NIHERST

Trinidad & Tobago

ICONS in SCIENCE & TECHNOLOGY

Volume 4

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Introduction

This publication is the fourth in a continuing series presenting the biographies of top Trinidad and Tobago scientists, based locally or abroad, who have received a NIHERST Award for Excellence in Science and Technology. The 12 men and six women featured in this volume are our 2013 awardees.

NIHERST received over 30 nominations for all six awards categories, which are:

- *The Rudranath Capildeo Award for Applied Science & Technology*
- *The Emmanuel Ciprian Amoroso Award for Medical Sciences*
- *The Julien Kenny Award for Natural Sciences*
- *The Fenrick De Four Award for Engineering*
- *The Anthony Williams Award for Technological Innovation in Arts and Culture*
- *The Frank Rampersad Award for Junior Scientist*
- *The Ranjit Kumar Award for Junior Engineer.*

As in previous volumes, the awardees represent a cross-section of fields including, inter alia, microbiology, entomology, engineering (biomedical, civil, electrical and petroleum), climate science, genetics, theoretical physics and neuroscience. By comparison to 2012, there was an increase in women nominees and twice the number of women received awards. There was also an increase in the number of nominations for junior scientist and engineer, and three of the four winners were women. The mix of awardees includes, in the majority, nationals who work in Trinidad and Tobago; some who have made their mark based in other countries; and a few non-nationals, researchers and/or educators living in Trinidad and Tobago, whose endeavours have contributed significantly to this country.

Much of the work of NIHERST, particularly its extensive science popularisation programme, necessitates finding creative ways to overcome the challenge of promoting science to non-scientists, of all ages, to foster the kind of wider literacy and awareness critical for strengthening national capacity in science, technology and innovation (STI). Our aim is always to bridge the distance between our scientists and our people. While the Awards for Excellence in Science and Technology are for the scientific community itself, these publications, recounting the scientists' life stories and achievements, target the general population. For the lay person - and students especially, on whom future development in STI will depend - complex scientific knowledge and in-depth exploration of technological advancements can be inaccessible and intimidating, or presented in ways that make the subject matter or concepts seem dull or remote from their lives. Each volume in this series has, therefore, been an evolutionary step as we experimented with different approaches and formats, to have broad appeal for the non-scientist reader, and young people especially.

For this publication, extensive interviews were recorded and those conversations have been condensed into profiles in a question and answer format. The aim was for these first person accounts to bring the scientists and their science even closer to the reader – for us to hear their voices and have them tell their own stories.

NIHERST considers this documenting of the achievements of Trinidad and Tobago's science icons to be important for several reasons. It is another avenue for highlighting the role and value of science to society and raises the visibility of our own people who are at the cutting edge of many scientific and technological fields. It is a chronicling and preservation of a key and largely underappreciated aspect of our country's heritage and a much needed educational resource. We, therefore, hope these biographies will be a source of national pride and, most importantly, of knowledge and inspiration to our youth and aspiring scientists in the future.

Jahson Alemu I

The Young Man and the Sea

About the Icon

Date of Birth: *04 January 1983*

Education:

- *Montrose Government Primary School*
- *St Mary's College, Port of Spain*
- *BSc Biology, The University of the West Indies, St Augustine, Trinidad, 2005*
- *MSc Marine Biology, The University of Bangor ,Wales, UK, 2008*

Awards:

- *The Frank Rampersad Award for Junior Scientist (Silver), NIHERST Awards for Excellence in Science & Technology, 2013*
- *Future Conservationist Awardee, Conservation Leadership Programme, 2006*

Other Achievements:

- *Eight peer reviewed articles*

Current Post:

- *Coral Reef Research Officer (Coral Reef Ecologist) at the Institute of Marine Affairs (IMA), Trinidad*

Coral reefs are the rainforests of the sea floor, providing some of the most biologically diverse habitats in the world to a multitude of marine species. Fisheries across the tropics are supported by reef fish which find a safe haven to live, lay eggs and raise their young among the intricate three-dimensional structures of the coral. Reefs also protect coastlines from erosion by high energy waves. A 2015 assessment of the value of natural assets found coral reefs to be worth six trillion pounds a year in services they provide for people (almost four times as much as the UK economy). Since his youth, Jahson Alemu I has both loved nature and felt deep affinity for the ocean. Now, as a marine biologist, he has combined these interests, bringing this passion and his experiences in the Indian Ocean, on the far-off island of Rodrigues back to his home country, and turning them toward the mission of preservation. Jahson's research involves studying the health and resilience of Tobago's reefs and demonstrating the benefits of conservation. His ultimate goal is to generate precise data so that leaders can make informed, practical decisions in the best interests of both the island's ecosystem and its people.

NIHERST interviews Jahson Alemu I

Q: ***What were the early influences that fuelled your interest in science?***

A: I was born and bred in Chaguanas. My mum was a seamstress and my dad was a craftsman working with materials such as calabash and leather. I spent a lot of time at my grandmother's home in Mamoral, in Central, at the base of the Central Range which was heavily forested at the time. I used to hike through trails and play in ponds with my cousins. I went to Montrose Government Primary School, then St Mary's College, where I joined the Sixth Trinidad Sea Scouts. They taught me how to swim, kayak, snorkel, sail and row and gave me this love for the ocean. In 2002, I entered The University of the West Indies, to do a first degree in Biology with minors in Zoology and Environmental Biology. In my second year, I visited Tobago for a week with friends and learned to scuba dive. I was studying ecology before, but after that the ocean was my niche.

Q: ***What would you count among your most rewarding research to date?***

A: One of my proudest achievements has been the work I did at Shoals Rodrigues – an NGO on Rodrigues Island in the Indian Ocean. It's part of Mauritius – same size and population as Tobago and even has a governmental system modelled after Tobago's. I went there to study reef fish populations and connectivity among different habitats. By the time I left, we were working towards the establishment of a Marine Protected Area Network of four MPAs for Rodrigues. Other research included coral reef resilience to ocean warming and the impact of the invasive lionfish to Trinidad and Tobago and even amphibian health.

Q: ***What is an MPA Network?***

A: An MPA refers to a marine protected area. This is an imaginary box in the ocean, managed to protect all within it. However, fish and the other animals living in the ocean don't know that the box is there so they move in and out freely to neighbouring habitats. An MPA Network is a series of MPAs spread over a large area in such a way that they not only protect areas of high biodiversity (such as coral reefs) but also protect the connectivity of animals to other habitats. Wrecks are similar. When a ship sinks, this is a blank slate habitat and a whole bunch of organisms can live on it away from the competition of the existing ecosystem. Marine Protected Areas protect organisms from fishing so they can feed, reproduce and survive, but extra organisms can spill outside of the protected area, so people who need to fish aren't left with nothing. But if we want to spread our reef and increase the viability for fisheries, we put artificial reefs outside (similar to sinking a wreck) so we provide more living space and facilitate greater reef growths.

So for example, fish live and forage in coral reefs but might find mates and reproduce on a distant reef or habitat. By protecting both areas, the connectivity is maintained ensuring the protection to the entire life cycle of the fish. Overfishing was a major issue in Rodrigues and unfortunately the livelihood of most of the island's population was directly or indirectly connected to fishing, especially sea cucumbers and octopuses for commerce. Through a community-driven process that had started before my arrival there, the communities identified what they wanted to protect and we helped them identify where would be the best locations that might encourage the rehabilitation of the reef populations.

Q: ***How did this experience impact your later studies?***

A: This was my foundation for marine research and working with communities. Honestly, while I knew we had an MPA in Buccoo, I didn't know much about it. On returning home, I couldn't help but compare and contrast Mauritius and Rodrigues to Trinidad and Tobago and we were three MPAs behind. Since then, my vision has expanded and focused on ecosystem conservation, so whereas in my formative years in research I was more interested in species level research, I am now interested in ecosystems and the conservation of the services they provide (such as fisheries and coastal protection). As a result, as part of my doctoral programme at the UWI, I am linking the continued provision of coral reef goods and services to human well-being and disaster risk reduction in Tobago.

Q: ***How does Tobago's reef compare to Rodrigues'?***

A: It's not comparable at all. The diversity of the Indian and Pacific oceans dwarfs anything I have seen in the Caribbean, although the reef in Bonaire comes close. There is so much diversity there in terms of number

of species, forms, function and colour. Corals in the Caribbean are not as diverse or as colourful but they are equally interesting. At one point, mean coral cover (coral cover is an index by which reef scientists measure reef health) in the Caribbean measured over 60 per cent and were dominated by large elaborate "antlers" of elkhorns and staghorns. Today, coral cover is much lower and averages around 20 to 25 per cent. Caribbean reefs are on a general downward trajectory but I don't believe all is lost. On a coral reef optimism scale with -5 being Caribbean corals are doomed and +5 being Caribbean coral reefs have a chance, I'd put it as a +3. It is unlikely our reefs will look like those in the Indo-Pacific, but the uniqueness of what we have here is undeniable and a lot of effort is being put into protecting it.

Q: ***What exactly is coral?***

A: Coral is like a jellyfish that doesn't move and is attached to the sea floor. It as an animal closely related to jellyfish and sea anemones and the individual coral organism is called a polyp. The coral polyp secretes calcium carbonate (basically chalk but in the marine environment it's called aragonite) which becomes its outer protection or exoskeleton which is what most people think of when they talk about "coral", not the polyp inside. The polyps reproduce asexually and then we get a coral colony which is what we see on the reef. Within the polyps are tiny single-celled plants called zooxanthellae, which have a symbiotic relationship with the coral polyps so they produce food for the corals and the coral provide shelter and raw materials for photosynthesis.

Q: ***Why are reefs important in marine ecology?***

A: Over 25 per cent of the world's fish diversity and over 10 per cent of the world fisheries are associated with coral reefs, and over 500 million people are dependent on this tiny bit of the sea floor for food, income and other goods and services. Coral reefs are essential habitats for a wide range of organisms such as fish, turtles, corals and sponges for breeding, feeding and protection from predators. The diversity in coral reefs is so high that they are referred to as the rainforests of the sea. However, they are quite vulnerable to the negative impacts of environmental change. Recognising this, many marine scientists spend a lot of time researching and advising management actions, trying to conserve, protect or build resilience within coral reefs.

Q: ***You mentioned threats to reefs in Tobago. What are some?***

A: Overfishing, coastal development and climate change stand out. Important to the survival of any coral reef is the maintenance of key ecosystem functions such as herbivory- by animals such as parrotfish and sea urchin- which is important in preventing corals from being overgrown by algae. (Think of it as lawn grass over growing your prized rose bush, and regularly mowing the lawn prevents the overgrowth). However, the over-harvesting of reef fish over the decades has resulted in fewer and less effective grazers (herbivores), in turn reducing the resilience of coral reefs. Coastal development is critical to the economic and developmental demands of Tobago. However, in some cases, poor coastal development practices such as hillside slash-and-burn and incompatible coastal development uses have resulted in large amounts of sediment and nutrients washing over reefs, both physically smothering corals in some cases and inhibiting sunlight from reaching corals which is needed for their survival.

Climate change presents two problems, ocean warming and ocean acidification which exacerbate the other threats. Corals in this region have a narrow upper temperature tolerance of 28 to 29 degrees F. If water temperatures are maintained above this upper threshold for a prolonged period, coral bleaching events can occur. Coral bleaching refers to the whitening of corals as a result of the temperature induced expulsion of the symbiotic algae from the coral. The algae give most corals their colour and without the algae what we see is the white exoskeleton through the transparent polyp. While corals can survive in a bleached state where they catch food in the water, they will eventually die if the bleaching is prolonged. As much

as 90 per cent of the coral's food can come from the algae, so if that bleaching is prolonged, the polyps starve. If cooling occurs in sufficient time, the algae can re-enter the corals. Already we've noted in Tobago, that some species die within weeks of prolonged and severe ocean warming, whereas others are more resilient and can survive for much longer and recover.

The second major issue associated with climate change is ocean acidification. This is more a long-term concern which results in most shell animals or animals which require calcium carbonate having less available, resulting in weaker shells and skeletons. Climate change is probably the greatest threat facing our reefs as the resolution to this problem requires global action whereas the other can be resolved through local management.

Q: ***And in terms of those areas that are within our reach, are we managing well?***

A: I don't think so, at least not in a meaningful way. The threats are complex and the management solutions are equally challenging to implement. But in a small country like ours, socio-economic development needs often take priority. Consider that 55,000 to 60,000 people live in Tobago, most of who live and work in the southwest. Housing, industry, commerce, trade and education are all developmental needs required in that area. Development of the coastline has a real impact on marine ecosystems, removal of mangrove for housing can increase the amount of sediment getting onto reefs, and the removal of mangroves destroys the necessary habitat for juvenile fish and shellfish populations such as grouper, snapper, parrotfish, shrimp and lobster. It is a difficult job reconciling developmental needs with environmental protections. However, the general well-being of everyone rests upon the sustainability or the health of the environment. The biggest house can't replace clean air.

Q: ***What are you currently working on?***

A: For the last four years I've been monitoring the health of reefs and studying resilience characteristics– which species seem better able to survive or adapt to climate change impacts and which won't. We may lose some and keep others. We don't see elkhorns and staghorns as much but other species may become equally as important.

I've also been studying an invasive alien species of Pterois commonly known as lionfish. Lionfish are a new threat to Caribbean reef. With no natural predators or natural disease in this region, a voracious appetite, prolific reproduction and of course, venomous spine, they have an ominous presence on our reefs. They aren't aggressive and won't attack and chances are if you get stung by one, it would be accidental. Most people experience intense pain at the site of puncture and, in a worst case scenario, some persons may be allergic to the lionfish venom and go into anaphylactic shock, much like from a bee sting. Regardless of the reaction, you should always seek professional medical attention. We've been educating the public through workshops, news articles, outreach programmes and culling events. In the wider Caribbean, researchers have been trying to encourage other predator species to start hunting lionfish, but with limited success so far.

Lastly, I'm working on linking coral reef ecosystem services to coastal zone planning. This is a bit complicated, but the idea is to model and quantify the services that coral reefs provide, such as coastal protection from storm surge, and weigh that against the short-term benefits we derive from coral reefs such as tourism and fisheries under different management and climate change scenarios.

Q: ***Would you recommend a career in your field to a young person?***

A: Definitely. Everyone asks what they need to study, which is great, and it would include biology, geology and chemistry. But beyond that, they need to get as much practical experience as they can. Volunteer at local research institutes or at universities or with NGOs and visiting researchers. There are lots of internship programmes, some of them you pay for, others pay you. Invest in yourself. Learn to scuba dive or swim. You know people are serious when they volunteer and they come to you knowing what they are about. We definitely see the world differently from underwater.

Yaisa Andrews-Zwilling

The Age of Alzheimer's

About the Icon

Date of Birth: *03 December 1977*

Education:
- *Arouca Government Primary School*
- *St Joseph's Convent, St Joseph*
- *BSc (Honours) Biochemistry and Chemistry, The University of the West Indies, St Augustine, Trinidad, 1999*
- *MSc Neuroscience, International Max Planck Research School, Germany, 2001*
- *PhD Neuroscience, International Max Planck Research School, Germany, 2005*

Awards:
- *The Frank Rampersad Award for Junior Scientist (Silver), NIHERST Awards for Excellence in Science & Technology, 2013*
- *Exemplary Leadership Award, J. David Gladstone Institutes, 2011*
- *Alzheimer's Association Award for Young Scientists, 2009*

Memberships/ Fellowships:
- *The Society for Neuroscience*
- *Alzheimer's Association International Society to Advance Alzheimer Research and Treatment*
- *National Postdoctoral Association, USA*
- *Scholarship from the California Institute for Regenerative Medicine*

Other Achievements:
- *US Patent No 20110135613 A1 for Methods for Treating Apolipoprotein E4-Associated Neurological Disorders (co-inventor)*

Current Post:
- *Scientist III, SanBio Inc., USA*

Modern medical advances are helping us live longer than ever before, but long life comes with its own challenges and perils. Some are inconvenient, some dangerous, but none are as feared for their impact on a patient's mind and identity as Alzheimer's disease. Little understood, Alzheimer's, which is projected by the Alzheimer's Association 2015 to affect 14 million people worldwide by 2050, strikes seemingly at random, robbing its victims of their memories, independence and ultimately, their lives. For over 30 years, Alzheimer's research was focused mainly on amyloid plaques – protein deposits left behind in the brain of the afflicted. At the world-renowned Gladstone Institute of Neurological Disease in California, however, a promising young researcher named Yaisa Andrews-Zwilling, following in her mentor's footsteps, is taking another path to a cure for the disease as she searches for answers in our genes. Her research focuses on apolipoprotein E4, a variant of apolipoprotein E (commonly known as ApoE), a protein integral to the functioning of the brain and nervous system. Researchers at Gladstone Institute have identified this APOE4 variant, which occurs in 25 per cent of the US population, as a significant genetic risk factor for the onset and progress of Alzheimer's. Dr. Andrews-Zwilling is currently working at SanBio Inc., a company which develops regenerative therapies, using adult stem cells, for neurological disorders, including stroke, traumatic brain injury, spinal cord injury and retinal degeneration. SanBio Inc os a scientific leader in cell therapies for regenerative medicine and clinical testing for SanBio's products is underway.

NIHERST interviews Yaisa Andrews-Zwilling

Q: ***How did you become interested in science and in your current field?***

A: I was very good at the sciences with an excellent and very supportive biology teacher and amazing parents who encouraged me every step of the way. I first wanted to be a medical doctor doing biochemistry at The University of the West Indies, but later learned that although medical doctors are extremely important, their work depends upon researchers, who do a lot of the groundwork in creating drugs and helping us understand the body. That intrigued me.

Q: ***You did your masters and doctorate in neuroscience at the Max Planck Institute in Germany, one of the most prestigious scientific and technological academic institutions in the world. What was that experience like?***

A: During my masters, I was actually really homesick. Of course I appreciated how lucky I was to have been among the 11 who were chosen out of 400 applicants interviewed that year, but I wasn't sure I could stick it out. My parents, in their wisdom, wouldn't let me come back to visit that first year. The intensity of the programme itself was not as bad as the homesickness. But my peer group was made up of other young scientists who were also a long way from home. I had friends from Poland, Siberia, Australia and Ireland so we relied on each other. Those close friendships helped me through. And then I met my husband who was also a student there, which really helped! I stayed on at Max Planck to pursue my PhD. During my time in Goettingen, I was able to learn from Nobel Prize winners and scientists who are the very best of the best in their respective fields. It was an amazing opportunity!

Q: ***What motivated you to study this disease?***

A: My initial interest in neuroscience came because I was fascinated by how this organ in our head controls our actions and thoughts from infancy – body, mind and soul. My parents would fly me home every year to visit my wonderful extended family, including my grandfather who really made me feel like his preferred grandchild. While I was in Germany, he had a stroke. It was shocking to see his deterioration from this 6' 4" strapping, amazing father figure to almost a child again. He started thinking I was my mother, and later not recognising me at all. And that changed the direction I wanted to go with the research. At first, I was fascinated with the brain in general but after what happened to my grandfather, I got interested in why some people age through 80, 90, 100 even – and have relatively good cognitive abilities, and why others don't and by their sixties already have Alzheimer's; why someone would suffer a stroke and recover completely and why someone else, like my grandfather, would have a stroke and completely deteriorate afterwards. I wanted to know how that happens and how I could prevent that from happening.

Q: ***You and your mentor Yadong Huang received a patent for your work on the APOE gene. Can you tell us more about the research that led you to your discoveries?***

A: I started off working on the basic communication between brain cells during my PhD, trying to figure out exactly how two nerve cells talk to each other. Later, of course, I decided I wanted to work on the sequence of events that leads to neuro-degeneration and how we could prevent it. Eventually, I came to the Gladstone Institutes in the United States where I started working on Alzheimer's disease. I started looking at a protein called Apolipoprotein, which is a mouthful, so we just refer to it as ApoE4. This is a genetic risk factor that increases your likelihood of getting Alzheimer's disease. The risk of getting Alzheimer's disease doubles if you have one apoE4 gene and increases 10-fold, if you have two copies. ApoE is a protein we all have. Most of us have the so-called "normal" form of the protein, ApoE3, which helps maintain the cholesterol level in your blood, and has a role in transferring fats and cholesterol to repair injured brain cells. The other isoform – or type – of the protein is ApoE4, which can't do its job properly and predisposes you to getting Alzheimer's. One in four persons has this protein. I really think Alzheimer's is one of the worst diseases. It really robs you of you. You lose yourself before you pass away.

Proteins are made of up amino acids, like pearls on a string, arranged in a 3D structure. ApoE3 sort of resembles a V-shape. ApoE4 is similar but looks like a tight U. Because of this abnormal shape, your cells see it as toxic, and try to get rid of it, keeping it from doing its job of transporting lipids to rebuild your brain cells. Not only is it stopped from doing its job, when they cut up this protein to get rid of it, the pieces are also toxic. So that is what our team at Gladstone are working on, coming up with a drug to fix that problem. They are called "structure correctors" and they fit inside the tight U and open it back up, making the abnormal E4 form look more like the E3 form and allowing it to do its job. We are making it useable in animal models, and then will take it to clinical trials to test on humans.

Now, one of the major milestones we've had is figuring out the role of specific neurons called interneurons, which act as the brain's brakes. Interneurons help the brain to focus on what it needs to and to ignore information it doesn't need, managing interactions between nerve cells. My work published in 2010 and 2012 showed that interneurons are the first set of cells that we and other animals lose when Alzheimer's progresses. These cells help to refine memories and retrieve memories but are lost by individuals with ApoE4 during the progression of Alzheimer's. We were the first to show interneurons' involvement in the memory retrieval process and that they are the first to be lost in Alzheimer's. So that's what my patent is based on - the role of these interneurons with respect to ApoE4 as well as another protein called tau, and how that cell loss in Alzheimer's disease is related to learning and memory.

Q: ***You weren't the first Gladstone researcher to work on APOE. Why the initial focus on APOE4 in Alzheimer's disease?***

A: After founding the Gladstone Institutes, Dr Robert Mahley initially worked on ApoE4's effect on cardiovascular disease. Dr Alan Roses found the link between ApoE4 and Alzheimer's, and Dr Yadong Huang and many others continued this work. Interest in ApoE4 is spreading now but they were a couple of the pioneers.

Q: ***What is the connection between brain plaque and Alzheimer's?***

A: The protein responsible for plaque is called amyloid which is what people normally think about when they think of Alzheimer's disease. Amyloids are naturally occurring in everyone. Their role isn't fully understood but if you have a mutation in this protein, or a change caused by aging, it gets deposited into the brain and causes amyloid plaques which are what most people associate with AD. Most research over the last 30 years has focused on amyloid. But pharmaceutical companies have yet to find a cure, so some focus is now moving to ApoE4 and other key proteins like tau. It's the best time to be researching in this field.

Q: ***Some of your research has been on traumatic brain injury in relation to ApoE4. How are they connected?***

A: With traumatic brain injury (TBI), there's physical trauma. A car accident or an explosion for soldiers or sports injuries- those things cause cell death or nerve death in the brain. If you have ApoE4, again your chances of having a detrimental effect after TBI is much more likely, and that's another thing that got me into this area of research.

Q: ***Do the drugs you are working on at Gladstone just prevent the risk or pre-disposition for Alzheimer's or will they also slow or even reverse the progression of Alzheimer's in someone already diagnosed with it?***

A: By the time family members start noticing that something is wrong and you get diagnosed, in most cases your brain has already deteriorated. A lot of the discussion is related to how we can prevent it from happening. The

ApoE4 drug not only helps in repairing brain cells, but in neurogenesis, which is the making of new brain cells. So new brain cells may be able to integrate and store new memories which will hopefully help, but it's difficult or next to impossible to get back memories that were lost.

Q: ***Is there anything more that can be done to prevent Alzheimer's?***

A: The major rule of thumb is "what is good for your heart is good for your head". So avoid high blood pressure, obesity, diabetes, cardiovascular disease- basically a healthy lifestyle with a diet that is not too high in fat and which includes exercise. There have been clear epidemiological links shown between those factors and Alzheimer's disease.

Q: ***What treatments are there that help prevent Alzheimer's? What drugs are there currently for Alzheimer's and how do they work or relieve its symptoms?***

A: There are four different FDA-approved drugs including one that does improve cognitive function at a very early stage, but there is no cure as yet.

Q: ***Which emerging technologies, recent discoveries or new understanding do you think will have a significant impact on Alzheimer's research and neuroscience in general in the future?***

A: Stem cell technology. It has revolutionised science and Shinya Yamanaka who won the Nobel Prize for it also works here at Gladstone. We no longer need stem cells from embryos. Thanks to his work, we can take body cells like skin and turn certain genes off or on to change those skin cells back into stem cells, then make any human body cell you want to make. The ability to restore stem cell-like properties to somatic (skin) has created powerful new opportunities for modelling human diseases and offers hope for personalized regenerative cell therapies.

