been caused by lateral dif-fusion of the human and mouse proteins through the fluid lipid bi-layer of the plasma membrane. Compared to most membrane lipids, however, membrane proteins diffuse through the lipid bilayer much more slowly. If proteins are completely free to diffuse within the plane of the membrane, then they should eventually become randomly distributed. Support for the idea that at least some membrane proteins behave in this way has emerged from freeze-fracture microscopy, which directly visualises proteins embedded within the lipid bi-layer When plasma membranes are examined in freeze-fracture micrographs, their embedded protein particles often tend to be ran-domly distributed. Such evidence for pro-tein mobility is not restricted to the plasma membrane. It has also been found, for example, that the protein particles of the inner arranged. If isolated mitochondrial membrane vesicles are exposed to an electrical potential, the protein particles, which bear a net negative charge, all move to one end of the vesicle. Removing the electrical potential causes the particles to become randomly distributed again, indicating that the proteins are free to move within the lipid bilaver. The transfer of electrons within the

inner mitochondrial membrane depends on random collisions between mobile complexes of membrane proteins. Although many types of membrane pro-teins have been shown to diffuse through the lipid bi-layer, their rates of movement vary. A widely used approach for quantify-ing the rates at which membrane proteins diffuse is fluorescence photo-bleaching recovery. The rate at which unbleached molecules from adjacent parts of the mem-brane move back into the bleached area can be used to calculate the diffusion rates of

various kinds of fluorescent lipid or protein

THE WRITER IS ASSOCIATE PROFESSOR, HEAD, DEPARTMENT OF BOTANY, ANANDA MOHAN COLLEGE, KOLKATA, AND ALSO FELLOW, BOTANICAL SOCIETY OF BENGAL, AND CAN BE CONTACTED AT

tapanmaitra59@yahoo.co.ii



damine

Business steps in The World Business Council for Sustainable Development is an asso-ciation of over 200 international commakes business sense. panies, which thinks private enterp-rise can and must supplement the role of governments in dealing with climate change. It then provides a platform for business to share knowledge and best practices, and motivation to pursue sustainable development. At the human cell were restricted to the other NOVEL GAME OF TAG half

act to rein itself in. But business does have a vested interest and can act as a powerful driver of reform. "Busines is responsible too... you cannot do good business in a failed planet," says WBCSD president Peter Becker. ACTION2020 is a programme devi-sed by the WBCSD to apply business solutions to attain environmental and

societal targets "Through collaboration toward common goals, business can address some of the critical... problems the world faces, while strengthening their own resilience to glob-al challenges," the programme says. Business schools, which train managers in using formal scientific tech-niques to isolate and overcome challenges of resources, personnel and markets, have been pressed to use their competence to launch busines

first glance, it may be ironic that prof-it-driven commerce, which leads the

charge against the environment, should

titute was neither drawn by the "pull" of the industry to train students in as a positive force. Academic research is counted on to sustainability nor driven by a "push devise solutions that are measurable so that we know they are working; scalable so that they can be positioned of students seeking such training. This undeniable truth, in fact, started the problem and hence the need and

Setting the stage

Vijay Padaki, honorary president of the Bangalore Little Theatre Foundation, presented a short play performed by students of IIM, Bengaluru, during the symposium, which conveyed powerfully the message of the mess that the world has landed in. The play was an adaptation of a 1920 Czech science fiction play, whose title translates a *Rossum's Universal Robots*. The original play was about rebellion of artificial humanoids created for "forced labour", the original meaning of the word *robot*. The adaptation of the play featured modern day robots tha are able to think almost like humans and are programmed to protect

humans at all costs When the robots see that humans have started to destroy the planet and endanger their own existence, they conclude that humans are their own worst enemy, who hence need to be destroyed. The action is set partly in the robot factory

urgency to open eyes in industry and

society. At the same time, a completed

study that was circulated to partici-pants was specifically to the effect

shop-floor and partly in the boardroom of the robot factory, and pure, mechanical objectivity of the robot conclusion, based on evidence before us all, that humans need to be destroyed for their own protection, conveyed the message of environmen Cost of current lifestyle more powerfully than any classroom pedagogy. Padaki said there were now genres of theatre that could convey basic and current science, which opens the possibility of art forms, in general,

to have global impact; and replicable to enable collaboration of different sectors. And most of all, solutions that are good for business, by redesign of processes, supply chains, consumer preferences, so that having the least impact on the environment still

that in a sample of the leading ICT companies worldwide, limited though the sector is, it was in the most suc-cessful of the companies that the IIM, Bengaluru, and the Kenan-Flagler Business School, which have run a sustainability module in their highest incidence of sustainability issues engaging the attention of senior managers and the board was MBA programmes since 2000, partfound. nered to get the movement going in India. The symposium at Bengaluru

to be used for science and environment awareness.

aimed to showcase both research that

Robot in the magma

ANDREW GRIFFIN REPORTS ON A NASA MISSION AIMED AT DERIVING A BETTER UNDERSTANDING OF OTHER PLANETS

he National Aeronautics and Space Administration is to throw a small robot into a volcano that will help explore the fissures and volcanic vents. Nobody really knows how volcances erupt, and the experiment will shed light on what actually goes on inside a volcano, as well as being practice for exploring similar areas on the moon and Mars. So Nasa is sending the robot to explore a volcanic fissure — a crack that erupts magma.

