| DIANE HILDEBRANDT |

TOP THREE AWARDS

- The African Union Scientific Award, 2009
- Distinguished Woman Scientist Award, South Africa, 2009
- ASSAf Science-for-Society Gold Medal Award, 2010

DEFINING MOMENT

I think life is made up of many moments that are important and that motivate and inspire. These include making a discovery in your research – it is awesome being the first one to see how wonderfully some (very tiny) aspect of the universe is put together; working with young people and seeing them develop into world-class researchers and being able to do things that could improve the quality of life of the poorest in Africa and the world.

WHAT PEOPLE DO NOT KNOW

My aim in life is to be bored – then I will have done all the things I want to do.

Diane Hildebrandt was born in Chingola, Zambia and came to South Africa in 1968. Her childhood was spent mostly in Rustenburg, where she completed primary school at Fields Primary School. She undertook her high-school education at Grenville High, the only government high school for English-speakers in Rustenburg at the time. The core of her matric subjects were mathematics and science, with English, Afrikaans, biology and accountancy. From here, she went on to complete her undergraduate and postgraduate studies at the University of the Witwatersrand (Wits).

Hildebrandt says that her entry into the world of engineering was a fortunate accident. "I enjoyed science at school but never thought that girls could be engineers," she recalls, and indeed, there were very few women who were enrolled for this course of study at university level. She changed to chemical engineering at the end of her first year because she believed that there were more opportunities and better salaries for engineers. Although she still thinks this is generally true, she now freely admits that it is not necessarily the best basis for a career choice. "However," she continues, "in this rather random way I became a chemical engineer and I suppose that this is sometimes the way that important decisions are made – by luck and chance". Over the course of her career, she has been pivotal in undertaking research on chemical reactor optimisation, process synthesis, reactor and separation system synthesis, Fischer-Tropsch and biotechnology – specifically the use of biological processes for biogas production and water clean-up.

In 1981, she completed her BSc in chemical engineering with distinction. This was followed by the attainment of her MSc in 1983. Upon entering the workplace, she spent a number of years in the employ of the Chamber of Mines Research Organisation, where she worked as a professional assistant in the Environmental Engineering Laboratory. In 1984 she joined Sastech, SASOL as a process engineer. In 1985, she was appointed as senior lecturer in the Department of Metallurgy at the Potchefstroom University for Christian Higher Education, and at this time she also undertook her PhD studies at the University of Witwatersrand under the supervision of Professor David Glasser, whom she credits as being one of the major influences on her career.

In 1988, she joined the faculty of Wits and in 1989 she was awarded her PhD. Her thesis was titled The Attainable Region Generated by Reaction and Mixing, in which she developed a new method for optimising chemical reactors – the Attainable Region (AR) method. She reflects, "I did a PhD simply because of the challenge – I wanted to see if I could do it". At the time, she made her choice of topic because she felt that it would be the easiest to work on – however, over the years, her contribution to this area has been consistent and far-reaching. Focusing on the optimisation of reactors, the work she undertook in her PhD studies has been included in several textbooks prescribed at undergraduate level, as well as being frequently cited in the field of chemical engineering.

In 1991, Hildebrandt had the opportunity to spend her sabbatical as an Assistant Professor at the prestigious Princeton University in the United States, returning to the University of the Wits at the end of that year. In 1998, Hildebrandt was promoted, taking up the post of the Unilever Professor of Chemical Engineering at the School of Process and Materials Engineering, a position that made her the first woman in South Africa to have been appointed as a full Professor in chemical engineering. This achievement was echoed in the Netherlands, when in 2003, she was appointed as a part-time Professor of process synthesis at the University of Twente, thus becoming the first woman professor of chemical technology in the Netherlands. She says jokingly, "I thought that it was great that a woman from Africa should go to Europe and lead the way!"

In 2005, the School of Chemical and Metallurgical Engineering established the Centre of Materials and Process Engineering (COMPS), a research centre where Hildebrandt functioned in the capacity of Professor and Director alongside her mentor, Professor David Glasser. Later, she also filled the additional role of the South African Research Chair of Sustainable Process Engineering. Here, she and Glasser developed numerous methods for the improved efficiency of equipment and chemical processes.

In 2013, Hildebrandt and the COMPS group moved to the University of South Africa forming the Material and Process Synthesis (MaPS) Research Unit. The formation of the unit positioned Unisa as a leader in developing Sustainable Energy Solutions for Africa and South Africa. The research of MaPS focuses on utilising underutilised resources, such as waste materials, to produce fuel and electricity. Hildebrandt is currently the Director of MaPS and is a Professor of Chemical Engineering at Unisa.

IMPROVING PROCESSES

Building on her work on chemical reactor optimisation, Hildebrandt has further explored comminution. This is a process fundamental to the mining industry, which is a major contributor to the South African economy. Comminution deals with the breaking down of mined rock into fine particles in order to extract minerals. Hildebrandt and Glasser applied the AR method to these processes, and were thus able to contribute to significant improvements in the extraction process, as well as increased energy efficiency associated with these procedures. This is an ongoing project, liaising with the mining industry to implement these findings in practice.