Q: ***Gladstone does outreach to high school students. What sort of outreach do you do?***

A: The Institute's main mission is to find cures for particular diseases afflicting mankind: virology, immunology, cardiovascular, neurology, but it also does outreach and communication in the neighbourhood, within the country and in general. Incidentally, as an intern in Trinidad, I worked at NIHERST's Science Centre which is how I discovered my interest in science education. I learned how to explain relatively complex themes to lay audiences, a skill that scientists don't always have. At Gladstone I put that skill to use. We do a lot of outreach at high schools and universities. We explain career paths in science and what you have to do to be a scientist. And students also get to see that someone who looks like me can be a scientist!

Ravi Birla

Engineering the Heart

About the Icon

Date of Birth: *20 May 1973*

Education:
- *St Joseph Muslim League*
- *Tunapuna Government Secondary School*
- *Hillview College, Tunapuna*
- *BSc Chemical Engineering, The University of the West Indies, St Augustine, Trinidad, 1996*
- *MPhil Chemical Engineering, The University of the West Indies, St Augustine, Trinidad, 2000*
- *PhD Biomedical Engineering, University of Michigan, Ann Arbor, MI, USA, 2004*
- *MBA Essentials & Entrepreneurship, University of Michigan, Ann Arbor, MI, Ross School of Business, USA, 2009*

Awards:
- *The Emmanuel Ciprian Amoroso Award for Medical Sciences (Silver), NIHERST Awards for Excellence in Science and Technology, 2013*
- *Outstanding Research Award, University of Michigan, Ann Arbor, 2005*

Memberships:
- *Biomedical Engineering Society, USA*
- *American Society for Engineering Education, USA*

Other Achievements:
- *US Patent No 20040132184 for system and method for forming a cardiac muscle contract (co-inventor)*
- *US Patent No 20060141620 A1 for system and method for forming a cardiac tissue contract (co-inventor)*
- *US Patent No 20100196322 for polymer for tissue engineering applications and drop delivery (co-inventor)*
- *US Patent No 20140328806 for energetic three-dimensional artificial cardiac patch and uses thereof*
- *US Patent No 20150335417 for two stage cellularization strategy for bio artificial hearts*
- *Over 50 peer-reviewed publications and one book*

Current Post:
- *Associate Professor, Department of Biomedical Engineering, University of Houston, Houston, Texas, USA*

Dr. Ravi Birla is a faithful son of the soil. While his research at the University of Houston focuses on the human heart, Dr. Birla's own heart is here in Trinidad and Tobago and he has much to say about how scientists can contribute to national development. Initially a chemical engineer, he pursued his BSc and MPhil at The University of the West Indies, St Augustine in Trinidad and then went on to read for his PhD in Biomedical Engineering in the USA. He has earned an impressive total of five patents for his biomedical inventions over the years. His research interests include heart muscle and blood vessel engineering and bio artificial hearts (hearts which are partially or completely synthetic in nature). His research is focused on creating three dimensional (3D) cardiovascular constructs which includes bioengineering 3D cardiac patches, the use of stem cells to support the cardiovascular tissues construct and the development of cardiac pumps which are cell-based. His work is truly groundbreaking as he has produced a bioengineered beating heart muscle which can function in the same way that the muscle of a real heart does. This can assist scientists with the creation of replacement parts for human hearts which are damaged– imagine the number of lives which can be saved!

NIHERST interviews Ravi Birla

Q: ***Can you share some details about your childhood?***

A: Both my parents are from India and I was born and raised in St Augustine, Trinidad. I was encouraged to excel in academics. We believe that if you are accomplished academically you would be successful in life.

I attended a Muslim school in St Augustine, despite being Hindu. Then, I attended Tunapuna Government Secondary School, after which I did A Levels at Hillview College.

Q: ***Where does India factor in your sense of self?***

A: India is close to my heart, but I was born and raised in Trinidad and Tobago and

it's my home. As far as India goes, my parents and wife are from there. I love visiting India, but I am more of an outsider there. When I come to Trinidad, I am coming home! My loyalties have always been clear—Trinidad and Tobago first, then India.

Q: ***At what point in your life did you discover your interest in sciences?***

A: As far as I could remember, I wanted to study sciences. I have a certain inquisitiveness about how the world works. I was always torn between two fields, computer science and chemical engineering. Computer science is more about physics and programming, while chemical engineering is more about chemistry and processes. I am more inclined to chemistry and processes, so chemical engineering was a natural fit.

Q: ***You earned the BSc and MPhil degrees in Chemical Engineering at UWI and then read for the Doctor of Philosophy in Biomedical Engineering at the University of Michigan. Having started in Chemical Engineering, what was the catalyst to enter biomedical engineering?***

A: I am fascinated by nature processes. I came to realise that while chemical refineries are very good at processing, the human body is even more remarkable and efficient. I wanted to apply chemical engineering principles to solving medical problems. I took courses in biochemistry, and the more I learnt the more I wanted to work in the field.

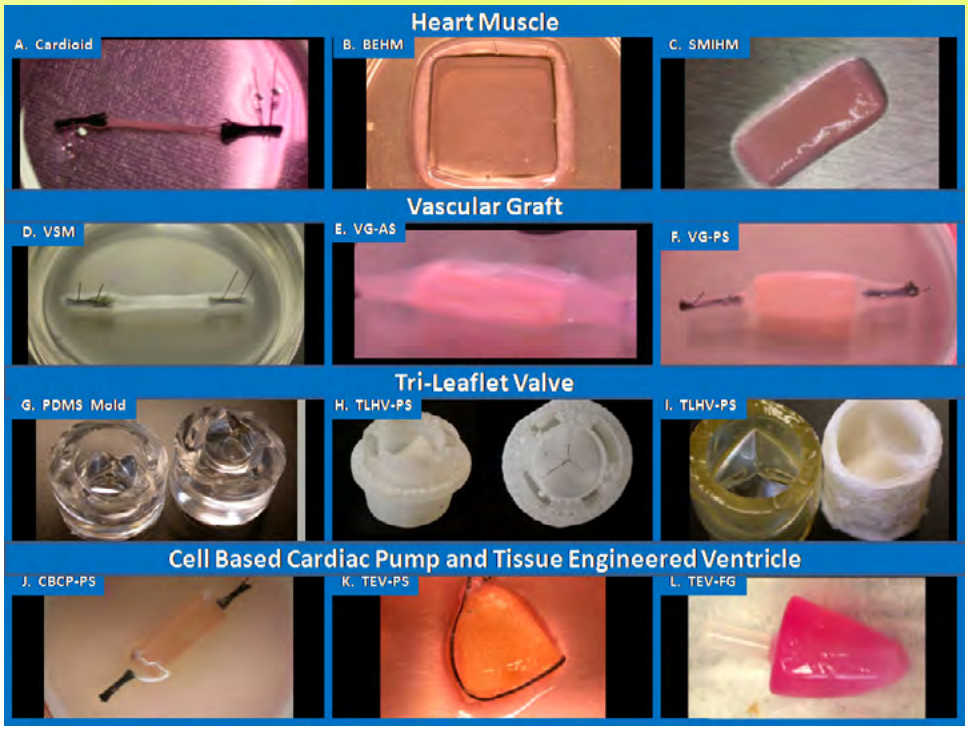
Q: ***Can you give an example of how chemical engineering principles can apply in the human body?***

A: The heart, which is my area of research, is the easiest example. The heart pumps blood through the circulatory system. It is electromechanical in its operation. It continuously expands and shrinks in response to electrical excitation. It endures mechanical stresses and it is prone to fluid stresses from the blood flow. Blood consists of particulate matter which is solid, and liquid which is the plasma. In chemical engineering terms, it's a two-faced transport phenomenon. Fluid flow which is the flow of liquids in cylindrical tubes is understood in terms of pressure and volume changes. These are standard chemical engineering principles which can be used to understand the circulatory system.

Q: ***Can you tell us about your research?***

A: I work on artificial tissue and organ development in the cardiovascular system. Our lab focuses on building the heart and parts of the heart—blood vessels, valves, and ventricles.

When you think about artificial hearts, you think about mechanical pumps with titanium parts. These have



already been used in patients with some success. However, titanium and cells don't blend as well. This is where tissue and organ fabrication comes in. You want artificial tissue that will integrate well with your cells.

We are also developing the core technologies for engineering artificial cardiovascular tissue. In order to engineer artificial tissue or organs, you need to recreate in the lab—in vitro—what happens in the body—in vivo. If you don't have the right environment and the right signals going to the artificial heart, it is going to die. So, a large part of what we do is to design and develop bioreactors, which are custom-made devices that simulate what happens in the body.

Q: ***As a member of various research teams, you have been awarded five patents, can you tell us a bit about them?***

A: Most of our patents are for tissue engineering models. The earliest patent was awarded for a method and system for producing self-organized heart muscle. That work describes a way for producing three-dimensional cardiac muscle in vitro.

Patent two dealt with the vascularization of 3D heart muscle and I was awarded patent three for the energetic three-dimensional artificial cardiac patch and uses thereof. The fourth patent was awarded for the use of fibrin gel for cardiac tissue engineering and the final one which I was awarded in 2015 was for the two stage cellularization strategy for bioartifiifical hearts.

Our latest work is using adipose-derived stem cells to produce cardiac cells. Adipose is fat. We recently got some fascinating results, where we took adipose cell and were able to bioengineer something close to a heart muscle. This is the first conclusive evidence that fat cells can be bioengineered to form three-dimensional heart muscle.

Another area of research focuses the fabrication of bio-artificial heart ventricles. There is a pediatric genetic condition called hypoplastic left heart syndrome, where babies are born with an underdeveloped left ventricle which cannot support the circulatory system. Within the first two years of life, the cardiac surgeon has to re-engineer the existing circulatory system so that the underdeveloped ventricle can take the load. I was hired 10 years ago at the University of Michigan to bio-engineer a bio-artificial ventricle. We have finally created a successful experimental model of a ventricle. We are applying for patent protection. We are among the first to work in this area and to achieve this level of success.

Q: ***What work are you most proud of and why?***

A: The publication of my book, Introduction to Tissue Engineering: Principles and Applications. Training the next generation of scientists is a very important aspect of what I do. The book is specifically designed to educate, motivate, and inspire new entrants in the field. I can only teach so many people, but if you have a book you have the opportunity to impact hundreds, if not thousands.

Q: ***Would you return to Trinidad and Tobago, if given the opportunity?***

A: In a heartbeat! Trinidad and Tobago is home. I left because research opportunities were not available at that time. If there is investment in research infrastructure and resources, I will work to develop biomedical engineering in my country. My work would be much more rewarding. We could produce our own scientists, have a PhD programme, and have our own labs!

Q: ***What is needed to develop scientific research, more specifically biomedical research in TT?***

A: Science and technology should be of national interest. It will advance society. The technologies that are developed will feed into our medical system.

The Trinidad and Tobago biomedical engineering research capacity is under-developed. There is a small biomedical department at The University of Trinidad and Tobago (UTT), but it focuses largely on teaching. The potential is there to convert that into a world-class department, but it requires a sizable investment from the government and private enterprise. If Trinidad and Tobago wanted to get into the field of biomedical engineering, now would be the time. It is a new field of endeavour and is in a major growth phase. In the US there are about 100 departments of biomedical engineering.

Everything we are doing here, we can do in Trinidad and Tobago. It's just a matter of having a vision and will to do it. So you guys can spread the word. Let me know when I should start packing my bags!

Dave Chadee

Fighting the Mighty Mosquito

About the Icon

***Date of Birth:** 30 October 1955*

Education:
- *Elswick Presbyterian School, Tableland*
- *Naparima College, San Fernando*
- *BSc (Honours) Biology, Dalhousie University, Canada, 1977*
- *MPhil Zoology, The University of the West Indies, St Augustine, Trinidad, 1984*
- *PhD Entomology, The University of Dundee, Scotland, 1987*
- *ScD Entomology and Parasitology, The University of Dundee, Scotland, 1999*
- *MPH Epidemiology, The University of Dundee, Scotland, 2001*

Awards:
- *Most Published Scientist, UWI Faculty of Science and Technology, 2015*
- *Most Outstanding Researcher, UWI Faculty of Science and Technology, 2014*
- *Award for Excellence (Science and Technology), The Anthony N. Sabga Caribbean Awards, 2014*
- *The Emmanuel Ciprian Amoroso Award for Medical Sciences (Gold), NIHERST Awards for Excellence in Science and Technology, 2013*
- *Most Outstanding Researcher, UWI Faculty of Science and Agriculture, 2012*
- *UWI Vice-Chancellor's Award for Research Excellence, 2010*
- *Research Award, Gorgas Memorial Institute, 1998*
- *Wellcome Trust Scholar, 1985*

Other Achievements:
- *300 publications and six books*

Current Post:
- *Professor, Department of Life Sciences, The University of the West Indies, St Augustine, Trinidad*

Professor Dave Chadee is an internationally recognised expert in vector-borne diseases and their control. His often groundbreaking research ranges across the disciplines of entomology, parasitology, environmental science, climate change and epidemiology. With 300 publications, he has added significantly to the literature in these fields and impacted public health management around the world. He is an authority on mosquitoes, Aedes aegypti in particular, and the development of surveillance systems and methodologies for controlling the spread of diseases such as dengue fever, the fastest growing mosquito-borne disease, affecting an estimated 390 million people each year.

NIHERST interviews Dave Chadee

Q: ***You grew up on your family's cocoa estate in Tableland. Did that rural environment influence what you went on to study?***

A: It certainly shaped me from a very early age. I have often told the story of being badly stung by caterpillars at about age four. My father put some in a jar, explaining their development from chrysalis to pupa and then to the butterflies that finally emerged as I looked on with great fascination. That's when my eyes were opened to science. The experience captured my imagination, as did all the other wildlife around me. We caught fish and songbirds too, with fishing lines and traps we had to make from scratch. And today I am in a profession where I have had to invent traps!

Q: ***Was school as much fun?***

A: I never liked school but now I love it! I thought it was too restrictive. I think the education system needs to be a little more flexible so students can learn at their own pace. My parents were primary school teachers and we were one of very few families who had encyclopaedia. So I had some advantages academically. I was certainly not an ace student though. But I exceeded my parents' expectations so they were quite happy.

Q: ***One surprising and unusual aspect of your academic background is that you didn't study science subjects at A levels. Why not? And how did you manage the leap into advanced sciences at university?***

A: At Naparima College I did English, Geography, History and GP because they did not offer A levels in biology or zoology. When I applied to Dalhousie in Canada to do a BSc in Biology, they accepted my O levels in chemistry and biology. I worked hard and ended up with a first class honours degree.

Q: ***When you did your honours project on "The reasons for the high incidence of Aedes aegypti in Trinidad", had you already decided to specialise in entomology?***

A: Yes. I returned home in 1976 to do the research project at the Ministry of Health's Insect Vector Control Division. Having completed my first degree, I went on to do my MPhil at UWI, St Augustine under the distinguished parasitologist and entomologist, Dr Elisha Tikasingh, working on the Culex caudelli mosquitoes in the Aripo Wallerfield Forest and Savannah.

Q: ***What was the reason for the high incidence in Trinidad? Was it not the same in Tobago?***

A: The high incidence of Aedes aegypti in Trinidad was due largely to the inadequacy of the water supply system which resulted in the need to store water thus providing breeding sites for the mosquito. At that time, Tobago was still free of Aedes aegypti.

Q: ***Your research, from very early in your career, has been mostly operational (in the field) rather that laboratory-based. Did your area of interest require that or did you not like lab research as much?***

A: Laboratory experiments are much easier to conduct because you control everything: temperature, age and sex of mosquitoes and so on. Field experiments can be affected by the vagaries of the weather and human and animal interference, but reveal more realistic behavioural patterns which can be used to design control programmes or develop behavioural models.

For example, when I started at Insect Vector Control Division, we had problems with the insecticides being used to control Aedes aegypti immatures. So I developed operational studies because the literature showed the insecticide was effective for up to 13 weeks and the advisory was to plan treatment cycles every 10 weeks. The duration of the programme at Vector Control was every three months but the mosquitoes were still surviving in these treated containers. Our studies revealed that the insecticides were being diluted by householders using and refilling the treated containers or by rain falling from the eves. For the experiments cited in the literature, the drums were covered but here, the householders' drums were open and exposed to the elements. We found that if water in the drums was used and refilled in five to six days, there was no mosquito mortality. And if rain fell into the containers, the insecticide would only last five weeks. So as a result of this operational research, the abatement programme changed immediately. This led to

training programmes for vector control workers and to community health education programmes.

Q: ***Other research you did around that time led to the introduction of the international regulation of spraying commercial aircraft. Can you tell us about that?***

A: In 1984, Le Maitre and Chadee published a 20-year report of all the insects collected on board aircraft landing at Piarco International Airport in Trinidad, including mosquitoes, many of which were vectors of diseases, thereby demonstrating that mosquitoes were able to be transported on aircraft. This provided the international community with the evidence required for the "blocks away spray program", which is used on board aircraft prior to landing in tropical countries. This and other work are good examples of the quality of our research and its relevance to international public health.

Q: ***During the 1978 yellow fever outbreak, did the Ministry enlist your expertise?***

A: Yes. We started doing work in seven forested areas. We embarked on an intensive collection of mosquitoes as well as sick or dead monkeys, to test for the yellow fever virus. Then I proposed we study the biology, ecology and behaviour of the four species of Haemagogus mosquito, i.e. the known forest vectors of yellow fever. It was the lack of understanding of the ecology and behaviour of these mosquitoes which resulted in our inadequate mosquito surveillance programme. We identified the peak biting times of these mosquitoes to determine the time of day yellow fever was transmitted and whether they took blood meals at canopy or ground level, etc.

I also wanted to determine for the first time in science, the diel oviposition periodicity of these mosquitoes, which is the exact time of day that these mosquitoes lay their eggs, so these could be harvested to determine whether female mosquitoes passed the virus onto their eggs - "transovarial transmission".

Q: ***Was that the impetus for pursuing your PhD at University of Dundee in Scotland?***

A: In 1984, I left for Dundee to do my PhD, looking at the oviposition periodicity of Aedes aegypti. I studied two strains of Aedes aegypti mosquitoes, one from Africa, one from Trinidad, and did field experiments in Trinidad. We looked at the impact of mosquito population density as well as physical interference on those egg-laying patterns to establish control systems including the development of an effective assay method to identify the "skip oviposition" behaviour because females do not lay all their eggs in one container but rather spread their genetic material around in many containers. Today, there are probably about 25 different mosquito traps which are sold internationally, all of whose developers use this data to enhance the collection mechanism and to provide the evidence for the efficiency of these traps. The icing on the cake for me was that through these local field trials, we established, for the first time in science, the oviposition periodicity of Aedes aegypti in nature. And our methodology has now become the gold standard for similar field studies. So it was really pioneering work when we started. Apart from dawn and dusk egg-laying peaks, we also saw the influence of the rising and setting sun, with more females laying on the eastern side than on the western side of houses. Those are the kinds of findings that have helped in the placement of these traps. Other research helped us improve outdoor and indoor spraying in communities and homes.

From the work I had done, I realised the mosquitoes' biting times were different from the times we were spraying. To control mosquitoes by truck spraying, we must make contact with the mosquitoes while they are flying in order to kill them. So we established peak biting times. We also investigated the indoor resting behaviour (90 per cent of Aedes aegypti hide in bedrooms on dark surfaces), oviposition, and evaluated the efficacy of the truck spraying programme. All of these findings were the building blocks for vector surveillance and control

strategies. So our work had very practical implications for the control of that mosquito worldwide, helping to reduce manpower, costs, logistics, transportation, insecticide use, by using an evidence-based approach. During the latter stage of my career, we developed strategies to break disease transmission within a week because we knew exactly where the mosquitoes were, exactly where to create barriers, etc. Unfortunately, the protocols for these control strategies are very often not followed.

Q: ***In T&T, are the scale and frequency of outbreaks significant for us? It doesn't seem like a lot of people, looking at the case numbers.***

A: Cases from Trinidad are generally under-reported and perhaps represent one third of the actual number of cases. This is not unique to Trinidad and Tobago but happens internationally as well.

Q: ***You left the public health service in 2004 to take up a full-time lecturer post at UWI. What are some areas you have focused on research wise?***

A: Yes, I welcomed the new challenge. Since 2000, I have been working on a sterile insect technique (SIT) project first implemented in South East Asia. We developed control strategies for the chikungunya virus transmitted by the Aedes aegypti mosquitoes in the Caribbean region. SIT is an alternative approach where the male mosquitoes are sterilised through radiation, so the females inseminated by these males are unable to produce fertilised eggs.

In Trinidad, we've also done some trials which have confirmed about 90 to 95 per cent of Aedes aegypti females inseminated by sterile males produced non-viable eggs. We are now developing SIT programmes with Paraguay, Brazil, Costa Rica, Guatemala and Mexico, with funding from the International Atomic Energy Agency.

Q: ***Can you tell us about the traps you have been working on over the years?***

A: A group from Tulane University approached me in 2003 to work on a joint project funded by the Bill and Melinda Gates Foundation to manufacture "Alot traps".

But the traps didn't conform to what I thought should be done and proved not to be very effective. So I asked to be separated from them. Instead, with a colleague from the University of Queensland, Australia, I developed the sticky and double sticky traps, which are far more effective in collecting adults and immatures. We ran trials in Trinidad of all three traps and have now proven that the double sticky is a far superior method to all others. We have also just come up with another version of Gravid Adult Trap - the "GAT trap"- which removes both adult Aedes aegypti mosquitoes as well as the eggs from the community in which it is placed. Within six weeks we removed something like 25,000 eggs in Curepe and over 2,000 adult mosquitoes. And the methodology also allows us to test the dead mosquitoes for viruses using molecular tools.

Q: ***Many of our scientists leave Trinidad to pursue careers abroad. Why did you remain here and what would you advise young people about this?***

A: I wanted to come back, partly because my research is on vector borne diseases in the tropics but mainly because of my family. My parents and I were very close.

But if you are working in science in the Caribbean region, you have to be prepared to live in a society where not much of what you do may be understood or appreciated. To young people, I would say that doing research and getting it published in international journals is very exciting and also possible here in the Caribbean. That's why these awards are important in that they let young people know what can be achieved here at home. So I say more power to your organisation and please continue rewarding people who try to make a difference.

Willi Chen

Renaissance Man

About the Icon

Date of Birth: *26 October 1934*

Education:
- *St Mary's College, Port-of-Spain*

Awards:
- *The Anthony Williams Award for Innovation in Arts and Culture, NIHERST Awards for Excellence in Science and Technology, 2013*
- *Lifetime Literary Award, NALIS, 2012*
- *Chaconia Medal (Silver), Government of Trinidad and Tobago, 2006*
- *Award for Art and Culture, San Fernando Constituency, 2005*
- *Art Award, San Fernando Art Council, 2004*
- *David Hough USA Literary Prize, University of the Virgin Islands, 2003*
- *Cacique Award for Stage Design, "Thunder Storm", National Drama Association of Trinidad and Tobago, 1994*
- *1st Prize Stage Design "A Street Car Named Desire" by Tennessee Williams, National Drama Association of Trinidad and Tobago, 1996*
- *Hummingbird Medal (Silver) Government of Trinidad and Tobago, 1989*
- *1st Prize for Sculpture "SOLAR MARINORAMA" , Central Bank, 1988*
- *US Writers of the Future Contest Award, L Ron Hubbard, 1984*
- *1st Prize Harbour Painting Contest, Shell Company, London, 1963*

Current Post:
- *Businessman, author, painter, sculptor*

Willi Chen is one of Trinidad and Tobago's cultural icons, most famous for his wide-ranging inventions and innovations in the arts. His creativity and accomplishments are all the more important given that he is largely self-taught and demonstrated tremendous ingenuity and resourcefulness in his creations, particularly with the use of indigenous and unusual materials and objects. Chen's works have been showcased on buildings, art galleries and theatres and stages both locally and internationally.

NIHERST interviews Willi Chen

Q: ***Which achievement or work of yours are you most proud of and why?***

A: That would be the "Solar Marinorama" which is a steel-sheeted abstract mural commissioned after winning a competition organized by the Central Bank in 1988. The competition was judged by the curator of the University of Modern Arts in New York and his team. I was the only competitor to send two entries and the second one placed in the first five also.

This massive mural, 64' x 14' and composed of individual pieces, had to be arranged for proper balance and placed between specific spaces. The components had to be transported to the sea coast for proper cleaning and sand blasting to remove all impurities, rust and undesirable parts.

Q: ***How did the idea or concept for the mural unfold?***

A: The name of the mural came to me instinctively. For the wide open spaces I thought of the world and skies, the "Solar" came to mind and "Marinorama" - pertaining to the oceans followed. Thus I coined the name "Solar Marinorama".

Q: ***And how was it made?***

A: We used my Marquette which was really a three-dimensional model made out

of cardboard and which was submitted as an entry in a box for judging. So using my marquette, large pieces of plain steel sheets were cut to shape and size and beaten to accommodate their iron structures that keep all components place. Each part was constructed according to plan and texture accomplished by adding a specially made paste of durable quality for adherence to the body. Other bits and pieces, out of other materials, were also used.

Six trucks transported the mural parts to the Central Bank on a Saturday morning. A team of 10-12 strong-bodied men hoisted each part to the wall of the bank. Using scaffolding and chain pulleys, and working under my direction, we succeeded in pinning the pieces to the wall with pegs and bolts, each individual part positioned in order. We worked on Sunday too. On Monday the whole mural was completely affixed on the wall- so that the Bank workers were amazed as the new work of art was displayed on the premises.