Researchers Carolyn Parcheta and Aaron Parness at Nasa's Jet Propulsion Laboratory have developed a new robot that will be able to climb into crevices where humans aren't able to go. Parcheta is a post-doctoral fellow at the JPL. She has worked with the robotics team at the lab to make the robot, known as VolcanoBot 2. (The first VolcanoBot went into an inactive fissure in Hawaii.)

The new one is lighter and smaller, and more able to get into difficult crevices. It can also store its data onboard, which could help it get deeper into the fissure.



Carolyn Parcheta, a postdoctoral fellow at Nasa's Jet Propulsion Laboratory, plans to take VolcanoBot 2 to explore Hawaii's Kilauea volcano in March this year. The bot will head into the same Hawaiian volcano as the first one, but look deeper and in more detail. fact that it didn't seem to pinch shut at the bottom as

expected. On both earth and Mars, fissures are the most common way that magma erupts out of volcanoes, and it is likely the same for the previously active volcanoes on the moon

Parness said, "In the last few years, Nasa spacecraft have sent back incredible pictures of caves, fissures and what look like volcanic vents on Mars and the moon. We don't have the technology yet to explore them, but they are so tantalising!

"Working with Carolyn, we're trying to bridge that gap using volcanoes here on earth for practice. We're learning about how volcanoes erupt here on earth, too, and that has a lot of benefits in its own right.'

PLUS POINTS

Eye on the fly





themselves. A decade ago. studving these complex behavioral dynamics was a tedious task, requiring Drosonhila melanogaster with Drosophila melanogaster with pieces of fluorescent polymer attached to each of its legs. These dye spots, each only 100 microns across, glow infrared when illuminated with red light hours spent watching fuzzy videos of flies being flies. jotting down and allow real-time tracking of leg position. their every action and the

time it occurred. "The problem was that, not only was this prohibitively timeconsuming and mindless, but the behaviours were fairly subjective and people would categorise them differently," says biologist Benjamin de Bivort of Harvard University. Now, that's all changing. With the plummeting cost and rising quality of high-definition cameras, sensors and machine-learning programmes, biologists are using computers or touchpads to automate the detection of fly behaviours, from grooming to mating — even detecting how often they eat. Today, such methods are so sensitive that they can reveal the individual motion of each of the six legs of a Drosophila.

"There's a revolution happening in behavioral neuroscience that comes about because of all these cheap sensors designed for phones and personal electronics," says de Bivort. These new techniques are giving

scientists the tools to integrate quantitative behavioral data into studies of neuroscience, ageing and even metabolism —zeroing in on the neurons responsible for different fly behaviours, for instance, and how neurodegeneration or obesity changes those neurons' activity. "This isn't just a tool to make

experiments go faster," says David Anderson, a neurobiologist at Caltech. "We're trying to take a field that's been defined by people sitting in the jungle with a notebook and make it objective and quantitative."

Cut sleeping sickness

SARAH CP WILLIAMS/THE SCIENTIST

A new method for making chemicals that lure tsetse flies to traps has been developed. It uses a cheap by-product from the cashew nut industry as its starting material, so the discovery may mean the flies — which carry sleeping sickness (also known as African trypanosomiasis) — can be trapped at a lower cost. The method. published in *Green Chemistry* last month, could offer a sustainable and more-affordable way to make two



"attractant" chemicals: 3ethylphenol and 3-propylphenol. Many existing odour attractants are prohibitively expensive and not widely available in large quantities. It is possible to use buffalo urine, which naturally contains chemicals that attract the flies, as a substitute though this has the downside of the new method produces the attractants from cashew nut oil starting material, it may mean African countries could produce the chemicals locally. Cashew nut producers, which are widespread in Sub-Saharan African countries including Côte d'Ivoire, Nigeria and Tanzania, generate more than 300,000 tonnes of this waste product every year.

The liquid contains the chemical cardanol, which can be used to make both 3-propylphenol and 3-ethylphenol, through chemical processes developed by Lukas Goossen, a chemist at the University of Kaiserslautern in Germany who iointly led the research David Cole-Hamilton, a chemist at the University of St Andrews, UK, who also led the research, said the resulting attractant could be coated on a plastic sheet or similar surface, along with an ordinary insecticide "The attractant lures the insects to e sheet where they are poisoned, he said.

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The data

VolcanoBot 1

is helping

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a 3D map of

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the fissure, including the

THE INDEPENDENT



TheStatesman

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would impact sustainability concerns as well as curriculum content in man-

agement institutes to sensitise managers and society of the need for new thinking. The participants were tea-

chers and researchers from leading

management institutes, universities

centres of economic research, in India and abroad, engineering colleges,

stakeholders like the Forrest Institute

symposium was dedicated to ways and efficacy of including sustainabil-

ity as a component of management

education. On a realistic note, the director of IIM, Indore, emphasised that his ins-