Another aspect of Hildebrandt's work has dealt with the optimisation of distillation systems. This is one of the most common methods of separating elements in the chemical industry, but traditionally these processes have used extreme amounts of energy. Hildebrandt and Glasser worked on designing distillation systems which would be more energy efficient, and so developed a distillation system design known as the Column Profile Map (CPM) method. This has been described as "one of the three most important developments in distillation over the last decade". In addition to its application in distillation, this method can also be applied to membrane separation.

Her team has also worked with a biomedical engineer in order to use imaging data obtained from patients to better analyse their state. She was also involved in the development of an efficient system for removing heparin from blood, and is now working on modelling the kidney and analysing the behaviour of neuromuscular blocking drugs.

While working at COMPS, her research group partnered with Golden Nest to develop a new, more efficient Fischer-Tropsch technology. Hildebrandt and Glasser have been working in this area for the last two decades. The Fischer-Tropsch reaction has great significance in the industrial arena, as it is used to produce synthetic fuels from coal, oil and organic wastes, but it is a very complex field of study which is still largely shrouded in mystery. Together, Glasser and Hildebrandt moved away from the traditional paradigm viewing it as a reaction alone, characterising it instead as a system with similarities to reactive distillation. Utilising the findings engendered through their research, they were able successfully to design and build a pilot plant for Golden Nest which could convert syngas into synfuel. This plant was built in Baoji, in the Shaanxi province of China. Hildebrandt headed up the team that was responsible for the conceptual design, overseeing the feasibility study, the engineering thereof, as well as the laboratory testing of the catalysts. This plant was later inspected by an international review committee, which approved the technology in use.

Their work extended to Chinchilla, Australia, when in 2005, Hildebrandt led a team contracted to LincEnergy to build a Fischer-Tropsch demonstration plant. The aim thereof was to test the concept of combining the Fischer-Tropsch process with underground gasification, a world first in this area. Her team conceptualised the reactor system, which has since been commissioned successfully, as well as overseeing the feasibility and engineering thereof.

Most recently, Hildebrandt and Glasser have been collaborating on improved process synthesis. This is a new way of designing flow-sheets for chemical plants, by making use of fundamental thermodynamics, in order to improve their use of raw materials while reducing carbon dioxide emissions, inter alia. Their work in these areas is currently being expanded as a biotechnology study. Small-scale modular units are under investigation, where organic materials (such as agricultural, municipal waste and medical wastes) can be utilised to supply fuel and electricity. Part of this investigates the installation of algal ponds on the outskirts of the plant, where local algae may be introduced to minimise the carbon emissions from the plant. Another branch of this research has investigated the reduction of water tainted as a result of by-products from the Fischer-Tropsch process. In practice, these findings may contribute to improved design of artificial wetlands, as well as contributing to the clean-up of water contaminated with metals (such as acid mine water drainage) and biological materials.

Hildebrandt is particularly interested in how she can apply the results of her research to improving the lives of those who do not have access to energy and clean water. Governments are being challenged to provide infrastructure capable of servicing the increasing demands for energy, while simultaneously reducing the impact on the environment, particularly in light of the prohibitive costs involved. Also, chemical industries and power stations make use of carbon-emitting fossil fuels in their procedures, further contributing to global warming. Inefficient processes in place at these institutions lead to greater carbon emissions than would have been the case had they been better designed and operated. Optimisation of these processes looks at reducing waste, concurrently improving bottom-line performance, and where possible, converting these carbon containing waste products to fuel and electricity. The implementation of such processes can improve the situation, particularly in developing countries, on three fronts: supplying energy, creating jobs and cleaning up the environment.

She explains her contribution, saying, "The effects of global warming will put severe pressure on communities… Some of the forecasts suggest that these pressures will lead to revolutions and war – not an inheritance that we wish to leave to our children. It is essential that we solve this problem quickly while meeting the energy needs of society". Her research, encompassing all the key elements needed to make waste-to-energy technology work, has been instrumental in developing methods by which organisations may reduce their environmental impact, in turn contributing to greater security in meeting Africa's energy, fuel and food requirements.

Alongside her prolific research, Hildebrandt has been an active mentor to numerous students who have worked with her, living out her belief that each one is a person who can go out into the working world, potentially drive industry and make a contribution to the betterment of Africa. She has supervised and co-supervised approximately 50 PhD students to completion, as well as over 40 MSc students and a number of students from abroad – with several more currently in the pipeline. "You get to a stage where the 'learner' becomes the teacher," she says, "and the student now is far ahead of you in terms of their understanding and in generating new ideas. I love this moment because then I know that I have been successful… It might not be good for my ego, but is does mean I have done my job well, and it really is special".