Q: ***Have you done another large-scale sculpture or just that one?***

A: I did one for the entrance of the Christ the King R.C. Church in Les Efforts, San Fernando – named the Triumphant Christ. This is a 12 x 30 foot metal mural. Also at the Pointe-a-Pierre roundabout, I have installed a metal column called the Escriva Lighthouse Tower. Some years ago Petrotrin, formerly Trintoc and Trinidad Leaseholds Limited, approached me to decorate their premises for their Independence Day celebrations. They specifically stated that they did not want any use of flags, buntings or banners. This tower was made out of plain galvanized sheets that looked like refinery fractionators.

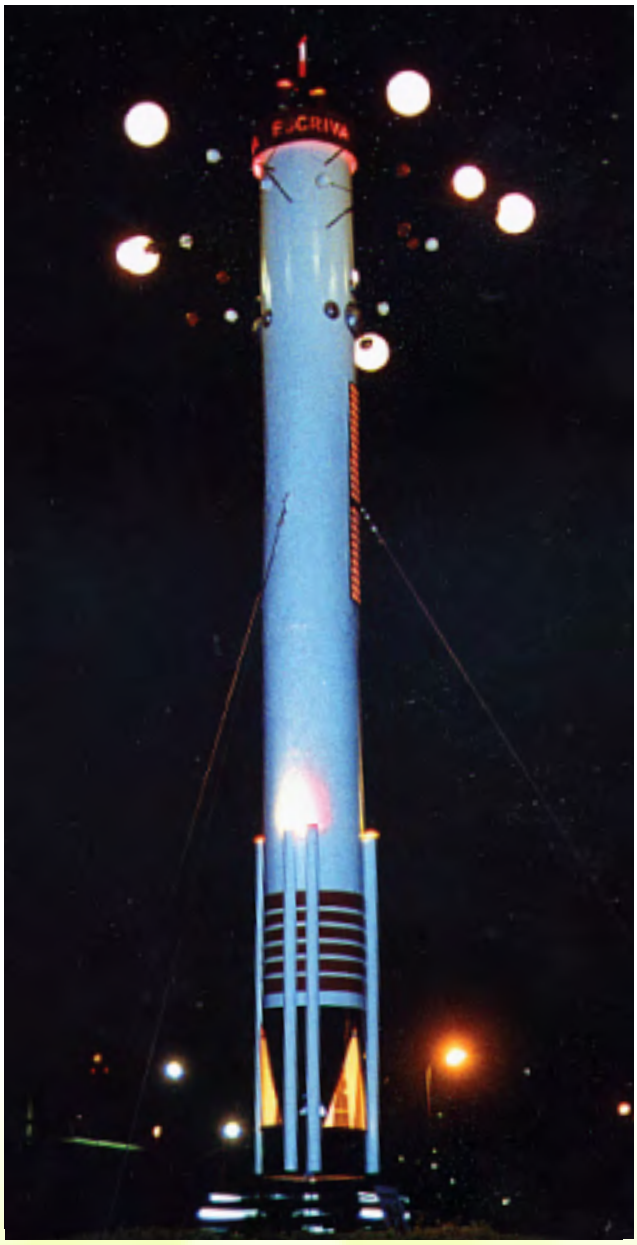
The relevance of this tower with the name Escriva is that Monsignor Josemaria Escrivá de Balaguer, founder of the Opus Dei movement, had advocated that prayer and work was the means of attaining heaven. So that Petrotrin is providing labour and the Escriva tower is identified with the priest for his duty (prayer) and the gases that rise from the tower represent the human spirits who ascend to heaven.

Q: ***Have your interests extended to inventions?***

A: Yes, I invented a boom and a hammer consisting of 4-inch steel pipes filled with concrete which was attached to a Land Rover jeep. The hammer was attached to a cable that was wrapped around a steel drum which was activated by the four-wheel apparatus of the vehicle. This device was simple to use and it drove steel pipes up to 100 feet into the ground. By this method a whole barrier was installed on a riverbank that made it possible to reclaim land.

Q: ***You have also been very involved in the theatre, writing plays and designing stage sets. How did you acquire the skills to get into that arena?***

A: I was always interested in writing. After Form Five at St Mary's College, I went to Higher Certificate which is Form Six. So you either went in the Languages, Modern Studies, Science or Mathematics group. The principal put me into the Modern Studies group because he said I wrote good essays. In those days at college I used to go to the library



and borrow books. I read books by Anton Chekov. He is a great storywriter. At that time I used to read a lot of stories and that prompted me to become a writer. I wrote stories and from that I graduated to writing poems and then I went on and designed stage sets and wrote plays. Well, when I read a play, I have an instinct of what the set design ought to be and I formulate it in my mind. This is not so hard.

Q: ***So you had an innate ability?***

A: Yes. Mr James Lee Wah from the San Fernando Theatre Workshop, a drama group, called me to do a stage set. It was for the Walcott play Ti Jean and His Brothers. That was the first stage set I did and then I was asked to do more. I drew out a set for the play A Streetcar Named Desire. I won the first prize for set design for that play from the National Drama Association of Trinidad and Tobago and also won a Cacique Award for another one I did, a Chinese play titled Thunder Storm for Raymond Choo Kong. And from designing stage sets, I went on to write about 20 plays. One was One Love and there was also Freedom Road. Freedom Road was quite successful and played in Canada as well. This play won the first prize for drama in the drama competition of the National Cultural Council (NCC).

Q: ***What did you do in set-making that was especially innovative?***

A: Innovative is the right word. I like that word. I will tell you why. When other people designed their sets and so on, they went to the furniture store and borrowed chairs and mirrors and it all came out nice and pretty. But I didn't go that way. I cut bamboo or I cut wood, I used cardboard or coconut branches, and I used fibre. I used paper from my

printery – the off cuts - to make the walls. So every part of the set was made of things or materials I found. Thus my sets were always different. The essence of the play must be reflected in the set design. The designer has to read the play and then get a sense of what he wants and then use his skill, his imagination. If you go the way of doing your own thing, the original way, it will carry more weight. Being original.

Q: ***So all of this work you did, was it self-taught?***

A: Yes. As a designer I was open to many ways and means of doing things. But there was my mentor, he was a painter, a ceramicist and Carnival costume designer, Carlisle Chang, who had an influence on my life.

Q: ***Your record for accomplishing a lot – the sculpting, inventing, writing and designing while also managing a bakery and printery is quite remarkable. How did you find the time to do all of this?***

A: I am an artist as well. All three activities were in control because I manage my time well and I must say that I am inquisitive, impatient and impetuous - wanting to find out how everything works. The bakery kept me very busy because I had to awake at 2:45 am each morning and work 18 -20 hours per day. It was just my nature.

Q: ***What advice would you give to persons for achieving success in whatever they do?***

A: Believe in life that nothing is impossible and that no mistake is too big to change. Be determined about what you want to do and work hard.

Q: ***So has your outlook on life and work been influenced by eastern or western culture?***

A: Both the Eastern culture and the Western have had an influence on my life. My parents taught me all the noble things of life in China. They encouraged me to be obedient, frugal and to respect everyone, especially the elderly, but most of all to help out in house work, to work hard and to be able to speak the Chinese dialect, Hakka. This is most important. Very few Chinese who were born in Trinidad can speak Hakka. I am one of the very few.

Q: ***Are there any projects forthcoming for the future?***

A: Yes. I am preparing for a one-man exhibition of all my works- literary, steel panels, murals designs, etc.

Myron Chin

Building Standards

About the Icon

Date of Birth: *17 August 1938*

Education:

- *Nelson Street Boys' R.C. School, Port of Spain*
- *Queen's Royal College, Port of Spain*
- *BSc (Honours) Civil Engineering, Loughborough University of Technology, UK, 1962*
- *PhD Structural Engineering, Manchester University, England, 1966*

Awards:

- *The Fenrick De Four Award for Engineering, NIHERST Awards for Excellence in Science and Technology, 2013*
- *Award for sterling contribution to Disaster Management in Trinidad and Tobago, The Office of Disaster Preparedness and Management, 2011*
- *Award of Career of Excellence in Engineering, The Association of Professional Engineers of Trinidad & Tobago, 2007*
- *Certificate of Merit, The Commonwealth Engineers Council, 1996*
- *Award for service to the Faculty, The University of the West Indies Faculty of Engineering, 1987*
- *Senior Fulbright Research Fellowship Award, 1986*

Memberships/Fellowships:

- *Fellow, Institution of Civil Engineers*
- *Life Member, American Society of Civil Engineers*
- *Member, Caribbean Academy of Sciences Fellow, Association of Professional Engineers of Trinidad and Tobago*
- *Fellow, Institution of Structural Engineers*
- *Registered Engineer, Board of Engineering of Trinidad and Tobago*

Other Achievements:

- *Over 80 peer-reviewed publications*

Current Post:

- *Independent Chartered Civil and Structural Engineering Consultant and Project Management Consultant, Trinidad and Tobago*

The Caribbean is a particularly challenging region for construction, dogged by the threat of earthquakes, floods and hurricanes. Historically, Caribbean builders have used materials and practices that provide little protection against the damage to the built environment by these natural forces. Dr Myron Wing-Sang Chin is a civil engineer, educator and disaster management expert whose work on plastic design theory and BS 968 steel has helped to establish global design standards. For over three decades, he taught more than a thousand civil engineering students at The University of the West Indies, St Augustine who have gone on to be leading professionals in the field. He has applied his engineering expertise to the development of CUBiC, the Caribbean Uniform Building Code, a region-specific template which has informed national building codes across the Caribbean.

NIHERST interviews Myron Chin

Q: ***What was unique about your childhood and family life?***

A: Well, I was born during the war years in Macqueripe. We were six boys and three girls. From time to time, the air raid siren would sound and we all had to go into an air-raid shelter which still exists today. Both my parents came from China. My mother was my father's second wife since his first wife had passed away. He sent for her based on a picture he had seen of her and to this day, I still have the ticket with which she came to Trinidad on the Canadian Pacific Steamships Ltd R.M.S. Empress of Russia on July 13, 1934. I've been to China several times myself. I've visited my mother's village and went to see the Great Wall which is fantastic. The engineering is amazing! We later moved to Santa Cruz. I won an exhibition from Nelson Street Boys' R.C. to go to Queen's Royal College and I did well. Even when helping out in the shop, I would study.

Q: ***Did you want to become a civil engineer from a young age?***

A: Originally, I really wanted to do medicine abroad, to follow in the footsteps of a schoolmate of mine. But my father was a shopkeeper with nine children to

take care of so he couldn't afford that. At the time, Shell Oil Company was offering engineering scholarships in mechanical and civil engineering. So it was purely by chance, not so much choice, that I eventually became a civil engineer having obtained a scholarship from Shell Oil Company to do so. Thankfully, four of my five brothers also got scholarships in their fields. I came back to work with Shell and then a year later I got a Commonwealth scholarship to go to Manchester University to do my PhD.

Q: ***Despite civil engineering not being your first career choice, you were still tremendously successful in it. Can you give us a summary of your work and the breakthroughs you had?***

A: I suppose I could classify my work in four areas. The first would be the continuation of my PhD research in the plastic design of steel structures. The second would be on building codes and standards. The third, after joining UWI in 1972, was to develop continuing engineering education. And then the fourth is disaster management.

Q: ***What is plastic design?***

A: According to plastic theory, phenomena called plastic hinges occur in a structure. These are sections in steel beams that undergo permanent deformation when the yield stress is attained. Plastic design allows you to save up to 20 per cent less steel than the previous design method, elastic design which focuses on working stress levels. This theory was developed by Baker, Horne and Heyman at Cambridge University during the Second World War as a means of coping with steel scarcity when designing air-raid shelters. After it was developed, Professor Horne moved to Manchester and I had him as my supervisor for my PhD studies. Out of my PhD work, my supervisor and I published a booklet entitled Plastic Design of Portal Frames in Steel to BS 968. This is one of the first set of design charts for the plastic design of pitched roof portal frames using BS 968, a stronger steel developed in the early sixties. This is now the most commonly used steel in building structures throughout the world.

Q: ***So were you the first person doing further research on it?***

A: A team at Manchester first investigated it. My research showed it was ductile enough, and today it is common practice. Plastic design remains more economical. This was one of the topics I introduced to my students at UWI. As I mentioned earlier, the second area I focused on was in the development of codes and standards for the region. Between 1982 and 1986, I was the project manager for the development of the Caribbean Uniform Building Code, better known as CUBiC, funded by the United States Agency for International Development and the Caribbean Development Bank. I worked with Tony Gibbs from Barbados, Alfrico Adams from Jamaica and Al Wason from Barbados. Regional governments still use it as a model for national building codes, but many things have changed since 1986 and a revised CUBiC is overdue. That task of updating is being undertaken by the CARICOM Regional Organization for Standards and Quality (CROSQ). The updated CUBiC will include new codes and methodologies for hurricane-force winds and earthquake forces. In 2002 I was team leader of an Association of Caribbean States (ACS) funded project on updating building codes of the greater Caribbean for wind and earthquakes. Trinidad and Tobago is now trying to develop its own national building code based on the International Building Code (IBC) which uses the latest procedures for design.

Q: ***Why have a national code if we have the regional or international one?***

A: For administrative reasons, the regional building code has not been applied across the region. The Jamaicans are using a variation of the IBC, adopting it as a base code and preparing an application document to reflect

the particular conditions of Jamaica. For example, in the IBC the seismic hazard maps would be related to the United States, so we had to replace those maps with those applicable to the Caribbean region. Similarly, for hurricane force winds we need wind speeds for the Caribbean, not the United States.

Q: ***Is any particular island more likely than others to suffer a natural disaster?***

A: No. All the islands are subject to both hurricanes and earthquakes annually. Despite our efforts, building practices continue to be subpar. The only solution is to continue to educate our builders, engineers and allied professionals in proper building techniques, codes and standards. The CUBiC was produced in 1986 – 28 years ago – and although it finds limited use in most islands, building code requirements are not enforced, and are thus ignored. For example, we advise against building houses with un-reinforced hollow clay blocks. With the slightest earthquake, those un-reinforced walls will collapse, as I showed my students in the 1997 Tobago earthquake. Yet if you drive around today, you still see houses with unreinforced clay block walls, so a small shake can bring them down.

Q: ***Just wondering - is your own house is disaster proof?***

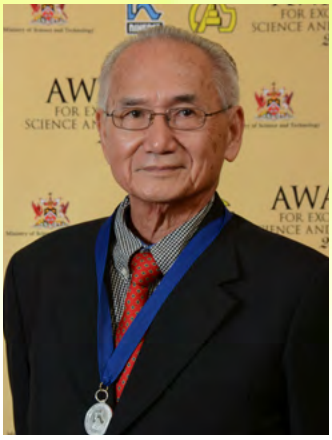
A: I just moved into a townhouse right in St Augustine and I looked at what the builders were doing. They followed small building guidelines thoroughly, both the block masonry and the roof design.

Q: ***Of the many disaster sites you have visied, did any stand out as professionally enlightening or otherwise?***

A: I visited Mexico after the Mexico City earthquake of 1985 and, to me, that was the most revealing one in terms of earthquake damage. I was actually in Belize doing a workshop on the CUBiC when the earthquake struck and the Secretary of the Belize Association of Professional Engineers and myself took a flight into Mexico City. It was the first time in my life that I saw such damage to high rise buildings. A lot of the buildings were constructed in an old lake bed and during a quake, behaved like a bowl of Jello. For certain buildings, the natural frequency of vibration of the building coincided with the period of the shaking soil. When that happens, you get resonance, the building shakes more than it would otherwise and, eventually, the building will collapse. You can avoid resonance by putting in what we call base isolation or dampers in the building such as pendulum weights – so the period of the shaking of the building is different from that of the ground. We are yet to have a base isolated structure in Trinidad and Tobago. In Martinique and Guadeloupe, there are several schools and hospitals that are base isolated. You can also retrofit with base isolation.

Q: ***What about the other areas of your work- continuing education for engineers and disaster management?***

A: Having spent six years in industry before becoming a full-time academic in 1972, I recognised that practising engineers often didn't have time to read journals and keep up to date. So I submitted a proposal to establish a continuing education committee in the Faculty of Engineering, UWI, which I chaired for 19 years. We mounted numerous continuing engineering education short-training courses, seminars and conferences. During the period 1976 to 1988, I also served as a member of the UNESCO International Working Group on the Continuing Education of Engineers and Technicians, and from 1989 to 1995, I was a member of the Executive Committee and Council of the International Association for Continuing



Engineering Education. In 2005, I became director of the National Emergency Management Agency when the director was posted to Washington and the hurricane season was coming. A hurricane was threatening to hit Trinidad, and we had to advise the then Prime Minister [Patrick] Manning to send people home early to secure their homes. As a result, there was a horrendous traffic jam since everybody decided to leave early and it caused chaos. The Office of Disaster Preparedness and Management is now working on a mass evacuation plan for Port of Spain since the current one needs fine-tuning.

Q: ***What aspect of your work are you most proud of and why?***

A: I am especially proud to have been able to impart my knowledge to over a thousand civil engineers who came through UWI from across the region. Most are doing very well in the public and private sectors. One student, Cromwell Goodridge, became Minister of Works in St Lucia. Nearer to home, another, Colm Imbert, became Minister of Works in Trinidad and Tobago. Many of my graduates became successful consulting engineers in their own firms.

Q: ***What was your time at the Seismic Research Centre like?***

A: I was invited in 2011 to join the Seismic Research Centre at UWI right as they obtained funding for the Global Earthquake Model (GEM), a project funded mainly by big insurance companies. GEM is charged with developing a model that can determine the risk of earthquakes in different regions of the world. They invited me to be the operations manager to launch the programme in the Caribbean, but they only had funding for one year so I was there for that length of time, long enough to launch the programme. It is done mainly on a voluntary basis with different working groups but people are busy and little can be done without funding. One area we worked on was micro zonation which The Seismic Research Centre is now doing for Port of Spain and environs. This will give us a better idea of the effects of a major quake on a particular area.

Q: ***In addition to your civil engineering work, you were involved in the Caribbean Conference on Artificial Intelligence. What was your role?***

A: In 1989, I organised the First Caribbean Conference on Artificial Intelligence (AI) and managed to get the leading AI expert, Dr Ed Feigenbaum of Stanford University to come as a keynote lecturer. Feigenbaum's laboratory went on to develop expert system programmes in medicine (MYCIN,PUFF,ONCOCIN), molecular genetics (MOLGEN), X-ray crystallography (CHRYSALIS), and analysis of pulmonary function (PUFF). It also developed the first transportable general-purpose expert system "shell" (EMYCIN). With the aid of computer scientists, experts in different subject areas could populate EMYCIN with their specialized knowledge in the form of rules and then the knowledge-augmented system could be applied to different problem areas.

Q: ***What work are you are doing now?***

A: Since my retirement from UWI in 2002, I have consulted for numerous firms. Currently, I'm mentoring young civil engineers who have recently graduated from UWI. I give advice on structural and civil design, reinforced concrete design and so on. This is very satisfying to me. In the words of Confucius, there is nothing more pleasing than to pass on to others the knowledge that you have gained.

Richard Dawe

Practical Teaching, Excellent Results

About the Icon

Date of Birth: *02 November 1943*

Education:

- *Chatham House Grammar School, Kent, UK*
- *BA(Honours) Chemistry, St Catherine's College, Oxford University, UK, 1965*
- *MA, Oxford University, UK, 1968*
- *DPhil, Physical Chemistry, St Catherine's College, Oxford University, UK, 1968*

Awards:

- *The Fenrick De Four Award for Engineering (Gold), NIHERST Awards for Excellence in Science and Technology, 2013*
- *Recognition for distinguished support, The Geological Society of Trinidad and Tobago, 2011*
- *Vice-Chancellor's Award for Excellence, The University of the West Indies, 2005*
- *Europe and Africa Regional Award, The Society of Petroleum Engineers, 1998*
- *George Sell Prize for best paper 1979, Institute of Petroleum, 1980*

Memberships/Fellowships:

- *Fellow, Energy Institute*
- *Fellow, Royal Society of Chemistry, UK*
- *Fellow, The Geological Society of London, UK*
- *Member, Society of Petroleum Engineers, UK*
- *Member, Board of Engineering, Trinidad and Tobago*

Other Achievements:

- *Over 130 peer-reviewed publications*
- *Over 100 other publications*

Current Post:

- *Professor Emeritus, Petroleum Studies Unit, Department of Chemical Engineering, The University of the West Indies, St Augustine, Trinidad*

Richard Dawe grew up in England in the 1950s, a bright boy but dyslexic in an era when such disorders often went undiagnosed, being neither recognised nor understood. However, he overcame the critical learning difficulties with reading, calculation and memory to advance through to tertiary education and become an expert in reservoir physics. He had an academic career with 22 years at Imperial College in London and 12 years at The University of the West Indies (UWI), St Augustine where he restructured its Petroleum Studies curriculum by modifying its Petroleum Engineering master's programme and spearheading the introduction of its Petroleum Geoscience undergraduate programme.

NIHERST interviews Richard Dawe

Q: ***What was your childhood like?***

A: I was born in London in 1943, in the middle of World War II. I was the eldest of three, all born within four years. My parents divorced when I was seven so my mother brought us up. She taught in local primary schools to support us and ensured that we all went to university. We grew up relatively poor but never lacked the basics. I went to the local grammar school when I was just under 11 and had problems in school because I'm dyslexic. At that time I didn't know and I only found out when my son was diagnosed as dyslexic, many years later! I can't read fast; spelling can be frustrating and remembering numbers difficult. I can't remember my cell number! I skip-read, and if I have to read something out aloud, it's like a bad newscaster- inflexions wrong and everything not emphasised well. I have never read to my children. My learning technique, I suppose, is to understand the basics and the rest follows. I feel science is mainly common sense so that is fine, but literature or languages- that is another matter.

Q: ***How did you get interested in science?***

A: I have always puzzled about how things work and are put together. I am one of those who take things apart but may not always get them back together again. I

had a primitive chemistry set when I was 10 and I remember the smell of burning sulphur, crystals and bangs. We did things then which Health and Safety regulations forbid now. At 16, during the holiday vacation while waiting for my A level results, I got a job in London, away from home for the first time, at Tate & Lyle. Some of the sugar cane came from Trinidad. I worked in their laboratory, read a book on sugar refining by Oliver Lyle, was introduced to practical chemical engineering and wrote my first ever report on a set of experiments on invert sugar – a mixture of equal parts of glucose and fructose resulting from the hydrolysis of sucrose. And so when I went back to school, I had grown up a bit. In October 1960, I won a place at St Catherine's College in Oxford to read chemistry and went just before I turned 18 in 1961.

Q: ***What was your academic and career history before coming to UWI?***

A: Chemistry at Oxford is four years. I enjoyed physical chemistry but I couldn't remember the big words and formulae in inorganic and organic chemistry.

Physical chemistry has a "simple" basis, is logical and has an applicable practicality about it. In my fourth year I worked on the solubility of gases in water for divers' bends – the potentially fatal intoxication you get if you dive too deep while breathing regular air. Normally below 100 feet they use helium but we were trying to find a replacement to be able to go to deeper points safely. Alas most gases are toxic. Afterwards, I won a British Gas scholarship and worked for my doctorate on the high temperature viscosity of gases (resistance to flow) and the interaction of gas molecules. As I was finishing I applied for a position at the Chemical Engineering department at the University of Manchester Institute of Science and Technology. I went there as an assistant lecturer in October 1968 and spent a year trying to develop a glass apparatus to accurately measure quantities of vapour and liquid produced by a boiling mixture (usually known as vapour-liquid equilibria). I then moved to the Leeds University Chemical Engineering department. The first research challenge there was to develop, possibly for commercial exploitation, an apparatus to measure the enthalpy of gases which is the sum of the internal energy of the system plus the product of the pressure of the gas in the system and its volume. We used the Joule-Thomson effect–the principle that when a gas rapidly expands it usually, but not always, cools.

Obtaining the enthalpy this way is much quicker than the then standard method used by the National Standards Laboratory, USA. In 1975 after six years at Leeds, I moved on to Imperial College. Oil had just been discovered in the North Sea and Imperial College had been selected to be a major oil and gas education centre. I spent the next 22 years there, became Senior Lecturer in 1986 and then Reader in Reservoir Physics in 1991. My research concentrated mainly on visualisation of multiphase flow in porous media at pore and core scale. During this period I supervised over 24 graduates to their PhD and saw some 500 graduate from our MSc in Petroleum Engineering programme.

I then moved on to the University of Qatar as the Occidental Chair in Petroleum Engineering. I had no idea where Qatar was and knew no Arabic. However, Qatar is special. There is a field there, the Dukhan field, which is some 80 km long– more or less the whole length of Trinidad. Offshore there is the largest gas field in the world and the Qatari (men) are the richest people per capita in the world. Then in January 1999, just as my contract was up for renegotiation, the oil price dropped to nine dollars per barrel so it was time to leave. At that time I saw an advert for a Chair in Petroleum Engineering at UWI St Augustine. I had previously been an external examiner for the Petroleum Engineering programmes and had visited Trinidad in 1991. Trinidad had felt familiar. They drive on the sensible side of the road (on a good day), the road signs had a familiarity as they were the same as the old road signs of my childhood in the United Kingdom and there seemed to be a lot of single mothers,like my mother, bringing up children. So in August 1999, I moved to Trinidad as the Trinidad and Tobago Methanol Company Chair (TTMC) in Petroleum Engineering sponsored by the TTMC.

Q: ***Was there no petroleum engineering at UWI at the time?***

A: There had been petroleum engineering at UWI since 1976 supported by the government and there had been a good number of graduates from the programmes going into the industry and some research initiatives. However, the changing oil prices and the consequent changing fortunes of the country meant that the petroleum engineering MSc changed its focus periodically. In 1999, the Petroleum Engineering Unit was struggling so I restructured the programmes to make the delivery more logical and also introduced a field project. These changes ensured that our petroleum engineering graduates from the MSc are ready for entry into industry.

Also in 1999, BP Trinidad and Tobago (bpTT) needed a significant number of junior petroleum geoscientists to help with the exploration activities being carried out but there were none being educated in Trinidad. Thus in 2001 we developed an undergraduate programme in petroleum geoscience in five months, an impossible task according to one senior member of the UWI management team. In April I was going around saying, "I have no staff, no syllabus, no students, no money, no buildings, I am not sure if I am in the right faculty or campus, and we want it by August." By September we welcomed our first 15 students. The programme development was achieved by the strong support of UWI, the industry and government. One key player was Wayne Bertrand who has been a pillar of TT's upstream petroleum industry, and a strong supporter of UWI and youngsters' education over the decades.

Q: ***What is the difference between petroleum engineering and petroleum geoscience?***

A: Petroleum geoscience uses all aspects of geology and geophysics to suggest where there might be oil and gas trapped underground in reservoirs and in volumes that can give economic returns. After a reservoir comes on stream, petroleum geoscientists monitor production to ensure accurate forecasts and identify potential geological problems and opportunities. Geology is therefore intrinsic to the programme but must be relevant to the hydrocarbon reservoir, that is, porous permeable formations. I often state, "Geology is to geoscience as chemistry is to chemical engineering".

Petroleum engineers then take that advice, drill to find the hydrocarbons, then exploit the discoveries in an economical way. Petroleum engineering involves the application of earth and physical sciences to the evaluation and exploitation of natural hydrocarbon resources. The dominant problems of the petroleum engineer are those of reserves estimates and flow and equilibrium in porous media, in well bores, in surface pipelines and in primary process equipment. The advice of petroleum geoscientists helps produce it, they scrutinise the economics to say how much money might be made during production and for how long. The upstream process ends with the gas and oil passing down a pipeline or being transported by ship or truck to a refinery to be converted into useful products, which is the work of chemical and process engineers.

Q: ***What do you believe to be your legacy?***

A: When I retired from the UWI in August 2011, I left the petroleum geoscience and petroleum engineering programmes healthy. Both were staffed with good colleagues and students, with good throughput and programmes accredited by world-class institutions such as the Geology Society of London and the Energy Institute. We were the first geoscience programme outside the UK

accredited by the Geological Society of London. I believe that our programmes are as good as the programmes at Imperial College. They are different and perhaps more practical but good. We now have over 160 graduates from the petroleum geoscience programme and some 270 from the petroleum engineering programme, since I joined the UWI. Many are gaining further degrees, either going abroad or staying in Trinidad and Tobago and with correspondence courses, and so a legacy is being created. Also many of our graduates have taken up local jobs, in the petroleum or associated industries, even one being a Minister of Energy.

Q: ***What would you say distinguished you as a teacher or educator?***

A: I wouldn't call myself the best teacher, not only because I didn't do all of the teaching myself, but also because it isn't for me to say. I want students to understand, not just learn to repeat. In later life when they are "on the job" they have to act positively, safely and responsibly as leaders. This they can initially learn as a student. For instance, one of the best ways for a student to learn is for them to present material to their peers in class. So one teaching method I often used was to say, "Now you're going to give me the lectures". They had to go, research the subject and then present a technical talk for maybe 20 minutes. They taught themselves, each other and even gave me a refresher each semester. When teaching, I based my lectures on material I'd used in Imperial College and I'd tell them, "If it's good enough for Imperial College, it's good enough for you. I expect you to be able to rise to that standard. You are as good as they are." I expected students to perform and at UWI they didn't disappoint.

Q: ***What about the need for alternative energies?***

A: Although Trinidad itself has currently sufficient hydrocarbon energy, sooner or later it will run out. Worldwide, the major convenient energy sources are hydrocarbons, oil, coal and gas, but they are all CO_2 emitters, and require expensive and complicated carbon capture procedures. Currently the world uses 80 to 90 million barrels of oil per day. The world should be moving to using energy obtained from the sun, and also wind, hydro and oceans. Sufficient energy is emitted in a day to satisfy the needs for a year provided proper converting procedures and delivery methodologies are developed. My favourite alternative energy is geothermal energy. Currently some is used near "hot rocks" in Nevis and Guadeloupe but there is sufficient to power the whole of the Caribbean if you have a long enough piece of wire! But if you drill down into the ground it gets warmer; so if you go deep enough and circulate water you can extract the heat. If the hot water is passed through a vapour power generator, electricity is produced and the now cooler water can be recycled. Environmentally friendly yes, but it is not economic at the moment but I am sure it will be in the future. And when that comes around it will require the skills of the petroleum engineers and the geoscientists to guide the process, so we won't be out of business.

Q: ***Do we need more scientists?***

A: We do, but not just in the way people often think. It's true that we need really good scientists who can invent and develop big things, but I believe the whole world ought to be technically competent. Thus aside from famous inventors and innovators, we also need a population that understands the relevance of science and its principles, and makes common sense decisions that are logical rather than hidden under "political correctness" which are really wrong and non-beneficial to the world e.g. approaches to climate change. The Petroleum Studies Unit is making its contribution and hopefully will continue to do so for many years to come.

Stephan Gift

Amplifying Research and Development

About the Icon

Date of Birth: *25 July 1955*

Education:

- *Bishop's High School, Tobago*
- *BSc (Honours) Electrical Engineering, The University of the West Indies, St Augustine, Trinidad, 1976*
- *PhD Electrical Engineering, The University of the West Indies, St Augustine, Trinidad,1980*

Awards:

- *The Fenrick De Four Award for Engineering (Silver), NIHERST Awards for Excellence in Science and Technology, 2013*
- *Award for Outstanding Contribution to the Organisation, NIHERST, 2010*
- *Prime Minister's Special Award of Merit for Innovation in the Field of Electronics, NIHERST, 2002*
- *BPTT Fellowship for scholarly work, 2002*
- *Young Innovators Award, Ministry of Culture, 1986*

Other Achievements:

- *US Patent No 4,774,721 for subscriber pair identification system (co-inventor)*
- *Over 80 papers published in international peer-reviewed journals*

Current Post:

- *Dean of the Faculty of Engineering, The University of the West Indies, St Augustine, Trinidad and Tobago*

From a makeshift laboratory in the family's backyard, Professor Stephan G.J. Gift has emerged as an accomplished academic in Electrical and Electronics Engineering. At the tender age of 24 years, he earned his PhD in Electrical Engineering and is published in some of the world's top ranked journals in Electronics.

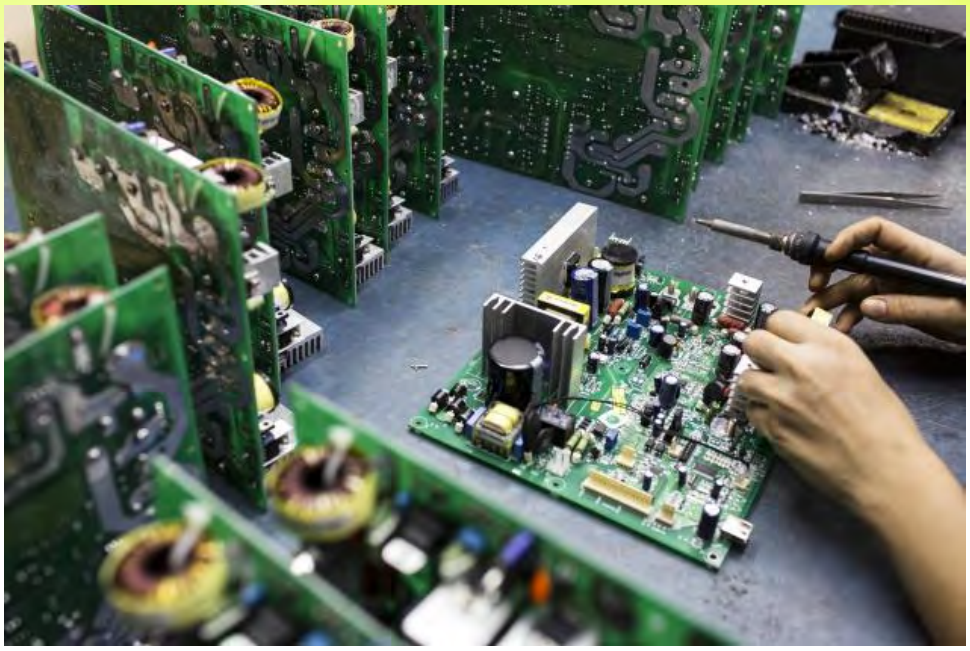
NIHERST interviews Stephan Gift

Q: ***What were some of the formative experiences of your childhood?***

A: I was born in Tobago. My parents are Vernon and Beulah Gift, both deceased. My father was an administrator, at the port authority in Tobago and my mother was a primary school teacher at Mason Hall Government. I have an elder brother, Christo, a lawyer, and a younger brother, Gerard, who is a mechanical engineer. Our parents allowed us a fair level of freedom. We played cricket, football and went hunting in an area we called "The Gully". We also flew kites on Christmas Day, because in Tobago the kite flying season is at Christmas time. That was great stuff, you know! I had a religious upbringing; we are Methodist and went to church and Sunday school. It was a gentle experience of doing good based upon this upbringing. I was also in the Cadet Force and participated in the July/August vacation camps they would have at Chaguaramas. Cadets from all over the country and the Caribbean gathered. The highlight of your career as a cadet was winning an exchange to Canada which I managed to do. In the Force, value is placed on doing well academically and being an all-round good person, being diligent, demonstrating responsibility, comporting yourself well and being regular and punctual at practice and meetings. This made it quite a formative experience.

Q: ***What early experiences influenced your career in science and technology?***

A: I started General Science in the early forms and then Physics and Chemistry in Form Three. I was fascinated by electricity. There was a device in the physics



book called an "electric buzzer". The book didn't tell you how to build it but it told you how it worked. I built one that worked. It gave me a sense of accomplishment and sparked an interest. Around age 13 I started doing experiments at home. My father was not happy with my working in the house because of the possibility of causing a fire, so he gave me a work space adjoining the garage. My elder brother helped me build shelves, benches and a desk. Eventually, I had a little lab right there.

Q: ***What are some of your most memorable experiments?***

A: I did experiments in Chemistry and Biology but the experiments in Physics is where the fascination lay. I built all kinds of things. One thing that took me a good while to get working was an electric motor. I saw many designs and I tried to get one to work. I struggled and I was not sure what the problem was. Every new design I saw, I would try it and I would fail. On one occasion, my family went to the beach but I decided to stay at home because I wanted to try this new motor design. As they were returning, I flicked the switch and off the motor went. I was so joyful. I ran out and told them "It's working. It's working!" I took it to school. We tried the one bought for the school, properly constructed and all that, but they couldn't get it to work. The teacher called on me to demonstrate mine. I put the battery in and off it went. The experience was great. There I was demonstrating to the class a motor that I had built, and it was working!

I graduated to amplifiers. There was a guy who repaired radios close to the school, and he would put out all this junk. I saw all these things and said, "Boy this is a lot of good stuff here." I would get pocket change, but not to buy transformers and tubes and so on. So, I salvaged components from the trash. I did not have a voltmeter. I would use a low voltage bulb from a torch light or something. If a circuit blew the bulb, I would know that the voltage was "high". Now that was really very crude, but then one day my dad gave me a job, and he told me if I completed it he would buy my first multimeter to measure voltage, current, resistance. I did get that multimeter!

I also constructed my first power amplifier which I used to play music. My Physics teacher showed me how to get sound through a speaker. Most speakers are mounted within the box with the cone facing out. He showed me how to mount it outside the box. And this one speaker unit with an amplifier, which delivered only four or five watts (not a lot of power) sounded as if it were a very powerful system! I used it for a sixth form party!

Q: ***At the early age of 16 you took the A levels in Physics, Chemistry and Pure and Applied Mathematics and was awarded an AMOCO scholarship to pursue your degree at The University of the West Indies (UWI). Can you tell us about your undergraduate experience there?***

A: At UWI, I read for my first degree in Electrical Engineering because electricity and electronics intrigue me. I could build circuits that other people designed but I couldn't design the circuits. I wanted to learn how to design these circuits and that is indeed what happened. I graduated with First Class Honours. I remember telling my father

that I got a First Class and he said that I did him proud. I was immediately offered a scholarship to do postgraduate work at UWI.

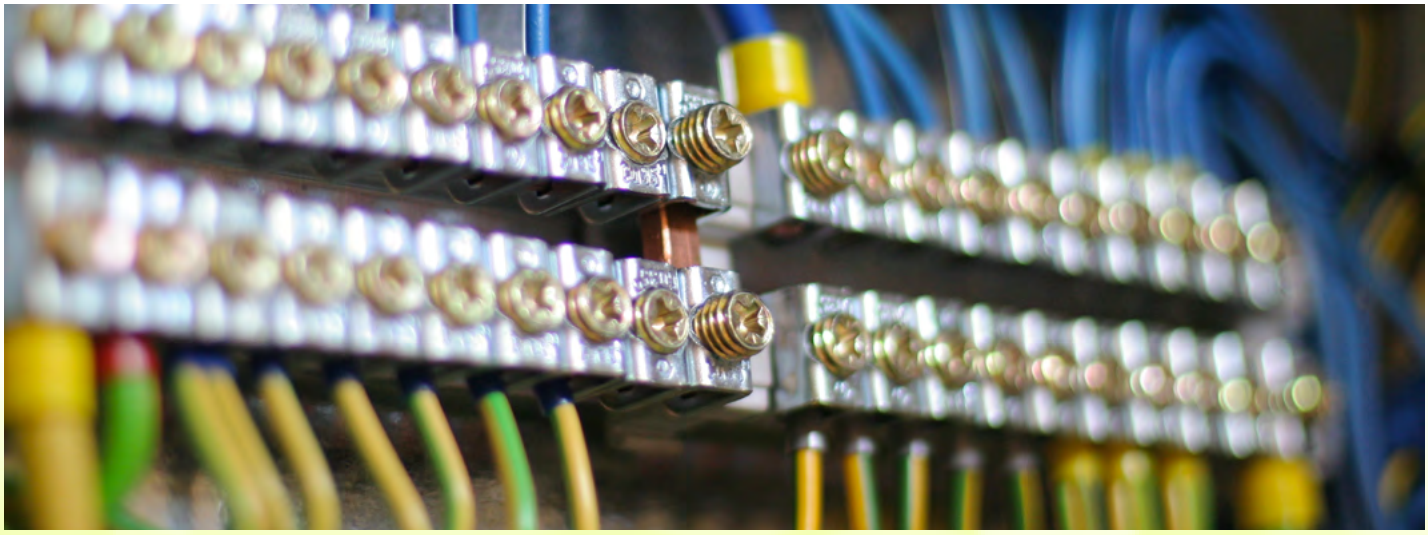
Q: ***What did you do for your postgraduate work?***

A: I registered for the MPhil and then transferred to a PhD. I gave myself three years to complete the PhD. After two and a half years or arduous work, I ran into very serious difficulty and I had to abandon the problem that I was working on. Through what I believe to be divine intervention, I was able to come up with another problem in Optimal Control Theory. In three months, I generated so much work that I was able to submit a substantial thesis. This harrowing experience gave me an unshakeable belief in God and also more confidence in myself. My external examiner commented that my work in just two chapters of the thesis was more than enough to be awarded the PhD! It caused me to recall the story of Jesus feeding the multitude with only few fish. My thesis experience, for me, was almost something like that. I am particularly proud of this achievement, as I was the youngest PhD graduate in the history of the Department of Electrical and Computer Engineering.

Q: ***What would you cite as your major career achievements?***

A: I got an offer at the national telephone company, then called the Trinidad and Tobago Telephone Company (TELCO), to form a research and development centre. I felt I needed to have industrial experience and an opportunity presented itself. I spent many hours in the field. We tested lines in the early hours of the morning when there wasn't much "traffic" - when consumers weren't using the telephone lines. We designed a piece of equipment called the Subscriber Pair Identifier, which was an advanced electronic test system that allowed TELCO to reconcile consumer usage with billing. This reconciliation exercise was necessary as billing often got muddled, some people got billed incorrectly and some people didn't get billed. Technicians would manually reconcile the records and it would take many days and there were many errors. It was very, very inefficient. The Subscriber Pair Identifier, which we patented, automated the process. It was accurate, fast and saved a lot of money. We designed everything including circuit boards. The parts were made in Miami and elsewhere and brought back in, and we assembled the boards locally. This was quite revolutionary for that time. We were very proud of this feat. We sold the equipment (USD$10,000 for one) to the Barbados Telephone Company and the Bahamas Telephone Company. It was on its way to being something TELCO could develop for Trinidad and Tobago. Unfortunately, 49 per cent of the company was sold to Cable and Wireless. The CEO figured that we didn't need to do any research here. I remember in one of his memos to us he put research in quotation marks. In other words, "you are not doing real research, Cable and Wireless has labs in the UK. We don't need any research in Trinidad and Tobago." So the lab was closed. We didn't continue with that beautiful experience of designing equipment locally which had export potential. At TELCO, we had in our hands a kernel for developing Trinidad and Tobago's research and development sector that could have mushroomed. Sadly, it was snuffed out in its early days. After this experience, I returned to UWI in 1995.

Aside from that I have designed important circuit elements- active filters, instrumentation amplifiers, current and voltage amplifiers and precision rectifiers. The goal of my research is to improve existing circuit designs. I've just completed a book on Electronic Circuit



Design with a colleague, Professor Brent Maundy, from the University of Calgary. I've also published over 50 peer-reviewed papers in electrical engineering.

I am also particularly proud of my work on the Calculus of Variation. Calculus was invented by Newton and is used in engineering and physics. There is an area called the Calculus of Variations which is about finding the best way to do something. Calculus of Variation is central to Optimal Control Theory. There are things called necessary conditions. That is to say, the solution to a problem must satisfy four necessary conditions. If you have a proposed solution that doesn't satisfy one or more of these, it is wrong. If it satisfies all four, it has a chance of being right. I felt there should be a fifth one. I published a pretty extensive paper where I developed new proofs, arguing for a fifth necessary condition.

I have also published on Relativity. The foundation of Special Relativity is that the speed of light is always constant; it never varies, even if you are running towards the light or running away from the light, it will always pass you at the same speed. I have shown with the Global Positioning System that light speed is not constant and in fact light travels faster west than east.

Q: ***Would you recommend a career in science to today's youth?***

A: We need more people trained in the applied sciences - applied physicists, applied chemists, engineers and so on. We need indigenous design and development of technologies, products and services that can compete on the international markets. Technology is the way of the world, smart phones, mobile computing, and various fascinating technologies. There's a need for people to design and develop technologies, so the opportunities in Science and Technology abound! There is a global industry of research and innovation where people are designing and developing things for sale in the international market place. Trinidad and Tobago must develop its scientific and technological research sector. Countries with strong research and innovation capabilities have strong, resilient economies. It is a deeply fulfilling experience to contribute to the development and sustenance of your country.

Shirin Haque

Blazing a Trail of Stars

About the Icon

Education:

- *TML Primary School, St Joseph*
- *St Augustine Girls' High School*
- *BSc (Honours) Physics, The University of the West Indies, St Augustine, Trinidad, 1987*
- *MPhil Physics (Astronomy), The University of the West Indies, St Augustine, Trinidad, 1992*
- *PhD Physics (Astronomy), The University of the West Indies, St Augustine, Trinidad and The University of Virginia, USA, 1998*
- *MPhil Psychology, The University of the West Indies, St Augustine, Trinidad, 2015*

Awards:

- *The Rudranath Capildeo Award for Applied Science and Technology (Silver), NIHERST Awards for Excellence in Science and Technology, 2013*
- *Women in Science and Technology Award, NIHERST, 2011*
- *Vice-Chancellor's Award for Excellence in Teaching, The University of the West Indies, 2005*
- *Distinguished Teacher Award, Association of Atlantic Universities, 2004*
- *Teaching Award, The University of the West Indies and Guardian Life Premium, 2002*

Other Achievements:

- *Over 30 refereed papers in scientific journals*
- *40 popular science articles*

Current Post:

- *Deputy Dean, Undergraduate Student Matters, Faculty of Science and Technology, The University of the West Indies, St Augustine, Trinidad*

Dr Shirin Haque was born in the village of Patna, India and came to Trinidad at the age of seven without being able to speak English and having no formal education. Despite this, she excelled academically and moved from kindergarten to St Augustine Girls' High School within just five years. Today, she is the only astronomer in the Caribbean region. Dr Haque has pioneered the cutting-edge field of Astrobiology at the University of the West Indies and was interviewed by the BBC for a feature Science in Action for her novel work on the Pitch Lake, the largest natural hydrocarbon lake in the world. Her work also appeared in the Australian Broadcasting Channel impressing top scientific leaders and attracting them to our island. She is the founding member of CARINA (Caribbean Institute of Astronomy) and holds numerous teaching awards from the UWI. Her unique passion and approach can be the reason for this from her popular brownie question of the week to her demos of astronomical theories using a Winnie the Pooh stuffed toy. She has also distinguished herself as a film producer with three science documentaries. She is currently the editor of the magazine "The Intellectual – Art, Science and Architecture".

NIHERST interviews Shirin Haque

Q: ***You came to Trinidad from India at the age of seven Was it a difficult transition?***

A: When I came to Trinidad, I could not speak English, nor did I have any schooling. To help with the transition my mum would talk to us in Hindi, and dad would speak to us in English, it wasn't too long before I caught up. I became bilingual quite easily. At the age of seven I began primary school and started learning English. From there I did the Common Entrance and passed for St Augustine Girls' High School.

Q: ***You were born in India but spent most of your life as a citizen of Trinidad and Tobago. Where do you consider home?***

A: Honestly, home is Trinidad and the Caribbean; this is where my spirit is now.

Q: ***You were always interested in astronomy and your family knew about it from the early age of five. Did they encourage this interest?***

A: I have been interested in astronomy for as long as I could see the skies overhead. I have a distinct memory of looking overhead while in India and thinking that the sky was like this bowl over us and I wondered what those lights were. I was always excited when my parents got me a book or magazine subscription on astronomy. At around age seven in Trinidad, I got a great little book on the night sky. I often used my father's binoculars to look up to the skies.

Q: ***Your parents had an interesting approach in guiding your academic path. How did this lead you to becoming an astronomer?***

A: My father never told me what to become. Despite being a scientist he never said you must be a doctor, a lawyer or an engineer. This was a blessing as it allowed me to follow things that just caught my eye, the things I am passionate about now.

Q: ***How did you start charting a career in your passion, astronomy?***

A: After pursuing a first degree in physics, I had this inkling that I wanted to do astronomy. I signed up for an MPhil in physics with a focus on astronomy. From there I did a PhD in physics and astronomy with the University of Virginia, USA.

Q: ***Was it smooth sailing for you at the tertiary level?***

A: While I enjoyed success I did have my periods of failure, which I tried to hide for a long time. I actually did not enjoy high school as I was never really quite comfortable. However, I found myself at university; it gave me that element of freedom. Today, as Deputy Dean of student matters in the Faculty of Science and Technology, I deal with students who are struggling and failing. I talk to them and let them know that they are not alone and they have support.

Q: ***In choosing a career path in astronomy, were you concerned about the limited scope for employment in this field in the Caribbean?***

A: I knew that securing employment could be difficult but I decided to take that risk. However I had decided that if I could not be employed as an astronomer, I would be content with teaching physics as I love it and the areas are related. I got lucky.

Q: ***Were there any role models that encouraged you to the field?***

A: I could never owe enough to Carl Sagan. I never met him but I wish I did. When I was growing up there was this televisions series Cosmos which had such an impact on my life. I would tape every episode. If there's any individual I really owe my continuing and becoming an astronomer to, it is Carl Sagan.

Q: ***When you started your career you pursued theoretical astronomy but at UWI you became instrumental in establishing the first obseravtional astronomy observatories in Trinidad and Tobago so you had to learn about observational astronomy. However, that is not where you are at present. Can you explain your new field?***

A: Right now, I am working on something we call Astrobiology. It has taken me to the pitch lake and mud volcanoes; someone would think that I am a geologist but astrobiology is actually a mixture of astronomy and biology. It is the study of living organisms and how they have arisen in the entire universe and how they proliferate. Decades ago this term would not have been seen in a textbook but it is now the big attempt to answer questions about life in the universe. It is a multi-disciplinary field that requires input from chemistry, physics, geology, sociology, you name it.

Q: ***Is your work in the Pitch Lake pioneering?***

A: This is the first time that astrobiological work is being done in the region. It's a collaborative project with institutions such as Washington State University, Columbia University

and the University of Turku in Finland. It aims to discover the limits of life in the universe.

Q: ***Why was Trinidad chosen? What is the relationship between the Pitch Lakes, mud volcanoes and astronomy?***

A: At this technological stage we can't go off to Mars or Titan (Saturn's largest moon) to bring a sample back and test it to see what's going on there. So one approach is to look at what we call analog sites on earth that may be similar. On Mars there are many geological features which are mud volcanic in appearance and several reports of methane presence on the planet which is an indicator that there might be microbial life there. The bubbling you see at the mud volcanoes consists of methane gas. Similarly, our tests show that there are large amounts of hydrocarbon on Titan. The Pitch Lake in La Brea Trinidad is a hydrocarbon lake with the presence of methane gas. We therefore use these sites to explore the possibility that any microbial life could exist on Titan or on Mars. We are proud to say that the team from Helmholtz's Institute in Germany and Washington State University actually published a paper based on this work in Science, one of the top journals.

Q: ***What is your role in developing Observational Astronomy at UWI?***

A: Before I began work at UWI, there was never any observational astronomy research, everything was theoretical. The University of Turku in Finland donated a telescope to the Department of Physics and we established St Augustine and Tuorla Observatory (SATU), one of the first observational research observatories in the Caribbean. It was established to carry out a project in conjunction with Finland which was monitoring a quasar (a distant object powered by black holes) that they were unable to observe at all times due to their location. Trinidad's location allowed us access to the quasar and so we were able to assist. The project made it to the top 100 science projects in Discovery magazine several years ago because it was the first evidence of a binary black hole system that had been found.

Q: ***You were on a BBC Science in Action feature in 2008, highlighting your work on astrobiology. How did that come about?***

A: After watching astronomer Paul Davies on BBC Hardtalk we invited him to Trinidad to do a lecture. As he had an interest in astrobiology, I took him to the Pitch Lake and he was fascinated by the work. His wife who worked with BBC decided to do a feature which was broadcast worldwide and I realized that things will happen, serendipitously.

Q: ***What has been your contribution to physics at the secondary school level?***

A: I go to the schools and ensure students know that law, medicine and engineering are not the only careers they can pursue. I am also involved in the revision of the CSEC physics syllabus. You can't change physics, but you can change how you teach it by highlighting contributions of local scientists in the syllabus.

Q: ***You have played a major role in popularising science through your documentary series. Which productions have you completed and what inspired you?***

A: Sometimes I think that I have a degree from the "University of Television" because almost everything I know is from television. While watching an amazing documentary one day I realised that there were no good local science documentaries. While I did not have any experience in production I bought a few books and soon after completed my first feature Adventures in Discovery in 2008, which was filmed across Montserrat, Antigua, Trinidad and Tobago. Afterward we did another called All is Number to highlight the relevance of mathematics in daily life and the final feature was Losing Paradise, which focuses on the turtles in Matura, those who seek to protect them, and the havoc caused by bushfires. I am currently working on the fourth project which features my work on the mud volcanoes and the pitch lake.

Q: ***Talk about your work linking psychology and physics.***

A: I was always interested in psychology so when the opportunity arose, I decided to pursue it. My research project was on the impact of life events with time and naturally I found a way to incorporate physics. I took wave modelling concepts from physics to portray how waves behave and likened it to how our experience with life events with time can be. We could put a mathematical creation to how you will experience good and bad things, and then build up a model of your happiness factor. I was always interested in linking psychology with physics. I was proud to graduate with the MPhil in Psychology after pursuing it simply for personal interest.

Q: ***You have used your own personal challenges to excel professionally as a teacher with numerous teaching awards. How did this come about?***

A: I understand failing students because I was there once. I have had times of failures and times when things worked out. Years ago, I applied to engineering and was devastated when my application was declined but today I look back and I know that's the best thing that could have ever happened to me.

Q: ***You have encouraged students with "crazy passions" to pursue that field. Why do you suggest this?***

A: I advise that they go for it because they will excel. It may be random but you find that success is realised anyway. Remember, your life has a path and if it's not happening for you maybe it's not for you.

Q: ***Do you feel that the scientific field of astronomy has received less than it is due?***

A: Astronomy is one of the areas in science that has a mass following but minimal professionals in the field. There are a large number of amateur persons and societies but probably only about ten thousand astronomers in the world. That number is quite small.

Q: ***What has been your observation about women in science education?***

A: In the Caribbean women are doing quite well in science compared to other parts of the world. However, while there are more women in science, they still hit the glass ceiling and do not make it to the top positions. I was the first female Head of Department of the Physics Department at the UWI.

Q: ***Given your deep interest in research and field work, how did you come to be an administrator?***

A: Most people who go into science do not typically aspire to be a Head of Department or a Deputy Dean. Somewhere along my career path, I ended up in administration and though it takes away from my original passion, somebody's got to do it. I would do anything to create opportunities for my students, especially the ones with the crazy dreams that nobody wants to listen to. We have sent undergraduate students to observatories abroad and ensured they are engaged in important science projects.

Q: ***You have received many university teaching awards, internationally and in T&T. What makes your approach to teaching so different?***

A: I love teaching and dealing with young people. I get excited about it and I think excitement is contagious. Students often get bored when they do equations that don't relate to anything but if you can make that connection like Carl Sagan did, they become more interested.

Q: ***What advice would you give to students as they pursue their academic careers?***

A: As you go through life, nothing is going to stay the same; there will always be changes. Sometimes at the height of what you are doing, you will hit a down period. Persistence is truly the key to success. In life, always try to give more than you take. My career has not been success after success and for that I am actually very grateful because failure taught me empathy and understanding.

Rajini Haraksingh

Reader of Genomes

About the Icon

Date of Birth: *04 June 1982*

Education:

- *The University School, St. Augustine*
- *St Augustine Girls' High School*
- *BSc Mathematics and BSc Biology, Massachusetts Institute of Technology, USA, 2005*
- *IB Mathematics and Natural Sciences Tripos, Cambridge University, United Kingdom, 2003-2004 (Cambridge MIT Exchange Program)*
- *MSc Molecular, Cellular and Developmental Biology, Yale University, USA, 2008*
- *PhD Molecular, Cellular and Developmental Biology, Yale University, USA/Stanford University, USA, 2012*

Awards:

- *The Frank Rampersad Award for Junior Scientist (Silver), NIHERST Awards for Excellence in Science and Technology, 2013*
- *Class of 1933 Kimball Scholarship, Massachusetts Institute of Technology, 2001-2003*
- *Bronze Medal, International Mathematics Olympiad, 2001*
- *Highest Academic Achievement and Best All Around Student, St Augustine Girls' High School,1998*

Current Post:

- *Lecturer, Department of Life Sciences, Faculty of Science and Technology, The University of the West Indies, St Augustine, Trinidad*
- *VP of Patient Research, Rare Genomics Institute, USA*
- *Researcher, Eastern Caribbean Health Outcomes Research Network, USA*

Dr Rajini Haraksingh is a human geneticist whose studies on genomic variation have yielded information to improve understanding of the effects of this variation on complex human diseases. A graduate of St Augustine Girls' High School (SAGHS) in Trinidad and Yale University in the United States, she initially pursued studies in math and biology before embarking on a career in genetic research. As a researcher, she has examined genetic variants and their expressions in illnesses varying from hearing loss to schizophrenia.

Dr Haraksingh is currently the vice president of Patient Research at the Rare Genomics Institute, an international non-profit which connects patients suffering from rare diseases to diagnostic and therapeutic solutions using genomic sequencing. Their work has been featured in the cover story of Time magazine as well as Forbes magazine, the Wall Street Journal and The Huffington Post, among others.

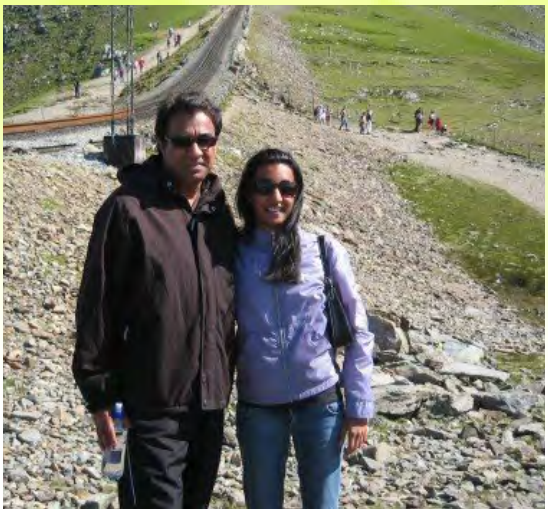
After completing her training abroad, she returned to Trinidad in 2015 to lecture in the Faculty of Science and Technology at the University of the West Indies, St Augustine Campus and recently joined a team that is exploring the underlying genetics of chronic Caribbean diseases. A true academic, Dr Haraksingh has co-authored several scientific papers and aspires to continue researching the ways in which our genomes define us and sharing this information through teaching and advising.

NIHERST interviews Rajini Haraksingh

Q: ***What were your early years like?***

A: I grew up in St Augustine, Trinidad with my parents who both lectured at UWI. I was quiet but not exactly shy. Education was kind of the prime endeavour in the household. It was expected that I would excel at school. I enjoyed the academic lifestyle and the intellectual freedom that came with it. We always had interesting people visiting. I spent most of my childhood in a five-minute radius. My home, schools and extracurricular activities were in a small geographic space, but I don't think this limited my view of the world. As an only child I spent





a lot of time alone and daydreaming; in fact I still enjoy daydreaming. I was always very active, from dancing and piano to swimming. My parents thought I should reduce the number of activities I did but I was able to balance them and they gave me a true holistic experience.

Q: ***Tell us about your schooling from primary school onwards.***

A: I went to the University School which provided a very well-rounded environment and then to SAGHS which empowered me and gave me a lot of confidence that has helped me to this day. I did drama and dance, I was a prefect, vice-captain and was always involved and organizing something. One thing I did not like was having to choose eight subjects for O levels. I was very interested in learning and thought narrowing my choices at a young age was ridiculous and unfair, in the end I took 10 subjects for O levels. I then went to Massachusetts Institute of Technology (MIT) to do my degree and spent a year abroad on an exchange program at Cambridge University in the UK.

Q: ***Do you think that one of the fundamental flaws in our education system is that we almost force kids down an avenue from very early?***

A: I'm in two minds about that. I think getting in-depth knowledge of varied subject matters at that age is important, but we have to train people to realise that choosing a particular subject as a teenager does not limit you to that field. Especially nowadays as information is easily accessed through the Internet, you could learn anything you want to learn at any age.

Q: ***Were you intimidated at all moving from SAGHS to an institution like MIT?***

A: I wasn't. I think my upbringing gave me confidence. I was very involved in the Trinidad Math Olympiad and International Mathematical Olympiad while at SAGHS. Through that I met a lot of my future MIT classmates and Trinidadians who were at MIT. In that way I was able to get a preview of what it would be like. Going to MIT was not a foreign idea; it was something I saw as very attainable. However, when I actually got to MIT things were a bit different. I was thrown into an environment where everyone was accustomed to being the best but we were now average. There was a lot of pressure to remain the best and that was difficult. In my third year I went to Cambridge on an exchange programme as I had always wanted to go to Cambridge but did not get in when I applied after SAGHS.

Q: ***How did you deal with that rejection?***

A: I felt rejected and sad especially since I expected to get in. Looking back though it was for the best. If I went to Cambridge I would have only been able to study math which would have limited me. The year I spent there was inspiring and fascinating though; the education system was very different from MIT. While they were both very rigorous, at MIT I felt that we studied more in groups while at Cambridge everything was much more individualised.

Q: ***So when did you narrow down your field to biology and mathematics?***

A: At A levels I chose chemistry, biology, mathematics and further mathematics, and I liked mathematics especially. Then at the undergraduate level I wanted to do something more practical so I did biology and mathematics. That was exciting as I started MIT right after the human genome project had just been announced and that propelled me into genetics.

Q: ***Are there any significant life events or persons that directed you down the path that you've taken?***

A: My participation in the International Mathematical Olympiad and the International London Youth Science Forum had great influence. I met students from all over the world. International experiences are great for students as they give them confidence to compete on an international level. My parents have been the most influential mentors and my teachers as well. A lot of my inspiration also comes from people I knew who were doing great things, rather than the big names you hear, and that's why we need to bring scientists into contact with the public. That direct link can inspire young people and help them realise that their dreams are attainable.

Q: ***We definitely agree, exposing young scientists to people like you is undoubtedly inspirational. Tell us about your work. What is the link between genomes and phenotypes and how does that impact on your work?***

A: I study the human genome which is an individual's complete set of DNA. DNA is a linear molecule so you can think of it as a long sequence of letters. The human genome consists of almost 3 billion "letters" of DNA sequence arranged in 23 pairs of chromosomes found in the nucleus of each cell in our bodies. We also have mitochondrial DNA that is found in the mitochondria of cells and this very tiny subset of our DNA is responsible for energy production. The sequence of the letters in the DNA is what encodes information about how that cell, and thus that entire individual, is built and functions. What I study is how the information encoded in the DNA translates to phenotypes (physical traits) about cells or organisms. This is fascinating as this information is what drives who you become. Human beings have always had questions about our origins and with the sequencing of the human genome project we are able to read and understand this information.

Q: ***What are the implications of this new understanding we have about genetics?***

A: Being able to read a genome means that we now have the instruction set to build an organism. In medicine we can now understand what the normal genomes look like versus mutated and diseased genomes, and this helps us understand disease development. With this information we can also engineer plants and animals to provide food and other necessities.

Q: ***You were involved with the 1000 genome project. Can you tell us more about it?***

A: Let's start with the human genome project. In the 1950s, the structure of DNA was discovered and we knew then that it was the molecule responsible for heritable traits. But we were unable to read what was in that DNA until the human genome project which produced the first whole sequence of a human genome in 2001. The Human Genome project took more than 10 years, hundreds of scientists and almost 3 billion dollars (US). The project was a huge triumph in terms of understanding ourselves genetically. But this was only one genome. After this we started the 1000 genome project to understand the differences among human genomes. We wanted to curate and categorize variation among human genomes. I was one of several hundred scientists and I studied a particular type of variation between genomes known as copy number variation. Copy number variation encompasses deletions or duplications of large chunks of DNA in one genome relative to another. These variants can result in disease traits or normal benign traits, and many are favoured in evolution, making them quite beneficial.

Q: ***What are you studying currently?***

A: During my PhD I studied methods to map where the copy variations occurred in human genome. We now have a good understanding of even more variations which helps us identify what is normal versus what is pathogenic. We study people with a trait and those without, and then try to figure out what's different. I just did a study where we were able to see a large per cent of the people with hearing loss actually shared the same deletion of a particular gene in their genome.

Q: ***We know that you are involved in a study of personalised medicine. What is that?***

A: Personalized medicine refers to a shift in the way that we

treat patients. Usually, if you have a particular disease we administer the standard treatment that anyone who has that disease would receive. However, people may have individual rare conditions due to mutations on the molecular level, which cause common illnesses like diabetes. With personalised medicine we investigate what is causing your diabetes at the molecular level and apply personalized treatment. This has worked in breast cancer patients where, by targeting treatments to the specific molecular mechanism that has gone wrong, we can administer effective treatments with less side effects. We hope that in the near future, in the same way that we know our blood type, we will know our genome sequence. This will transform the way that medical care is given as it will be truly personalized.

Q: ***How far away do you think are we from personalized medicine becoming the norm?***

A: It's coming! During my PhD we collected my advisor's genetic information and tried to build a model that could predict occurrences in his body on a molecular level. We detected that he was pre-disposed to diabetes, then through testing over time saw him develop diabetes, and were able to intervene and see at the molecular level that it was resolved. We are seeing personalized medicine trickle into the clinics now especially for sub-typing cancers and determining more targeted treatments rather than using systemic chemotherapy or radiation.

Q: ***What other projects are you working on currently?***

A: I am currently working on the Eastern Caribbean Health Outcomes Research Network (ECHORN) project. It is a collaboration among several universities designed to understand the role genetic factors play in non-communicable diseases like heart disease and diabetes which are prevalent in the Caribbean.

Q: ***How would you describe the field of genetics in Trinidad and Tobago, and what are the future prospects locally?***

A: I see a lot of prospects for applied genetics in this country. We already have a living curation of all the cocoa genes that exist on our planet at the International Cocoa Genebank. We have done work on animal breeding, for example the buffalypso. I think one of the biggest prospects for genetics in this country is in the field of medicine. We have a unique population with unique genomes and hence unique genetic variants that may be responsible for the state of our health. By studying our genomes we should be able to resolve the root molecular causes of many diseases to which our population is particularly prone, such as diabetes and heart disease. This would allow us to develop more personalized clinical diagnostics and treatments for our population. We can also apply genetics to developing treatments to diseases that have become huge public health concerns, such as the chikungunya virus.

Q: ***Would you encourage T&T students to venture into genetics?***

A: Yes, but first they need to know that genetics is an option and that is why NIHERST'S projects are valuable. They expose students and the public to science, they show them the vast array of options which exist. NIHERST is absolutely critical in the development of science and technology and scientific capacity. The organisation helps people to understand and digest what's happening in the world.

Q: ***International statistics show disproportionately fewer women in STEM fields. Have you seen this in genetics and if so, what can be done to address it?***

A: In genetics I haven't faced any discrimination based on my sex but biology is different from the other sciences like mathematics and engineering which are more dominated by men. We have to encourage and allow girls to pursue careers in STEM. They need to know that gender does not matter when it comes to dreams. This is embarrassing, but I didn't learn to code for some years because I thought coding was for boys. That was very silly of me. The fact that many women raise families which is a full-time job by itself is also a factor which affects the number of women in high level positions.

Q: ***Do you have any hobbies outside your field?***

A: I like to be active. I've been a dancer my whole life and have done a couple half-marathons. Last year I did a US dance tour which was fun but intense. I enjoy being busy and prioritising effectively. I'm learning now in preparation for when I have a family. I also love doing yoga and having afternoon tea.

Rohanie Maharaj

Through the Glass Ceiling

About the Icon

Date of Birth: *26 March 1965*

Education:

- *D'Abadie Government Primary School*
- *St Joseph's Convent, St Joseph*
- *BSc (Honours) Major Analytical Chemistry, The University of the West Indies, St Augustine, Trinidad, 1986*
- *MSc Food and Technology, The University of the West Indies, St Augustine, Trinidad, 1988*
- *MPhil Food and Technology, The University of the West Indies, St Augustine, Trinidad, 1991*
- *PhD Food Science and Technology, Université Laval (Laval University), Québec, Canada, 1995*

Awards:

- *The Rudranath Capildeo Award for Applied Science and Technology (Silver), NIHERST Awards for Excellence in Science and Technology , 2013*
- *Award of Excellence, Johnson and Johnson Caribbean, 2005*
- *George F Stewart International Research Award, 1993*
- *Research Grant, Natural Sciences and Engineering Research Council of Canada, 1991-1995*
- *Research Studentship, Organization of American States and NIHERST, 1987-1990*

Other Achievements:

- ***Over 40 publications including 3 co-authored books and 10 book chapters***

Current Post:

- *Programme Leader, Food Science and Technology (BSc, Diploma, Certificate) and Associate Professor (Biosciences, Agriculture and Food Technologies), The University of Trinidad and Tobago*

Despite the tremendous progress made by women over the last 50 years in all areas of professional life, the gender gap remains wide in most countries, and especially in historically male-dominated arenas like business and industry, and in the Science, Technology, Engineering and Mathematics (STEM)-related activities that drive them. A UNESCO study on Women In Science (2015) found that only 30 per cent of the world's researchers are women. In the United States of America, women hold fewer than 25 per cent of STEM jobs, according to a Department of Commerce study. Dr Rohanie Maharaj defied the gravitational pull of gender bias to rise to leadership positions, in both the corporate world and academia.

NIHERST interviews Rohanie Maharaj

Q: ***Your parents were entrepreneurs and farmers and you pursued career paths promoting enterprise and innovation, particularly within the agricultural sector. Is that a coincidence or was it a more direct influence?***

A: I never thought about that actually or made that connection. It would have to have been a subconscious influence. I grew up in D'Abadie near the Trestrail farm. I loved sitting on my back porch experiencing the serenity of the environment, the greenery and animals around. I really just gravitated towards the sciences, not really thinking about why. After my A levels, I didn't know what I wanted to do. I got a job at Penta Paints as a laboratory technician, and found myself so engrossed in that job. I simply enjoyed just being in that lab environment, creating, mixing and analysing paints. I think my true love for science started because of that experience. But it was in the final year of my BSc in Natural Science with Chemistry major that I took a course called Elements of Food Technology, taught by the late Professor George Moon Sammy. He was really an inspiration for me. I loved listening to him and that's when I realised, "Hey, this is what I want to do." So it was really having had such a gifted teacher and mentor that I pursued Food Science and Technology, which aligns with Agriculture and Entrepreneurship. My MSc, MPhil and PhD were all in that field.

Q: ***What did you study for your postgraduate work?***

A: I did a lot of research on tropical fruits and vegetables, looking at improving post-harvest storage practices. For my MSc, I worked on papaya and for my MPhil I researched the breadfruit. I was able to enhance the post-harvest storage life of mature breadfruit by more than 35 days under a combination of refrigeration and controlled atmosphere storage where the air surrounding the fruit was optimised to precise levels of five per cent oxygen and five per cent carbon dioxide at 16˚C. Compare that to how quickly it turns overripe in two to three days under ambient conditions. Fruits and vegetables breathe, they take in oxygen and give off carbon dioxide and also transpire i.e. give off water vapour, leading to senescence and decay, which ultimately results in death of the crop. Storage conditions like modified and controlled atmosphere reduce oxygen and increase carbon dioxide levels surrounding the crop. This retards the process of senescence and increases longevity.

With breadfruit, farmers cannot earn as much because of the high post-harvest losses that occur due to the high respiration and transpiration rates of breadfruit. Using technologies such as refrigeration in combination with modified or controlled atmosphere storage, you can delay ripening and senescence so you have breadfruit in this green state that can be stored for longer periods and used for further agro processing.

My PhD research at Laval University in Canada tackled this from a new dimension. It was on the effect of ultraviolet radiation technology on post-harvest storage of tomatoes. I was looking at abiotic stress, which is stress created artificially using radiation that elicits the production of defence compounds – phytochemicals – in plants. Phytochemicals are beneficial compounds derived from fruits and vegetables. Apart from basic nutrition, they fight off diseases and that was part of my research. I used the tomato fruit because it was also a tropical crop and I wanted my research to be applied when I returned to Trinidad. I got very good results. The research showed that the defence compounds are activated as a result of the stress produced delayed ripening and senescence. It was pioneering research and in fact I received the George F. Stewart Award for best international research paper and presentation at the Institute of Food Technologists meeting in Chicago in 1993.

Q: ***How was it pioneering?***

A: Very few people had done research on abiotic stress through the use of artificial ultraviolet C radiation for delaying senescence in crops at that time. There wasn't much work using artificial radiation to show beneficial responses to stress. You know when you are stressed out you can often have detrimental reactions to the stress. Stress can often lead to death. We were trying to stress crops to elicit beneficial responses, i.e. health benefits through elicitation of bioactive compounds which not only fight off diseases but have a role to play in diet and nutrition. There's a lot of research now on phytochemicals and their effects on humans in terms of fighting cancer and diabetes. It is the same phytochemicals, such as flavonoids, protecting the plants that humans can get those benefits from.

Abiotic stress can produce these bioactive compounds which ward off diseases. Artificial radiation generated by UV lamps is used in hospitals to sterilize equipment because of its germicidal properties. Such radiation can kill off micro flora. However we used it not only for disease

prevention but for retardation of ripening and senescence of fruits and vegetables, through the activation of these phytochemicals.

Q: ***After your PhD, you returned to Trinidad and worked for 12 years for the multi-national conglomerate, Johnson and Johnson. What did your work there involve?***

A: I started as a Quality Assurance Manager and moved my way up through several promotions, including Operations Director of the Trinidad manufacturing facility and a member of the Board of Johnson and Johnson (Caribbean). Working with that company gave me depth and breadth of exposure as it was a very performance-driven company. You had to achieve targets. I was able to accomplish quite a lot there. For example, we had to manufacture and re-engineer local products for export to US-based markets like Puerto Rico. We would do some research and development work which involved stability studies for raw material and packaging substitution trials, to be able to create dossiers for registration of such products for these markets, thus enabling the export of pharmaceuticals, consumer healthcare products and even medical devices. The US is a highly regulated market. To get Food and Drug Administration (FDA) approval, required a lot of data from research, clinical trials and stability studies, etc. For many of the products, we re-engineered to be able to sell the products there. We came up with low cost formulations for products like Savlon and baby soaps and we re-engineered the technology for adult disposable diapers. We outsourced products to third party contract manufacturers which improved quality standards for those manufacturers. I was responsible for the quality assurance and regulatory compliance, making sure those products met the standards and were registered in those markets.

Q: ***Was there research and development work taking place here in terms of innovation?***

A: It was more technology transfer and adaptation, but innovation came from research on raw material substitutions for cost savings or process modifications for improved efficiencies. But there were also things we developed from scratch like shampoos and conditioners, adult soaps, etc., with our own ingredients and product formulations. I also had responsibility for companies in the Johnson & Johnson Caribbean group of companies regionally, in Trinidad and Tobago, Jamaica, the Dominican Republic and Puerto Rico. I oversaw regulatory activities, working with manufacturers and third party suppliers to ensure we met the standards and regulations of countries we exported to. I was tasked to obtain the ISO 14001 environmental certification of the Trinidad manufacturing plant. It took us a few years to get that certification but I felt that was a great accomplishment for my team and I when we met those international standards.

Based on those experiences, I co-authored three books with some of my colleagues from the US, on environmental compliance, health and safety compliance, and process safety management and management systems.

Q: ***You were one of few female heads in that international corporation. What was your experience from a gender perspective?***

A: I was the only female head on a Latin American team representing manufacturing companies from Trinidad and Tobago, Venezuela, Colombia, Argentina and Brazil. We reported to the Vice President of Operations in Brazil and every quarter, I flew to Brazil to present on the performance metrics of the Trinidad manufacturing plant. I was only too proud and excited because each time we would be number one, exceeding our production quotas and equipment efficiencies. My male counterparts in Latin America were very envious! But in Trinidad, we were a small, family-oriented company. We had great machine operators and engineers who were very innovative and creative people. We could have turned around anything. When the Managing Director or Sales Department would call with a sudden or urgent request, we would work 24/7 to make products or pack a container. Literally it would happen overnight and with the quality requirements because of my quality background. So my colleagues really respected me and the Latin Americans would come to Trinidad to see how we did things. There was great camaraderie and I learnt a lot from them too.

Q: ***In 2009 you left the corporate world to take up a position at The University of Trinidad and Tobago [UTT]. What has that career shift been like for you?***

A: After 12 years at Johnson & Johnson, I felt the need for change. I wanted more balance in my life, time for my family, and also the opportunity to teach, conduct research and to develop and mentor young people. As an entrepreneurial university, UTT was a good fit for me coming from industry. I could use the knowledge I had acquired and include it in my courses. I was hired as an Associate Professor in the Biosciences, Agriculture and Food Technologies unit. It was a new unit with just a few people and I was charged with developing the curriculum for, and teaching, food technology. So I was working on things I knew well. I launched the three year Bachelor of Science degree in Food Science and Technology, a two year Diploma in Food Technology and last year, the Certificate in Food Technology.

Q: ***You are also engaged in research at UTT. What are your areas of focus?***

A: I continue to conduct research in my area of specialisation – post-harvest technologies for fresh fruits and vegetables. I secured a grant from McGill University as part of a CARICOM food safety and food security project for the region, which helped me jump-start my research work at the UTT. The research involved physical, chemical and microbiological hazards in crops and foods prepared from such crops and actually testing crops grown in Trinidad and St. Kitts for food safety parameters such as pesticide residues, heavy metals and microbiological contamination in fresh fruits and vegetables grown in open fields and greenhouses. We also investigated food safety issues around prepared school meals and, more recently, on street food, examining the necessary quality systems and infrastructure that need improving, with respect to public health. This is very important in the absence of updated national food safety legislation to monitor and enforce quality and safety practices, from primary production to manufacturing and consumption, i.e. from farm to fork.

From a regulatory, quality and food safety perspective, we need to ensure whatever we do locally is of very high standards for international export. Our laboratories must be accredited and state-of-the-art, and our employees trained in best practices. So that's some of the work I'm doing as part of my industry outreach activities to ensure that manufacturers are competitive.

Q: ***For women in the workplace, having a family and children is often a big obstacle to getting the highest levels. How did you manage?***

A: In reality, it's still a man's world. You see it at board level and most CEOs are male. For a woman to make it to the top, she can't have her cake and eat it. We often have to take decisions which may not be in our best interest in terms of our personal lives. In order to achieve what I did at Johnson and Johnson, to put in those hours, I had to make many sacrifices in my personal life. You have to give up something. So there was that guilt as well, as I missed out on opportunities with my children growing up, attending school functions, etc. Luckily, I have great family support, my mom, my siblings and my husband. They helped and gave me that freedom to be what I wanted to be in my career. My husband especially took charge. He would take care of the children, dropped them to school and even cooked. I am forever grateful to him for giving me that opportunity.

Lexley Pinto Pereira

Pharmacologist of Medicines and Poisons

About the Icon

Date of Birth: *27 March 1948*

Education:

- *St Anne's High School, Bombay, India*
- *MBBS, Grant Medical College, University of Bombay, India, 1970*
- *MD Clinical Pharmacology, Grant Medical College, University of Bombay, India, 1974*

Awards:

- *Emmanuel Ciprian Amoroso Award for Medical Sciences (Silver), NIHERST Awards for Excellence in Science and Technology, 2013*
- *Award for Dedicated Service to the Pharmacy Profession, The Pharmacy Board of Trinidad and Tobago, 2003*
- *Vice-Chancellor's Award for Excellence in Teaching, The University of the West Indies, 2002*
- *Rhodes Trust Award, The University of Oxford, 1994*

Other Achievements:

- *Over 70 peer-reviewed publications*

Current Post:

- *Professor Emerita of Pharmacology at The University of the West Indies, St Augustine, Trinidad.*

A Clinical Pharmacologist of drugs and therapeutics, Professor Lexley Pinto Pereira is distinguished as the only clinical pharmacologist in Trinidad and Tobago. Among her achievements is the key role she played in establishing the country's Poison Information Centre, now at the Sangre Grande Hospital and the initial National Drug Formulary used by all resident physicians. Her ground-breaking research on chronic respiratory and metabolic disease yielded significant information on conditions associated with asthma in children and adults, and contributed to the development of the Caribbean guidelines for asthma.

Professor Emerita of Pharmacology at The University of the West Indies, she is an inspiration to her students and has been described as a "tireless educator of pharmacology". She has contributed greatly to the advancement of the Department of Paraclinical Sciences under the Faculty of Medical Sciences at The University of the West Indies. She is the primary architect of the curriculum in Pharmacology in the medical programme and introduced the relevance of clinical pharmacology applications in the programme. She was the first academic in the country to mentor postgraduate students in Pharmacology. Her contributions to medical education in the Caribbean led to her receipt of the UWI Vice Chancellor's Award for Excellence in Teaching in 2002.

NIHERST interviews Lexley Pinto Pereira

Q: ***Trinidad has been your home for the past 25 years but you were born in India. What was it like growing up there?***

A: I was born and brought up in Bombay. I am the youngest of six children, life was tough, hard and happy. My mother gave up her career as a headmistress to take care of the family so my father, a medical doctor, was the sole breadwinner. The cost of living in Bombay is extremely high so I think they did a good job ensuring all the children were educated to the postgraduate level. I spent a lot of time studying but I also spent a lot of time with my brothers. I was a bit of a tomboy and played a lot of hockey, cricket and football with my brothers.

Q: ***What was school like?***

A: I disliked primary and early secondary school. I began to enjoy it at the O levels stage because it was more competitive and interactive. I also detested mathematics at first. It is strange but my love affair with mathematics only started at around O levels. I enjoyed science and history but loved English literature and language. I only went into the sciences because I was close to my brothers who pursued the sciences so I got to do experiments with them at home which nurtured my love for science. My father was also my role model at the time and it seemed like medicine was the profession I was expected to enter.

Q: ***How was your university experience?***

A: That was the most glorious time of my life. I really loved medical school. Interacting with the patients was interesting. After class we would sit and try to diagnose them and decipher what treatment we would give and then realise we were completely wrong during class the next day. We learned to balance leisure and studying. When I see students today studying excessively I tell them "go and get a life". If you stay with your books all the time you restrain your mind. Today's generation is definitely more pressured. Medicine has advanced tremendously, biologicals are replacing synthetic agents, the information highway seems limitless, but I do think our students gear themselves to meet the challenge extremely well.

Q: ***What did you do after graduating?***

A: I did my residency in medicine and then switched to pharmacology which I loved. I thought if I could marry pharmacology with medicine that would be perfect. Clinical pharmacology was an emerging discipline at the time and so I did my MD in pharmacology. I switched because India has a vibrant pharmaceutical industry with research and development, drug trials and the marketing of the drug so therein was the romance of being a clinical pharmacologist. I eventually joined a multinational pharmaceutical firm as a medical advisor and stayed there as deputy medical director until I came across to Trinidad around 1989.

Q: ***What brought you to Trinidad?***

A: My late husband took up an assignment here so we migrated. The pharmaceutical industry in Trinidad was not at the level where they were doing innovative drug research so I started practising medicine. In 1991, I joined the UWI Faculty of Medical Sciences as a lecturer and I've stayed in the Faculty since. At UWI my primary job was teaching, then I got into curriculum development and postgraduate teaching. I learned a lot from my graduate students. In my academic research, I was prompted to look closely at asthma as my young son had developed the condition after we moved here. I began to examine the profile of the condition in our population, triggers that bring on the acute episodes, the drugs patients take and don't take, all with particular relevance to our paediatric population.

Q: ***Can you tell us about that research?***

A: Well we found that the common cold was the most significant and frequent cause for producing acute asthma in children who came to the hospital. So with my graduate student, we got samples from the nasal pharynx of each child and worked in collaboration with the University of Wisconsin, Madison to demonstrate which specific virus was the culprit that was associated with these severe exacerbations of the disease. We were also able to report that the average age for the first wheeze of the child in Trinidad is less than three years and that only about 32 per cent of repeat attendees at Accident and Emergency do their follow up visits at the clinic. That is concerning because a regular follow up could prevent a future attack. Our studies showed that just about 40 per cent of patients take their medication as prescribed, about 50 per cent do not know how to use their inhaler device and a paucity of knowledge on when and why to use their prescribed medication was one of the main causal factors that took them to the emergency room repeatedly. It was discouraging to note that the biggest offenders in these categories were the elderly and children.

Q: ***What causes asthma and why doesn't everyone with the flu get asthma?***

A: Asthma generally has two causes, genetic and environmental. The lungs of asthmatic patients are

different from the non-asthmatic individual in that they are hyper reactive or "super sensitive" comparatively. The connection we made between acute asthma and the common cold is beneficial to the patient and caregiver because we can encourage parents to be alert when the child is developing the flu or the virus. Administering preventer or controller therapy aggressively at that time can avoid the occurrence of an acute attack. Asthma cannot be cured, but it can be controlled and that is what follow-up visits and preventer therapy aim to do.

I'm sure you've heard mothers say their son had asthma but "grew out of it". That's absolutely correct. It can happen. Interestingly, boys tend to get asthma earlier than girls because their respiratory system tubes are much finer and narrower and their immune system is not as developed as their female counterparts. This, however, levels off as they get older. However, even if their asthma seems to have "disappeared", it's important that they are still careful as their lungs may still be hyper reactive.

Q: ***Are there natural medicines that effectively control asthma or do people have to use the prescribed drugs?***

A: Drugs when taken correctly are not toxins. I cannot decry natural remedies but as of now there is no hard evidence that tells us that natural or plant remedies are the solution to relieve an acute attack or control future attacks. It is okay if patients feel comfortable using natural medicine, but if they do so and neglect to take their prescribed medication then they're looking for trouble.

Q: ***You were instrumental in the development of the Trinidad and Tobago National Drug Formulary and the Poison Information Centre. Why were these not established earlier?***

A: Trinidad and Tobago is a relatively small and young country and developing a formulary is something that would be done by clinical pharmacologists who are not commonly found here. I got involved because I saw the formulary as an important country-specific instrument. It gives one everything that a resident physician might want to know about a drug: its name, availability, strength, indications for use and so on. I spent time in Wales on a Rhodes Trust Award and learned about the formulary and the importance of a Poisons Information Centre so that was the basis of me starting these in Trinidad.

Q: ***Tell us some more about the importance of these developments.***

A: The formulary gives medical doctors access to a wide array of suitable drugs to use when administering treatment. Physicians may not always have time to keep abreast of new drugs on the market or all prescribing information on candidate drugs. And then drug representatives could be biased when selling their drugs. A formulary pockets all that information in a single document for all prescribed drugs. I advised and hoped that the formulary be updated biennially by a team of qualified representatives to ensure a continuous readily available topical formulary but this has not been done.

As for the Poison Centre- in Wales I saw how a centre worked, the advantages it offered and the number of lives that were saved. It was a ready reference centre for any medical professional if they had a patient who overdosed or ingested anything toxic. It saved resources and prevented morbidity and mortality, so I felt it important to have one in Trinidad. I collaborated with the World Health Organization in 2001 to start the centre at the UWI. It was later moved to Sangre Grande Hospital and is still there today under the direction of a toxicologist.

Q: ***What work are you doing now and are there any issues in your fields of interest that you wish to address in the future?***

A: I would like to investigate why some patients in Trinidad are poor responders to drug treatment even when it is taken as prescribed. It could well be due to non-compliance but I want to examine whether there is a genetic basis to this. Every drug has a receptor in our bodies with which it interacts to produce a particular response. The main class of drugs that relieve asthma work on receptors in our body called beta receptors. I want to investigate whether the beta receptors in these non-responder patients have been susceptible to a genetic differentiation. I'm also interested in investigating

asthma control in our population. I am currently working with colleagues to examine the prevalence of pre-diabetes in schoolchildren, evaluate lung function and monitor the cohort till at least secondary school level.

Q: ***You have been credited with improving the pharmacology curriculum at UWI. What new element did you introduce?***

A: Over the years we have introduced more clinical pharmacology into the programme which was predominantly basic pharmacology without exposure to patients or application of knowledge to the clinical scenario. With this approach, students can apply principles of pharmacology when they see patients in clinics, anticipate or look out for unwanted effects and be cautious in prescribing too many drugs which may have the potential to interact. I often bring consenting patients into the class. We discuss their condition and which drugs should be administered. This encourages students to think and extrapolate their knowledge of pharmacology to its clinical application. I do try to ensure my classes are interactive, that my students learn for life and their career, and not for an exam. I don't want them to learn by rote. I want them to appreciate, analyse, rationalise and apply the material. That, I believe, is where I have made the difference with teaching pharmacology. The rewarding proof is when students come back from their senior clinical years thankful for having learnt so much in Pharmacology.

Q: ***Who are some of the people in your field that you admire?***

A: Professor Martin Partridge from Imperial College London was a tremendous reference source and encouraged me with my asthma research and Professor James Gern from Wisconsin Madison with whom we collaborated for the asthma research. Professor Christopher Triggle from McGill University has been a fabulous sounding board and Professor Philip Routledge from Cardiff University prodded me into looking at initiating a Poisons centre in Trinidad. The current UWI Principal, PVC Professor Sankat encouraged me in my early years at The UWI and Professors Seemungal and Teelucksingh have been excellent academic colleagues.

Q: ***As the only clinical pharmacologist in this country what do you think could be done to encourage more students into clinical pharmacology?***

A: The fact that Trinidad and Tobago does not have an active pharmaceutical industry limits someone who wants to pursue this career locally. In time, postgraduate courses in Clinical Pharmacology will be shaped and become part of the training in the Department of Medicine.

Q: Do you think enough students are going into science? If not, what can be done?

A: I think today's brilliant young minds are going more into technology and applied science. However, the global need for scientists will never be satiated. Locally, we need to build our capacity to handle national issues through exchange programmes with developed nations, workshops and regional training sessions. We also need to change our curricula to harness scientific capacity in students from an early age. I must say in this regard NIHERST has done a great job, your programmes have had great impact on many, including my children. The government must come on board and expand programmes like the Caribbean Youth Science Forum to encourage our young thinkers into science.

Q: ***What are you involved in outside of academics?***

A: A lot of my interests were nurtured by my family. My late husband taught me to appreciate classical music; my younger son at this age of my life persuaded me to learn to swim which I now love; my elder son encouraged me to be electronically savvy and my daughter introduced me to the new generation of young writers. So there is a lot of family support in my life. I think my story has been one of observation, listening and learning from experience.

Jim Phillip

A Lifetime of Pan

Jim "Jimi" Phillip is a pan musician extraordinaire whose early fascination with our national instrument fired his passion and led him on a journey to become an internationally renowned pan maker, pan tuner, arranger, teacher, author and innovator. With over 40 years of experience in the field, his pan tuning skills have been much sought after by schools and steelband groups in Trinidad and Tobago, the Caribbean and beyond. He has also taught the playing of pan and conducted pan workshops for the Ministry of Culture, The University of the West Indies and The University of Trinidad and Tobago. Phillip is a strong advocate for music literacy for pan players as he believes all players of different musical instruments must be able to relate and communicate with each other.

About the Icon

Date of Birth: *01 November 1951*

Education:

- *Chaguanas Government Primary School*

Awards:

- *The Anthony Williams Award for Technological Innovation in Arts & Culture, NIHERST Awards for Excellence in Science and Technology, 2013*
- *Rudolph Charles Pan Innovation Award ,WITCO, 1988*
- *Rudolph Charles Pan Innovation Award, WITCO, 1986*

Current Post:

- *Pan musician, pan tuner, pan inventor, pan innovator, pan teacher*

NIHERST interviews Jim Phillip

Q: ***What was your childhood like?***

A: I grew up like any other kid. We lived in Chaguanas off Caroni Savannah Road. When we were small, my siblings and I used to play hide and seek and cowboys and Indians. I went to kindergarten in Chaguanas and then I went to Chaguanas Government School. My dad, Ancil Phillip, worked with the Caroni sugar factory and was a pan tuner for a while and my mother, Ferris, was and still is a home maker.

Q: ***Would you share with us some of your first memories of pan?***

A: When I was about two or three years old I saw my father with this thing on the ground and he was knocking it. I didn't realize it was a pan. Later on, I got to know that my dad was a pan tuner and had his own band. Then, when I was about five or six, I saw this steelband in Chaguanas called Wonderland Steelband. I just got into a trance while they were playing.

Q: ***So how did you actually get involved in playing the pan?***

A: Well, after seeing Wonderland I spoke to my sister who knew one of the guys in the band and they took me into the band and that is where I started to learn how to play. So I really got involved in pan from the age of six.

Q: ***Who were your early influences or role models in pan?***

A: Yeah, well I came out under, I have to say, the late Henry "Bendix" Cumberbatch from Chaguanas. He was the teacher and arranger for the same Wonderland and I learned a lot of the musical rudiments from him. Then when I got into the making of the pans, which was in 1967 when I was 16, I met Wallace Austin. He is a tuner for Exodus right now and I learned how to tune under him. The reason I started to make my own pans was that if I were somewhere and the pan went out of tune I would be able to fix my own pan. After I made one I made another one to try to better it. Then someone wanted a pan and I made it. So making and tuning pan became like a job.

Q: ***Was it challenging for you to do?***

A: When I got into tuning I was doing it from what I saw other pan tuners do when they came to the panyard, but I was making a lot of mistakes. The pan wouldn't sound good. The grooving wasn't good, the notes were not set good and I didn't know how to get it to sound right. But it was when I met Wallace Austin, whom I mentioned earlier, and I started to work with him that I learned the way to properly tune a pan.

Q: ***What is involved in the making and tuning of a pan?***

A: First, you get a drum and you take the bottom and hammer it until it gets into a bowl shape. Then, draw in the notes; shape and groove the notes; then final shaping and setting. Then the length of the skirt is measured and the pan is then cut off from the drum. The pan is then heated on a fire, taken off and cooled (which is called tempering). After that, the pan is cleaned and ready for tuning. Tuning is a very technical thing. If someone is going to get into tuning he or she must have an ear for music and sound and notes because you won't be able to hear when a note is at the level.

Q: ***What are some of the challenges involved in tuning a pan?***

A: Well, I always say that tuning a pan is unpredictable. I can't say that I am going to tune this pan and I will finish it in one hour. It might go to three or five hours. It's an art where the person who is doing it has to use a lot of strategies.

First you have to lift up the note up from behind and get it like a hump and then you have to hammer the hump, shape that hump and carry it back down. There are so many points to hit. Sometimes you hit this point, the note starts to sound good and then you hit that point and it goes totally out. So you have to find ways of knowing how much to lift, how much to hit, where to hit it, at what time, how hard. That is why I said no matter how skillful a pan tuner is, there can be problems with a note. Plus,

for each drum, the material is slightly different. So each drum has its own feeling or its own flexibility.

Q: ***So no two pans are alike then?***

A: Well, similar but with different vibes. Every pan you make you have to get the feel of it. And how we get that feel of a pan is when we start to hammer it; we will feel the material. It's a feeling. You have to be experienced to feel it. If we select a drum, we hit the drum – boom! And we hit another drum – boom! We hear a slightly different tone with each drum. So then, depending on what we hear, we will take the drum and make a double second pan or take another drum and make a soprano pan.

Q: ***What innovations have you made to the steelpan?***

A: My first innovation was in 1968, a year after I had started making pans. I wanted to see a pan with just what I called the belly, without the skirt which is the broad edge that borders the circumference of the pan. So my first innovation was a skirtless pan also known as the porta pan. The porta pans are much shorter, and are easy to transport because they take up less space and can withstand pressure, so they are not easily distorted. The tone of this pan is also more sonorous. Another innovation was the collapsible pan stand. I saw people going out and they would have this big stand and it could hardly fit in a car trunk and I knew something had to be done. So I made a stand that could be quickly broken down, folded and fitted into a sack to be carried.

I moved to Canada in 1975 and lived in Vancouver for two years, then moved to Edmonton, then Montreal. During this time, I was making pans and tuning them as a business. People were asking for pans, but you know in these countries if you buy a guitar, you get a booklet. And they want to buy a pan but how are they going to play it? At that time there were no books or anything so I decided to start writing a book and I wrote a book on how to play the soprano pan. I also wanted to see the bass pan, which is the full barrel pan, shorter because there are lots of problems when you are travelling, when you are loading the pan and they take up a lot of space. So my idea was to cut it shorter. That is another innovation.

Q: ***What about inventions? Have you invented anything?***

A: Yes. Sometimes when you are hanging a pair of pans it is like one instrument. Two drums make one instrument because of the range and size of notes. But when you look they are not hung level. I came up with a device – a pan balancer – to show where to bore the hole so that when you hang the pans they will be level. Then another invention of mine was the pan note measure. It is a precise measuring device that a pan tuner uses for drawing the notes on the pan when it is being made. Before, notes used to be placed by taking the measurements from other pans which involved a lot of moving back and forth. This device makes it less complicated.

Q: ***How do you get your ideas? What is your creative process? How do things come to you?***

A: To me, when you have a problem, instead of crying about the problem, you have to try to find a solution. So if I have a problem with something, I will try to find a solution to see if I can fix it. And then, I will think about it, go to sleep thinking about it, wake up, look at this, look at that. I like to look at things that move. I like to look at movements and things like that. I think, I look at this and I get pictures in my head. Then I will go and do a little sketch and then

go to sleep, wake up, walk, think. Think, watch and just start to put things together.

Q: ***Which of your innovations or inventions is your favourite?***

A: The skirtless pan because of how it looks. Some people don't respect the pan because it looks like an oil drum that is common. You know, when you tell somebody the price of a pan, they find it is expensive because it is only made from a drum. I say, well a piano is made from wood, a guitar is made from wood but you don't see it as a piece of wood! So people see it more as an instrument without the skirt.

Q: ***With regard to technologies that could be applied to the further development of pan and pan making, what do you think would have the greatest impact?***

A: Well we have to look into electronics. We have to find proper ways for putting mikes on the pans to get that impact when you play a pan, like the impact you would get from a guitar or a keyboard. So we have to look into electronics to get it right. But it requires understanding of the instrument because of the way in which sound comes off the pan – how it vibrates, whether the sound is better from above or below (the instrument).

Q: ***Do you think it is important for pan players to have formal training in music?***

A: Yes. In fact, I learnt to read and write music on my own. I did this because I needed to be a musician and you have to know about music and what's going on. I couldn't be a musician and I'm talking to another musician and not understanding. I can't be a pan player and not be able to relate to a sax player. I must be able to talk to them and talk about the same thing. I'm not separate as a pannist. I'm an instrumentalist just like them. I needed to learn music so we could all communicate.

Q: ***If you look back at your life now, is there any other field you would have wanted to go into?***

A: I would have liked to do electronics. I fiddle around a little bit with diodes and resistors. I have a book with electronic projects and I made a little amplifier.

Q: ***And what is your philosophy with regard to your life and work?***

A: Well, if you want to have a go at something, I think you go at it and you keep going, and you see what you could achieve. So if somebody says, I want to play pan before I die, I say you better start now because you never know.

Philip Phillips

Where the Deep Ideas are

About the Icon

Date of Birth: *28 June 1958*

Education:

- *San Juan Primary School*
- *Edward E. Devotion Primary School, Massachusetts, USA*
- *Walla Walla High School, Washington, USA*
- *BSc Mathematics and Chemistry, Walla Walla College, Washington, USA, 1979*
- *PhD Theoretical Chemistry, University of Washington, Seattle, USA, 1981*
- *PDF, Miller Institute, University of California, Berkeley, USA, 1984*

Awards:

- *John Simon Guggenheim Fellowship, John Simon Guggenheim Memorial Foundation, 2015*
- *The Rudranath Capildeo Award for Applied Science and Technology (Silver), NIHERST Awards for Excellence in Science and Technology, 2013*
- *Fellow, American Association for the Advancement of Science, 2012*
- *Bliss Faculty Scholar, University of Illinois College of Engineering, 2005*
- *Edward A. Bouchet Award, American Physical Society, 2000*
- *Senior Xerox Faculty Award, University of Illinois College of Engineering, 1998*

Other Achievements:

- *Over 100 published papers in refereed journals, one book*

Current Post:

- *Professor, Department of Physics, University of Illinois, Urbana-Champaign, Illinois, USA*

Professor Philip Phillips was trained as a theoretical chemist but is among the leading thinkers today in the field of theoretical condensed matter (or solid state) physics. Indeed, it is this very background in chemistry that he believes enabled some of the new thinking he has brought to his field. His research seeks to explain experimental observations that challenge standard theoretical paradigms in electron transport and magnetism in solid state physics. He has also made important contributions to the understanding of conductivity and superconductivity, which are driving technological developments in areas like electronics.

NIHERST interviews Philip Phillips

Q: ***Your childhood was split between Trinidad and Tobago and the United States. How did those early years shape your sense of identity and choice of career?***

A: I was born in Tobago. I have four siblings. Both my parents had studied history and were teachers. We moved to Trinidad and I attended San Juan Primary School before we left for Boston when I was 10. My parents were very authoritarian, beyond the strictness of the typical Caribbean upbringing of that era. I certainly wasn't free to be myself. But what I did know from a very young age was that I could privately think whatever I wanted to! So I cultivated my imagination, and maybe that's when the seeds of becoming a theoretical physicist were sown.

Q: ***What was school like? Were you a good student?***

A: In Trinidad, I definitely learned discipline. I was very good at math. English, too, but I really wanted to perfect math. My older sisters helped me advance beyond my grade by teaching me square roots or whatever they were learning. So I found school very engaging because, once again, it was all about the mind. When we moved to Boston, then later to Walla Walla where my father went to teach, I did just okay at high school. Not as well as in Trinidad because schooling there

was so by rote—a lot of memorization and repetition. I was a curious student but I didn't really catch on to the American system. Math and English I would always do well in but the rest I didn't care too much for.

Q: ***Not even the sciences – physics, chemistry and biology?***

A: Of those, I was best in biology in high school. Believe it or not, I was absolutely horrid, and I mean horrid, in chemistry and physics! I got Cs and Ds if I was lucky. Nothing in chemistry made any sense and physics was even more of a mystery. It wasn't a problem of being unable to do the math. I just couldn't do the physics.

Q: ***Yet you went on to Walla Walla University and majored in chemistry and math and did many physics courses. How did you make that giant leap given your poor understanding of those subjects in high school?***

A: I didn't really know what I wanted to do. I wasn't sure I wanted a career in math. Then the summer after my freshman year at college, I read a workbook on chemical bonding and I found it quite easy. I then took chemistry from a professor who was supposedly the toughest teacher and I did very well. We went over the periodic table of elements. I had never realised there was any kind of structure or theory behind it. The elements are structured according to their similarities, and the similarities are predictable, based on the number of orbitals, protons and electrons they have. The numbers mean something and they predict their function. That was revelatory and revolutionary to me, seeing there was structure, order and predictability in this vast array of stuff on the periodic table! That's when I knew I wanted to be a scientist. Not an experimental scientist but a theoretical scientist. Every question I asked, I didn't think of an experiment that I needed to do; I thought about the mathematical equation I would use to gain an understanding. The following year I took physics - the other thing I wasn't good at in school - and that now didn't seem very hard. And I realized why. In college, we were given deep explanations as to why things are, you weren't just left alone with this "cookbook" type of approach of high school. I need to know the conceptual basis before I can really access something.

Q: ***You did your PhD in theoretical chemistry. Can you explain briefly what that is?***

A: Theoretical chemistry is a branch of chemistry where physics enters more prominently. I was in a group that attempted to predict the properties of single atoms and molecules using computer programs. But I didn't care about the properties of a single molecule of oxygen or if oxygen is similar to sulphur etcetera from a physics perspective. You don't see a single molecule in nature. You see a liquid, air, and things are very interactive. Theoretical chemists attempt to use the abstraction from a single molecule as a way of understanding the whole. That approach assumes no new physics happens when the molecules come together but, of course, a lot does happen. That's how you get a solid or a liquid. You can't go from any understanding about a single molecule to predicting a liquid. So ultimately, I didn't find this interesting.

Q: ***But you still did your PhD in it and not in physics?***

A: Yes, I used the PhD as a degree in which I learned how to

do research. I figured out that was the real goal of a PhD. For some, a PhD is career defining. They end up working in that area the rest of their lives. I wasn't going to do that.

Q: ***You took up a fellowship at University of California, Berkeley. What did you focus on there?***

A: I started doing statistical mechanics which was a very difficult jump to make from chemistry. It's a branch of physics which tries to predict what the properties of collections of atoms are from the basic interactions between them. Statistical mechanists study polymers (substances whose molecules have high molar masses and are composed of a large number of repeating units), rubber, the elasticity of solids, things like that. The problems there have a more conceptual basis. I'm interested in things that have deep phenomenal issues, so I found I could explore that through solid state physics.

Q: ***What is solid state physics?***

A: Its goal is to understand the electronic and magnetic properties of solids. At Berkeley, I started taking the quantum background I had from my PhD and applying it to collections of things. Chemistry departments were realising they couldn't ignore solid state physics as a lot of things were happening in it and they wanted chemists who could straddle both fields. There were actually quite a few of us. So I got a job at Massachusetts Institute of Technology (MIT). But the amount of straddling that was tolerated tapered down so I converted from being a chemist to a solid state physicist. For me, that was where the deep ideas and problems were.

Q: ***What would be an example of a deep idea for you?***

A: Well, super-conductivity for one - spontaneous symmetry breaking and localisation. Localisation was my first physics research problem. The fact that you could trap electrons by introducing randomness and changing their environment is a big idea. One area I started working on was conducting polymers. I came up with a general exception to Anderson's Localization Theory. Phil Anderson had won the Nobel Prize partly for this theory, which predicts that conduction in one dimension is impossible because of random defects. An orderly array has the same kind of atoms at every site. If you introduce any disorder, the electrons won't be able to conduct i.e. move from one end of the wire to the other. Prior to that, people thought that because electrons are waves, they'll always conduct electricity. So it was a surprise that just disordering the system would trap electrons.

But in the early 1980s, a class of polymers was discovered that conducted electricity. These are very thin, one-dimensional strands of polymers. I thought, if these polymers conducted electricity so well, then how on earth are they doing it? The accepted theorem says they shouldn't be able to. Defects in the polymers would disrupt the flow. If it were true, there had to be exceptions to the theorem, and I came up with one. That's the work I did at MIT. It's called the random dimer model, explaining the conduction of some polymers. People initially thought that my theory had to be wrong. It went from being outrageous to almost trivial, then accepted virtually overnight. You could work through the math and it was so simple. People were kicking themselves because they didn't think of it. It's still my most cited work. The original paper has over six hundred citations.

Q: ***After nine years, you left MIT to take up a teaching and research post in physics at the University of Illinois. How was that transition for you?***

A: I never in my wildest dreams thought that I could end up there because it's the top solid state physics department in the world. This is the department that Nobel laureate John Bardeen built. He invented the transistor (a semiconductor device used to amplify or switch electronic signals and electrical power) and developed the theory for superconductivity. So you can't just come to Illinois unless you've really done something. It was the perfect place for me. We try to explain experiments

in a completely independent way, not wedded to any particular school of thought.

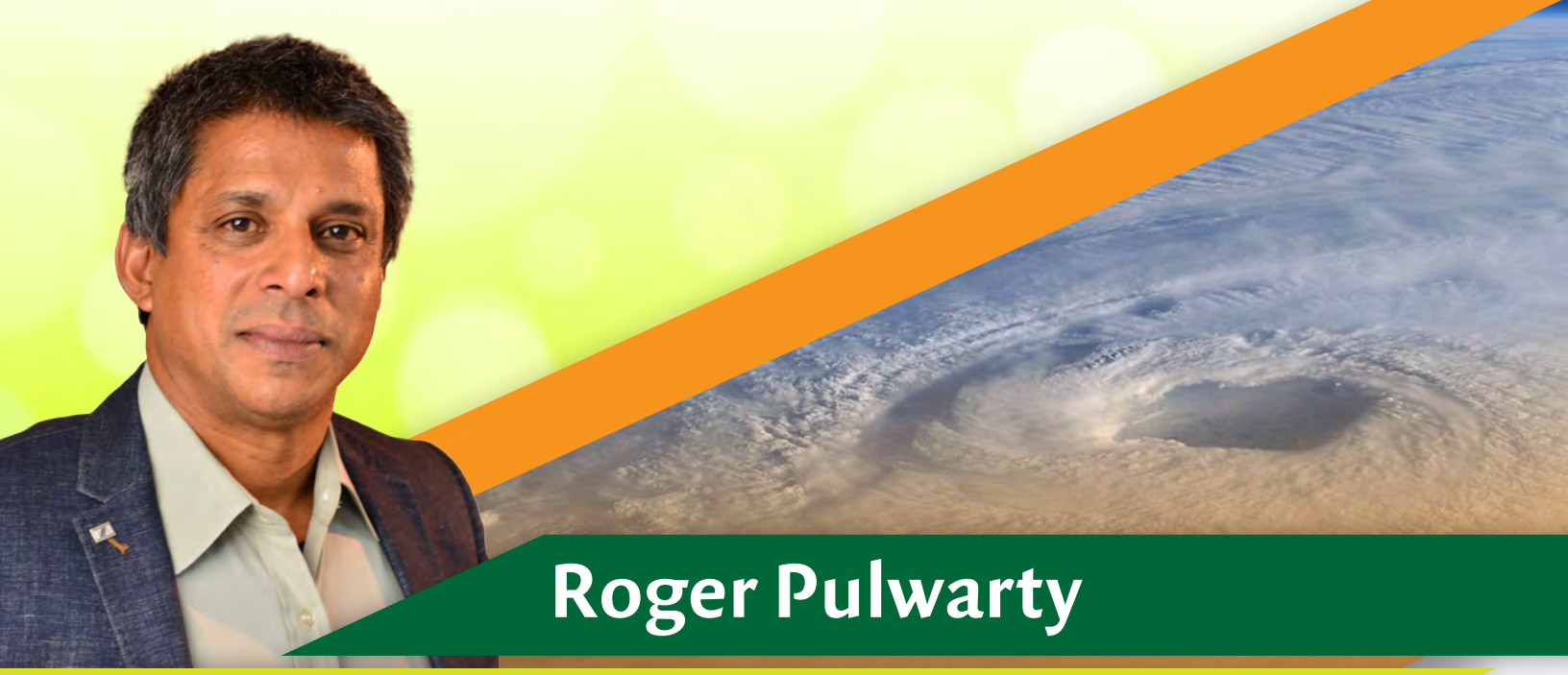
Q: ***You've done some seminal work at Illinois on Motts' theory of insulation as well as on superconductivity. Can you give an overview of your contribution in those areas?***

A: The big thing I've done there is Mottness. The Mott problem became central to solid state physics in 1986 when high-temperature superconductivity in copper-oxide ceramics was discovered. Superconductivity is electrical transport without any resistance. At ultra-low temperatures, most metals superconduct. The key advance in 1986 was that the transition temperatures for superconductivity rose above the temperature where air – nitrogen - liquefies. Liquid nitrogen is cheaper than beer so the refrigeration problem facing traditional superconductors was solved. Theoretically, however, the new materials were a complete puzzle because they were a special type of insulator called a Mott insulator. Traditional insulators insulate because all the electronic states are completely full. Mott insulators insulate even though there are lots of empty electronic states. Mott theorized that this happens because the electrons are so repelled from one another they just stay put. Slater, on the other hand, argued that Mott insulators insulate because a transition occurs that results in the electronic states being filled. I invented the term Mottness to help settle this debate. If Slater is right, then all properties of Mott insulators could be explained by the transition he had in mind. Mottness refers to whatever is not accounted for by the transition that Slater proposed. In essence, Mottness refers to the explanatory residue which is left over if one attributes Mott insulation to the Slater mechanism. Experimentally, there is a lot left over and it is central to explaining what is going on in high-temperature superconductors before they superconduct.

To explain Mottness, I have had to use many concepts and methods from particle physics. It turns out that the problem of Mottness is the problem of strong interactions. In strongly coupled systems, the whole exhibits properties not seen in its constituents. An example of strong interactions is the hardness of rubber as a result of vulcanization which is the chemical process for converting natural rubber or related polymers into more durable materials. After this process, individual strands of the polymer that make up rubber become intertwined in a mesh-like structure. That mesh-like structure is not a property of any individual strand but an organisational principle of the whole. Protons are made up of tiny particles called quarks. They never occur free in nature, just bound inside a proton. Why? The strong interactions between electrons in a Mott insulator is a similarly deep problem. To explain this problem, I have had to invoke excitations called unparticles and even use methods from string theory. The similarity all these problems share is that some organisational principle emerges from the strong interactions, which results in some high-order structure. In the case of rubber, it's the cross-linking that creates a material capable of driving a car on. I think the strong interactions in a Mott insulator create new entities which have no particular mass. All particles have a well-defined mass. Unparticles have no definite mass and hence no particular energy. Precisely how such entities superconduct is what I am currently working on.

Q: ***Does it matter if a complete theory of superconductivity is not arrived at? If we already have, and will continue to have, materials and technologies for superconduction, is the theoretical work so important?***

A: Yes, because if you understand the theory then you can start understanding new things. Understanding quantum mechanics led to the revolution in nanotechnology. We're discovering new superconductors but we still don't know how they work. What we need is an agreed-upon theory. Right now, we have lots of statements that can explain this or that fact but no general principle that unifies all the experimental observations. If we unlock the guiding principle, that will help lead the experimental work. Answering fundamental questions about nature has always led to technologies that could not have been predicted. It is the deep understanding of nature that has propelled human civilisation forward.



Roger Pulwarty

Facing the Winds of Change

About the Icon

Date of Birth: *14 March 1960*

Education:

- *Exchange Presbyterian School, Couva*
- *Presentation College, Chaguanas*
- *BSc (Honours) Atmospheric Sciences, York University, Canada, 1986*
- *PhD Climate Science, The University of Colorado, Boulder, USA, 1994*

Awards:

- *The Rudranath Capildeo Award for Applied Science and Technology (Gold), NIHERST Awards for Excellence in Science and Technology, 2013*
- *Department of Commerce (Gold, Silver), United States Department of Commerce, 2010, 2015*
- *The National Oceanic and Atmospheric Administration Awards 2008, 2014*

Other Achievements:

- *Over 60 peer-reviewed publications and co-editor of two books*
- *Led two internationally-recognized multidisciplinary climate adaptation research programs*

Current Post:

- *Senior Science Advisor for Climate Research, and Director National Integrated Drought Information System; NOAA, Boulder Colorado, USA*

The global controversy over the extent to which human activities are the cause of global warming in our time has subsided substantially on the basis of the findings of the scientific community. World leaders and citizens now have greater awareness of the scale of anthropogenic influences and a heightened sense of urgency and willingness to adopt measures to reduce carbon emissions and implement strategies for dealing with the impact of climate. Dr Roger Pulwarty is a member of that scientific community. His cross-disciplinary work has helped increase international understanding of the complexities of climate change and the ways that countries, particularly vulnerable small island developing states (SIDS), can adapt. Dr Pulwarty is a Senior Scientist at the National Oceanic and Atmospheric Administration (NOAA) in the USA, and works extensively on climate-related issues across the Americas. He has been the recipient of a number of prestigious awards and was a leading contributor to the Intergovernmental Panel on Climate Change which was awarded the 2007 Nobel Peace Prize for its efforts to combat climate change.

NIHERST interviews Roger Pulwarty

Q: ***Did your home and school life orient you towards a life of research and critical thinking?***

A: Yes, on both counts. Too often, our schools produce really good students who are not always encouraged to think critically about the information they are receiving. Thankfully, I had excellent teachers – in my family, and from elementary through high school at Presentation College, Chaguanas – who emphasized learning over simple memorisation. My major struggle was staying focussed on the subjects being taught instead of everything else that my elder sisters and brothers were reading - from West Indian literature and folk stories to Jean Paul Sartre and Voltaire. My sisters and brothers were the people to whom I looked up. They taught me that simply being able to quote these people was not the point. Insight had to actually inform one's actions. One can draw on ideas from diverse sources, to improve the way one thinks, learns and innovates. That was the greatest gift I ever got.

The notion that one's work should help improve human conditions also sprang from a sense of responsibility and respect for the people in my village, which was ingrained by my parents and siblings. Other factors included the legacy of individuals in my extended family, such as my mother's aunt, Gema Ramkeesoon, an activist for women's rights, and my grandfather, who was a chemist and a leader in the early Presbyterian Church.

Q: ***You pursued a BSc in Atmospheric Sciences in Canada in the mid-1980s and did undergraduate research related to climate change when it was not so widely known. What sparked your early interest and what was the scientific understanding about climate change when you began studying it?***

A: The idea that climate varies and changes is not new. The Mediaeval Warm Period in Europe (950-1250 AD), in part, helped kingdoms there emerge out of the early Middle Ages. The Swedish chemist, Arrhenius, outlined the role of carbon dioxide (CO_2) in climate change, in the late 1800s. By the 1960s and 1970s, we knew that changes from planetary orbits to phenomena such as the El Niño-Southern Oscillation (ENSO), created different climatic conditions. What became clearer in the 1970s, however, was the anthropogenic factor - the role that humans play in shaping the rate and magnitude of climate change.

After high school, I worked under Will Georges, a soil physicist, at the Caroni Agricultural Research Station in Waterloo, taking measurements of soil content and of weather conditions. I learned the value of weather and climate analyses in agriculture. As an undergraduate, I published a paper, with Stewart Cohen, a Canadian climate impacts expert, analysing climatic effects on the global food system. I went on to a PhD in Climatology at the University of Colorado, Boulder, a leading centre for climate research. My dissertation focused on the dynamical controls on precipitation over the tropical Americas. The annual cycle of convection (heat transfer of a fluid by mass motion) which drives precipitation, was not well understood, especially over the Amazon Basin, at the time. Convection in the region is not shaped by simple solar heating alone but results from complex interplays among land surfaces, vegetation, physical and thermal oceanic contrasts, and extra-regional influences such as ENSO.

From one field, I have been fortunate to publish with co-authors in over eight different disciplines, and to develop and lead multi-disciplinary research teams. My goal, however, was not only to produce papers but to address multi-disciplinary problems, characterize uncertainties, and put this knowledge into practice. I had developed a strong background in atmospheric sciences, applied mathematics and statistics. Through interactions with Gilbert White, a geographer, and others, I came to realize early on that while climate hazards will always occur, disasters, in many cases, result from the decisions we make, before, during, and after such events. Gaining further insight into the science and decision-making interface required that I take applied courses in the policy sciences, anthropology, social philosophy, and human geography. Fortunately, my scientific mentors, Professors Roger Barry and Herbert Riehl (the latter known as the "father of tropical meteorology"), allowed me to take those courses with the proviso that I sustain a high standard in climate research to support my main thesis.

Q: ***Understanding and responding to climate change is a multi-disciplinary problem. Would you agree? Can you talk more about your work and how it has addressed this problem?***

A: The ocean surface and deep water, the atmosphere, volcanic activity, land and sea-ice surfaces, and human

interactions all drive climate. Interdisciplinary research is unavoidable in climate studies. Different perspectives are needed to understand this complex system that produces changes in long-term trends and in short-term extremes, such as periods of floods and droughts that can last from a few days to a season to decades.

In the 1990s, I spent a great deal of time in the Venezuelan Andes, and in Brazil, Chile and Ecuador, working on the climate impacts on water resources, agriculture, fisheries and disaster risk. Many international scientists came together in these projects, supported by the US National Science Foundation and NOAA.

I then worked on the interactions among climate, water resources and fisheries with scientists and tribal communities in the Pacific Northwest and the south-western United States. We had to identify acceptable trade-offs between the rights and sovereignty of native peoples versus the needs of industry and the economy, and how these are affected by climate. I investigated the climate systems and the decisions that impacted species viability and water supply, and worked with state governments, tribal communities, and industries, on how to best use this information to manage collaboratively. In between, I published papers on hurricanes in the Caribbean and on theories of vulnerability and disaster risk. These, and other assessments in which I have been involved, have, of necessity, been comprised of multi-disciplinary teams. As a result of these efforts, I was asked by the NOAA Climate Program to help lead the development of integrated research and applications across its science and services portfolio.

Working with Leonard Nurse, a distinguished Professor at Cave Hill, Neville Trotz, Chief Scientist at the Caribbean Community Climate Change Centre (5Cs), and others, I helped develop an MSc programme at UWI, Cave Hill focused on climate science, vulnerability, and adaptation. We now have about 80 graduates of this programme, spread around the region in different ministries and institutions. I consider that to be one of our biggest achievements; furthering the capacity and capabilities of the people in our region to respond to a changing environment. The guiding, if idealistic, assumption is that if knowledge exists and is made transparent, then we cannot, or least should not, absolve ourselves of the responsibility for managing climate-human interactions. This responsibility requires a break with more reductionist approaches to science.

Q: ***As the Senior Advisor for Climate Research for the U.S. National Oceanic and Atmospheric Administration (NOAA) Climate Program, what have you focused on?***

A: NOAA, as a publicly-funded scientific agency, is required to show how its research and observations serve the public good. The NOAA Administrator, Dr. Kathryn Sullivan, captures this responsibility in an inspired and compelling way, as the need to "equip our communities with the information, products, services and tools, that allow them to become more resilient". My role involves helping to realize these connections in the case of climate, and in communicating advances in scientific and decisionmaking fora, including the U.S. Congress. To illustrate, the National Integrated Drought Information System (NIDIS), signed into Public Law by the U.S. President, engages multiple agencies and disciplines. I lead the development and implementation of this national modelling, risk assessment and early warning system. I also chair the World Meteorological Organization Climate Services Information System team, a pillar of the U.N. Global Framework on Climate Services. We investigate the best ways to develop and coordinate integrated knowledge systems, ensuring continuity among basic research, observations, and decision-making. Finally, we focus on the resources needed to sustain these systems over the long-term.

Q: ***Can climate change still be mitigated? What will be its biggest or most immediate impact in this region, and are we taking enough action?***

A: For a long time we've paid close attention to mitigation but there is now a stronger focus on adaptation, as well. Even if we stop putting CO_2 into the atmosphere today, existing excess CO_2 will warm the Earth by at least another half a degree C- the so-called "committed" change. Mitigation is critical because there are limits to

adaptation in some areas. For example, by putting CO_2 into the oceans, we lower the pH, making seawater acidic (actually, less alkaline) enough to break down aragonite- the carbonate mineral that corals use to create reefs. Only a reduction in CO_2 can alleviate this problem.

On a welcomed turn, increasing attention in research and in development agencies is being placed on how opportunities for innovation and ways of doing business can make our economies and our natural heritage more resilient. This framing inspires efficient technology, the maintenance of ecosystem functions that support habitat protection, tourism, and agriculture, and gives communities direct roles in shaping their future. The moment we throw our hands up and surrender, we replace these opportunities for learning with an opportunity for losing.

Q: ***How can policy makers and scientists instil in populations a sense of urgency concerning climate issues?***

A: It's important to remember that while managing the causes and impacts of climate change is urgent, we do not want to create a false image of our risks or underestimate the complexities of adaptation. Key questions, require on-going attention, such as "How often should we revise our assumptions about the direction and magnitude of changes?" and, "How best to incorporate new information as events unfold?" The real challenges are for communities to see themselves as determinants of their future, and for us to help them develop capacity that provides benefits with risks already being felt. We've sought to engage in research and with communities to advance the scientific-basis for action related to climate, and as importantly, to coordinate our information and actions to benefit the vulnerable. The latter is a fundamental question of our values and institutional planning that science alone cannot answer. It is also how transformations can begin.

Q: ***What has been the impact of the IPCC?***

A: When the IPCC started in 1990, the focus was on potential change, and not as much on societal responses. Now we see attention on climate resilience, the formation of the 5Cs, and efforts like the U.S. President's Climate Action Plan, heavily informed by the IPCC. The IPCC was never intended to be a detailed source of information about local changes in climate. That's the responsibility of regions and nations based on their own critical problems and societal contexts. This is one reason the Climate course at Cave Hill was developed– so the region would have direct access to a cadre of professionals in and of the Caribbean who are able use that knowledge to help communities respond. The IPCC has been very effective in guiding international policy, identifying research priorities, and spurring action. The IPCC represents a collaborative landmark in scientific history, a successful example of the coordination and communication of scientific knowledge at the global level.

Q: ***Can you describe your reaction and that of your colleagues to the IPCC winning the Nobel Peace Prize in 2007?***

A: Many people enter scientific fields with the aspiration that their work will have social benefits, but which in many cases, remain unrealized. The prize was a rich lesson on the value of science. Note than no individual won the prize. What was recognized was the process and institution of the IPCC.

From the industrial revolution through to the previous century, the scientific community had great hopes for the role science could play in bringing insight into reducing human suffering, how we deal with conflict, and the solutions that were needed. Yet, many times, what we found was dissonance.

Niels Bohr and Albert Einstein never expected nor wanted their discoveries to translate into devastating weapons. The recognition that men and women in science can play leading roles in peaceful, progressive change was the biggest impact of the prize. It further illustrated that integrating research from several fields provides a frontier of knowledge, as important as single discoveries. It takes thousands of people bringing diverse knowledge and approaches to ensure resilience and to imagine alternative futures in the face of modern, complex problems– the many minds of the world working and thinking with others, beyond the confines of their respective disciplines.

Haroun Shah

Pathogen Detective

About the Icon

Date of Birth: *02 July 1946*

Education:
- *Coffee E.C. Boys' School, San Fernando*
- *ASJA Boys' College, San Fernando*
- *Naparima Boys' College, San Fernando*
- *Ewell Technical College*
- *BSc (Honours) Applied Biology, University of East London, England, 1975*
- *PhD Microbial Biochemistry, University of London, England, 1981*

Awards:
- *The Rudranath Capildeo Award for Applied Science and Technology (Gold), NIHERST Awards for Excellence in Science and Technology, 2013*
- *OSCAR (Outstanding Scientific Contribution to Animal Replacements) Crystal Plaque, Dr Hadwen Trust, 2004*
- *Medal for Outstanding Scientific Research, Finnish Academy of Sciences, 1990*
- *Dean's Award, The University of East London, 1975*

Fellowships/ Memberships
- *The University of Western Australia's Herman Fellowship Award, 1998*
- *Fellow of The Royal College of Pathologists (FRCPath), 1996*
- *Membership of The Royal College of Pathologists (MRCPath), 1991*

Other Achievements
- *Over 200 peer-reviewed publications*

Current Post
- *Professor, Department of Natural Sciences, Middlesex University, London, England*

In 1998, Professor Haroun N. Shah led a team of young researchers in the development of a rapid, low-cost method for identifying human infectious disease pathogens, which drastically reduced diagnosis time from days to minutes. Using mass spectrometry, Shah innovated with new instrumentation and created the first database of mass spectral profiles of microbial pathogens that allowed the methodology to work. It is now used by some 3,000 hospitals in Europe and North America, and is fast being implemented in developing countries where the method's accuracy and low cost are having a major impact on public health services.

NIHERST interviews Haroun Shah

Q: ***You spent your childhood in San Fernando before leaving to study in England where you have lived since. What was your early life in Trinidad like?***

A: I grew up in Coffee Street at the base of the Naparima Hill which gave me a very carefree childhood. My father, a supreme court marshall in San Fernando, was also president of ASJA (Anjuman Sunnat ul Jamaat Association) and the one who proposed establishing ASJA Boys' College in 1960. My mother was a teacher. They had eight children and gave us very strong family values. Education was of prime importance, for my mother especially, but they did not inhibit us from doing other things. I loved science and began experimentation from the age of six with my chemistry set. I built my own laboratory below our house. Later on, my brother, a petroleum engineer, would bring home crude oil samples for me to distil and fractionate. After Common Entrance Examinations, I was due to go to Naparima College but was the guinea pig for my father's creation and had to attend ASJA.

Q: ***Did you do well there?***

A: I barely passed my eight O levels. Science entirely consumed my interest, not languages. Luckily, being a new college, ASJA, unlike others, allowed me to

pursue all three science subjects- physics, chemistry and biology. This had a great bearing on my career. I started A levels in Trinidad, at Naparima, and finished in the UK. By then, all my siblings had started emigrating, either to Canada or England. I was offered a place at McGill University but I had envisioned England with so much vibrant culture. The "Beatles" led me there in August 1967! Amongst my luggage on the 14-day journey on the S.S. Antilles was my tenor pan and guitar.

Q: ***Were you on a scholarship there?***

A: (Laughs) I had been working since I was 15 in various stores in San Fernando and after my O levels I worked as a teacher, eventually accumulating £1000 to study abroad. When I arrived in the UK, university tuition fees were £25, but within three months, they increased tenfold! I was penniless in less than a year and forced to study part time, working evenings and weekends to support myself from then onwards.

Q: ***What work did you do?***

A: Every job I could find - in bakeries, on buses, post offices, pubs, restaurants, various factories. In winter, I offloaded night trains. I worked excessively and was so run-down at one point, I collapsed at university and was hospitalised. Britain was now unwelcoming, racism was rife and my future looked dismal. It was one of the lowest points in my life. I wrote to my mother asking to return home. Her response, in a ten-page letter, was swift and uncharacteristically brusque, pushing me to confront the challenges of life and citing examples from her own journey. Her words made me more determined than ever to succeed. In three years, I applied for 52 personal grants that barely saw me through to graduation. The hard work paid off, though, as I got the university's only first class honours and the Dean's prize.

After jobs at ICI (drug development), Royal Marsden (cancer research) and Kew Gardens (plant biochemistry), I moved to the Biochemistry Department at the University of London's Royal London Hospital Medical College in 1972. The challenge was to lead in the burgeoning area of "anaerobic microbiology" (life without oxygen). I worked full-time and, after hours, pursued my PhD there on anaerobic bacteria in the alimentary tract. I studied the chemical makeup, physiology and biochemistry of many components of the microbial flora, publishing my first scientific paper in 1975. Japanese and European scientists later named some species, such as *Prevotella shahii* and *Leptotrichia shahii*, after me, in recognition of work I had published in biochemistry, pathogenicity, systematics and evolution. I completed my PhD in 1981, binding six papers into my thesis, and was appointed as a full time lecturer.

Q: ***You then went on to the University of Kuwait. How did that come about and what was your experience there like?***

A: Around 1984, the University of London was in financial crisis and unpaid sabbatical leave was being granted to academics. I was offered a two-year posting at Kuwait University. At that time, my marriage had broken down, so going abroad with my two little girls, who were seven and five, seemed the right thing to do, in spite of the risks posed by the war between Iraq and Iran which threatened Kuwait several times. I knew applying for research funding when I got to Kuwait would take months. So I successfully applied for a £250,000 grant from the UK's Medical Research Council [MRC]. This allowed me to travel between Kuwait and London to procure laboratory equipment, chemicals, consumables, etc. to set up my laboratory immediately. The Dean challenged my team to deliver at least one scientific paper in an internationally recognised journal. We published four and the Emir himself thanked me on my departure. Ironically, it was in Kuwait that I encountered the London-based Nostalgia Steelband which was on tour, and began playing again! I became, and remain a director of the steelband.

Q: ***You then returned to the University of London in 1987?***

A: Yes, and I was promoted to senior lecturer. It was my golden period, having landed seven major research grants, worth several million pounds, from the MRC. Between 1987 and 1991, I published 42 papers and received several commendations including an MRCPath degree. I went to Canada for family reasons and also for having received

a Canadian MRC grant of CAN$1.3 million for research at Dalhousie University. I returned to England after two years, having been offered a post at the Eastman Dental Institute. The institute was aspiring to become part of the renowned University College London (UCL) but was barred because of its low rating of two. Universities are ranked from one to five, based on an extensive research assessment exercise. One of my duties was to improve Eastman's score but, after a year, the task seemed insurmountable. With support from the Dean, Saheer Gharbia, my second wife who is a Molecular Biologist, joined me to take on this prodigious exercise. Working insane hours - 15 to 20 - daily for two years, restructuring the scientific focus and obtaining MRC and Wellcome Trust grants, we achieved the seemingly impossible. Eastman became the first institute to be elevated from two to five, which sanctioned its amalgamation with UCL. But the exercise left us utterly worn out and I left academia to pursue a new career at Public Health England (PHE) in 1997.

Q: ***Was your work at PHE very different from your research at the university?***

A: Yes. PHE's work directly impacts patient care whereas university was more academic. My main duty initially was to establish a new laboratory, the Molecular Identification Services Unit (MISU), to analyse emerging, atypical and rarely isolated pathogens that eluded conventional diagnostic methods. Little was known about their pathogenicity, transmission, stability or source. Despite considerable opposition from some of my peers who felt my experience was too academic to undertake this challenge, within one year, MISU was running the first such service and remains fully operational today based on the same methodologies I established. Saheer also joined PHE to establish the new Applied and Functional Genomics Unit. We combined genomics and proteomics (designated "proteogenomics") and led PHE into a new era of science.

Q: ***Why could the pathogens not be identified with existing methods?***

A: Traditional methods did not have the accuracy to identify such unusual pathogens that were referred to MISU. I began to explore new technologies, especially mass spectrometry (MS). MS instruments have been used for a century by physicists and chemists to study the nature of matter. Their application in biology, however, posed major obstacles and had to await the development of techniques that enabled very large molecules, such as proteins, to change their state to a "gas" so they could now travel in a charged field for analysis. There are numerous types of mass spectrometers. The one we first used was Matrix-Assisted Laser Desorption/Ionisation Time of Flight Mass Spectrometer (MALDI-TOF-MS) at a company in Manchester. In the method we used, a bacterial/matrix admixture placed at one end of a tube under vacuum, was bombarded using a soft laser to create a plume of ions or charged fragments. These travel at rates - milliseconds - that are inversely proportional to their mass/charge ratios to reach the detector where their electrical signals convert them into the mass spectrum that give a characteristic MS fingerprint of the bacterial pathogen. Our initial success was dramatic. I held the first such conference at PHE, to explore potential applications of this novel technology on 27th October, 1998. I expected about 30 scientists but over 150 people turned up including from CDC in Atlanta.

Q: ***How did you go about developing the methodology using that instrument?***

A: At the conference we demonstrated that the identification of a pathogen, which normally took hours to days through analysis of the various carbohydrates metabolised by bacteria was now possible in two to three minutes by switching to protein analysis by MS. I retained the instrument in my laboratory for a month and my PhD students began experimentation, devising a plethora of protocols based first on fractionation of bacterial cells, and then eventually using whole cells. After considerable

work, we developed a method in which each pathogen, e.g. for TB, cholera, pneumonia, etc., yielded a unique "mass spectrum" or electrical "finger print", based on the makeup of their complex proteins.

The company was so excited by our results they let us keep the instrument for a year. We redesigned a new automated instrument which was built and delivered in 2000. The challenge was now to assemble a database of several thousand bacterial species to act as a reference source to compare unknown pathogens. The accuracy of identification of a species and its variants by this method is entirely dependent on having a comprehensive database of representative MALDI-TOF MS profiles.

Q: ***How was the database built and how big is it today?***

A: We reported the first database in 2004 in a scientific journal. But there are major companies who assemble and market these databases, which now contain over 100,000 spectral profiles. More specific databases are also being developed. Our group is currently involved in an EU project to assemble a unique database of over 600 anaerobic bacterial species.

Q: ***Did the system get tested in the field?***

A: Yes. Field-testing new technology to assess its robustness is essential. While the MS technology was being employed routinely in my laboratory, Saheer and I were awarded a new grant in 2005 for nearly £2 million to explore new forms of MS such as electrospray ionisation, orders of magnitude superior to MALDI-TOF MS for protein analysis but far more complex and cumbersome to field-test. I felt it necessary to field-test MALDI-TOF MS as the method for rapid diagnostics. I contacted numerous hospitals but all except my former employer, The Royal London Hospital, refused permission. With a few PhD students, we analysed over 600 isolates blindly and compared results with those obtained by the hospital. All results, except for the hospital-acquired pathogen, *Clostridium difficile*, were highly successful. We collaborated with a German group, AnagnosTec, to resolve that problem, exploring more potent organic solvents to disrupt the extracellular polymeric layers of the cell prior to MALDI-TOF MS analysis and was immediately successful.

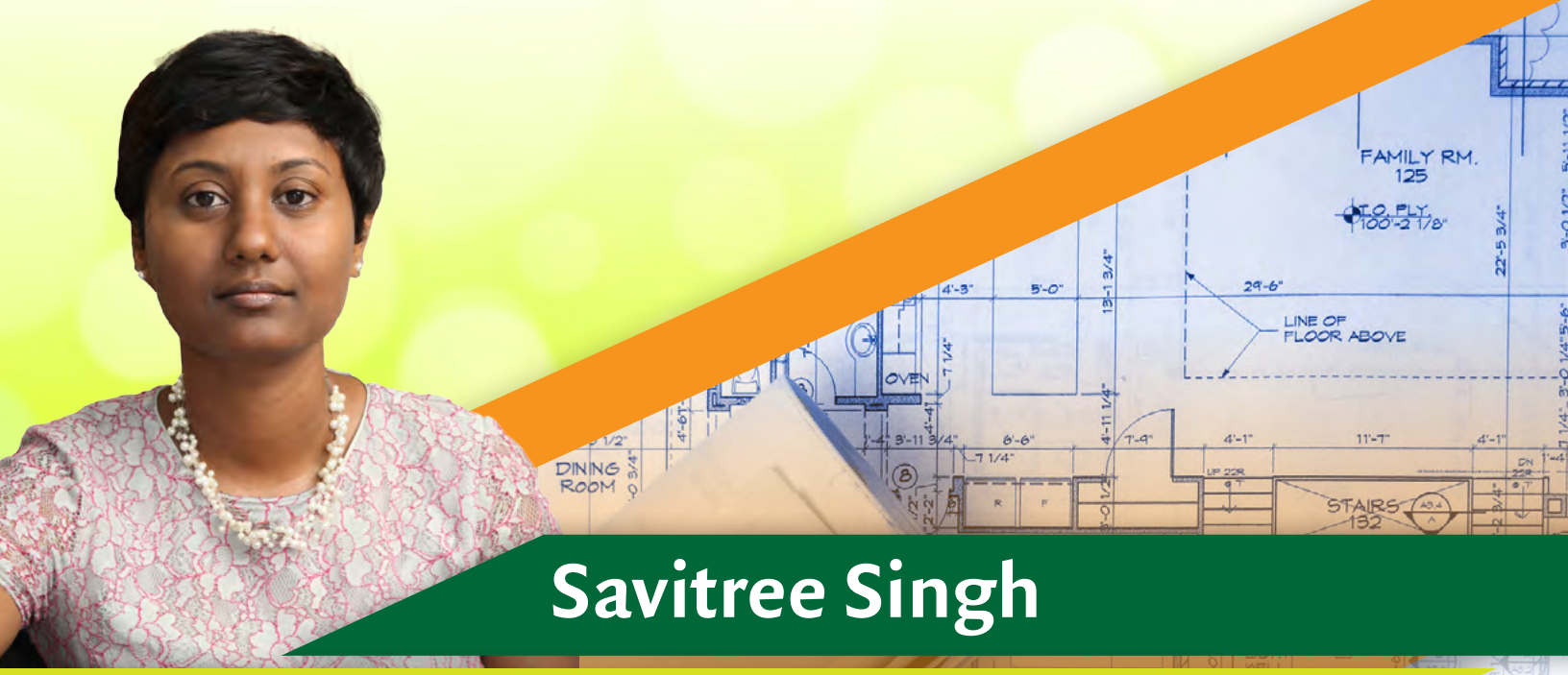
Q: ***How else is this diagnostic system being used today?***

A: In the past, mass spectrometry focused on human diseases such as cancer, diabetes, multiple sclerosis, etc., by analysing surrogate markers for these diseases. These were seen as lucrative markets and took precedence. Today, microbial diagnostics has surpassed these applications, driving the technology globally and extending applications into diverse areas such as agriculture, aqua/marine farming, manufacturing processes involving microbes, environmental studies such as antibiotic resistance monitoring in rivers, sewage, etc.

Q: ***What research are you doing now or hope to be doing in the future?***

A: Much of my time is spent taking the technology to developing countries where I believe implementation will have immense impact on healthcare. In 2013, I spoke at CAREC (now CARPHA) in Trinidad and suggested a group comprising UWI, Eric Williams Medical Sciences Complex, CAREC and others be set up to take the lead for the Caribbean and Latin America. Two local persons were trained in my laboratory at PHE in 2014.

Since leaving PHE in 2015 and moving back to university, I have the freedom to experiment and help in the design of new instruments. One very new form of MS, referred to as "Top-down" proteomics, is rapidly pushing ahead. Led by ThermoFisher Scientific, with whom we have been collaborating over the last four years, I presented our initial findings in April 2015, showing areas where it is superior to MALDI-TOF-MS. I am convinced these technologies will make the most incisive breakthroughs in diseases of all types. Saheer and I are also compiling our second book, "*The Triumph of MALDI-TOF Mass Spectrometry and New Developments in Tandem Mass Spectrometry for Clinical Microbiology*". My dream is to see my home country get involved immediately and become a leading global pioneer in this revolutionary, futuristic field.



Savitree Singh

Building The Future

About the Icon

Date of Birth: *12 December 1983*

Education:

- *Ramai Trace Hindu School, Penal*
- *Barrackpore Secondary Comprehensive School*
- *BSc (Honours) Civil Engineering, The University of the West Indies, St Augustine, Trinidad, 2005*
- *MSc (Merit) Diploma of Imperial College, Imperial College London, England, 2009*

Awards:

- *The Ranjit Kumar Award for Junior Engineer (Silver), NIHERST Awards for Excellence in Science and Technology, 2013*
- *Outstanding Young Engineer, The Association of Professional Engineers of Trinidad & Tobago, 2013*
- *Kenneth Severn Award Certificate of Commendation, The Institution of Structural Engineers, 2011*

Memberships

- *Association of Professional Engineers of Trinidad and Tobago*
- *Institution of Structural Engineers, UK*

Current Post

- *Director, KS&P Limited Consulting Civil & Structural Engineers, Trinidad*

Whether large or small, temporary or enduring, buildings have met our basic human need for shelter, reflected our historical heritage, and defined our island's landscape from time immemorial. As Trinidad and Tobago continues to progress, the demand for new structures, both dwellings and businesses, continues to increase. With modern times comes new challenges and so today's engineers must incorporate safety regulations and environmental concerns in planning their creations, which must perform their roles effectively and protect the people within from natural disasters. Savitree Singh is, undoubtedly, a modern engineer. Whether she is designing and overseeing a vast engineering project, supervising other engineers' projects as a director of KS&P or assisting her home community, her work is marked by passion, thoroughness and a distinct drive for excellence. She is a graduate representative of the Institution of Structural Engineers and an accomplished structural engineer. Her love for engineering is matched only by her deep desire to spread that love to young people.

NIHERST interviews Savitree Singh

Q: ***When did you discover your interest in science?***

A: I have liked mathematics since I was young. I inherited that from my dad. Numbers always made sense to me. Math problems only have one right answer; they weren't subject to interpretation and I appreciated that.

Q: ***Was there any significant event or person that led you to sciences or was it a natural attraction?***

A: I think it was mostly natural attraction. As a small child, I remember looking at my house and trying to figure out how they built it, wondering how the builders put up the columns and beams. Later, in secondary school, my physics and chemistry teachers encouraged several of us to pursue engineering.

Q: ***Why civil engineering?***

A: Actually, I first wanted to pursue petroleum geoscience but when I applied, UWI's Petroleum Geoscience programme only took the top twenty applicants from the Caribbean. I was not one, so civil engineering was my second choice. I was initially unhappy about it but from my first year, I realised that I enjoyed it. I enjoyed the bridges and buildings; that childhood interest just came back to me. For my postgraduate studies I pursued the specialised field of Structural Engineering.

Q: ***Is this a decision that you regret?***

A: Not really. A year or two ago I had the opportunity to enter the petroleum engineering sector and I turned it down. It was a lot more money but I enjoy my job.

Q: ***Given the field you're in, where can one find visible evidence of your work?***

A: My work can be easily identified. I help construct buildings, after all. The University of Trinidad and Tobago Wallerfield campus, the Chaguanas Borough Corporation, as well as the Victoria Keyes and Four Roads Housing Projects in Diego Martin are projects with which I have been involved. In the construction of a building, the structural engineer has a limited but important role. The contractor builds the building but the structural engineer determines where columns, beams and walls are placed with the guidance of the architect. Structural engineering involves designing the building and also supervising during construction. This ensures that what is depicted on paper becomes a physical reality, ready for the purpose for which it was designed.

As an engineer, there's always a sense of achievement when driving past a project you worked on, or knowing that you are inspiring or mentoring younger engineers. For specific achievements, I think that when the UTT Wallerfield campus is completed, I will be very, very happy. Ten years from now I'll want to return to that campus, walk around and think back on my work there.

Q: ***You've risen to the position of company director at a relatively young age. What is your role at KS&P?***

A: I've been with KS&P Ltd for nine years and I think my promotion to director is a recognition of the work that I've done at the firm. As director, my concern has been to uphold the firm's reputation for providing good engineering services and to continue its tradition of hiring local engineers. It's a big responsibility. As an engineer I was focused on individual projects but now I have to manage people and numerous projects. There is a more human element now.

Q: ***What projects are you currently involved in?***

A: I mentioned UTT's campus. We're at the supervision stage. That is, making sure that our designs and instructions are followed properly during construction. Another of the firm's projects is a residential development with approximately 300 houses.

Q: ***Does your very demanding job allow time for community work on a pro bono basis?***

A: My community wanted to build a new mandir so they asked me to help. I've developed some drawings which they have used for construction. It's really nice to give

back to the people who look out for you and whom you see during your daily commute.

Q: ***Have you any special plans or goals for the future?***

A: I'm currently a graduate representative for the Institution of Structural Engineers. Right now we are on a drive to inspire students to enter the field of structural engineering. There has been a loss of interest in engineering. Younger people are interested in trends; they're not really inspired by people in the Engineering field. If you ask a young engineer who inspires them now it's very difficult to get an answer so we are in the process of trying to bring about interest, whether it's via workshops or competitions to get them more involved in the field of Engineering. We have a committee that hosts a yearly design-build competition in which secondary school students are required to build a model of a tower or bridge at the UWI. You'll be amazed at how enthusiastic they are; they're very passionate about this competition. So enthusiasm exists- we just need to get them more aware of it.

Q: ***And this committee is based here?***

A: Yes, it's the Caribbean division of the Institution of Structural Engineers. Local engineers volunteer time and services to create the modules, and assist with the competition. Sometimes we do workshops or lectures at schools. It's all part of a campaign to raise the profile of engineering and its appeal to students.

Q: ***How receptive is the local engineering community to green energy and sustainable engineering?***

A: I think a good engineer will always be sustainable. If a builder builds a house on his own, he'll use a lot of materials and it will be expensive. But with an engineer's guidance the same house should be a structurally safe and more economical design. Carbon emissions still provide a challenge because we need specific training in that field. But locally, I think there has always been that initiative to be sustainable, from both engineers and architects.

Q: ***Is it true that contractors are not held by any regulations to build as the engineers recommend. How does that feel, knowing that your vision may not be the final product?***

A: During the construction phase of a project there is constant monitoring to ensure that the design is followed. When there is deviation from that, you have to inform the client and ensure that it is built to standard. So if there is a problem on site, you resolve it with the contractor to ensure that the client gets the best quality work. If what you observe isn't to standard, one can make an informed decision to not approve the work. I think that in Trinidad and Tobago, we need better regulations. Whilst there are competent contractors, there are also many inexperienced contractors who often get jobs they can't properly perform because they have the lowest price.

Q: ***How would you describe the state of your field locally and internationally?***

A: The field is in good hands internationally. When you travel, you see beautiful structures, elegant buildings that inspire. There will always be people who are driven to

create bigger, better structures. There's always that drive in the human mind or the human psyche to be better and I think a lot of engineers have that quality. Here, we are still a young country and at present, regulations are not enforced properly. But some firms locally are designing buildings and structures to international standards, which is very important because Trinidad and Tobago has natural disasters such as earthquakes. It is a slow process but I think we're going in the right direction.

Q: ***Of the new or emerging technologies you see in the field, what stands out?***

A: There is always new software to design buildings and structures. When my mentor worked on the designs for the Hall of Justice and the Financial Complex he used punch cards and very large computers. Back then they had to go to the UWI every time they needed to run an analysis for a building. We can do that now in half an hour. So our technology has greatly improved our efficiency and effectiveness but we have not eliminated the need for human expertise. Even the best engineering software requires a user who is competent and fully understands the engineering involved.

Q: ***Do we have shareware of free software that children can use to break into the field?***

A: Yes there are a few trial programmes that allow you to introduce children to engineering. For example, one programme might model simple beams which can make simple bridges, to demonstrate how it vibrates or supports the weight of a person. Knowing how many people a beam can support is useful for safety. Additionally, the Institution of Structural Engineers is creating its own package to encourage students into the field.

Q: ***How did it feel to receive the award for Junior Engineer at the 2013 Awards for Excellence in Science and Technology?***

A: I was quite surprised and humbled that I had received the award for Junior Engineer. I really appreciated the recognition and it's a powerful impetus to continue doing good work. So thank you.

Q: ***Do you have any advice for students thinking about studying Engineering?***

A: Imagine your daily life, from the time you wake up to the time you fall asleep. Your quality of life is made better due to the contributions of engineers. From the house you live in, to the roads you drive or walk on, to that phone, tablet or computer you use. Our lives are inexplicably linked to engineers. This will be your contribution to society as an engineer.

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