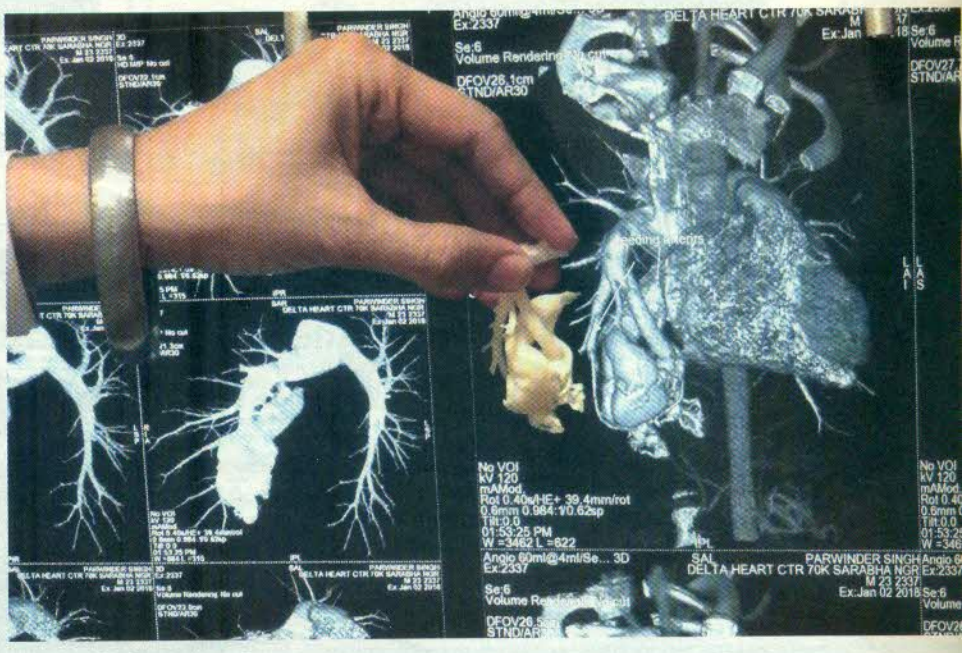
Raising the bar in technical education

Contribution of 3D printing technology in minimally invasive surgeries and precise procedures, will lead to enhanced patient safety and huge reduction in operation time. An insight by Guru Nanak Dev Engineering College

The Department of Production Engineering at GNDEC has an established Manufacturing Research Lab (MRL), at Guru Nanak Dev Engineering College (GNDEC), which is involved in rapid and additive manufacturing activities. The department has published roughly 150 research papers in the area of FDMR (fused deposition modeling) and rapid prototyping, in addition to holding four Indian patents.



Assisting healthcare professionals through latest technology

The MRL at GNDEC is a place that sees a lot of activity. Students, researchers, and faculty make abundant use of the facility for their respective projects. The GNDEC MRL also honours requests for expert assistance in product development from various sectors such as industry and healthcare. Some of those requests pose greater challenges in execution. One such request came from Dr Harinder Singh Bedi, Chairman of Cardiac Sciences, Ludhiana Mediways Hospital.

A 23-year-old man consulted Dr Bedi for bluish discoloration of his body and shortness of breath since childhood. The patient had not undergone any specific treatment and it was initially thought that he had a heart problem. When his skin colour started getting worse, he approached Ludhiana Mediways Hospital and was promptly referred to Dr Bedi.

Considering the delicate nature of the surgery and potential danger to the patient's life, Dr Bedi chose a very unconventional and novel approach. He decided to study and understand the precise nature of the malformation closely and to the minutest detail. To enable this, he fell back on the latest in technology 3D printing and approached the MRL at the Production Engineering Department of GNDEC.

Dr Bedi observed that the patient's heart scans were normal and hence suspected a lung problem. He prescribed a CT scan to clarify his suspicion and start the correct line of treatment as soon as possible. The results were startling. The scan detected a large connection between the right pulmonary artery and the vein, which was bypassing the patient's lung. Dr Bedi diagnosed that his blood was entering the heart without picking up oxygen from the lung. In medical terms, this condition is referred to as large pulmonary arteriovenous malformation (AVM) and is a rare disease. Dr Bedi realised that the AVM could suddenly burst and lead to life threatening bleeding.

Case study

The CT scan showed the malformation to be extremely complex, with the arteries and veins hopelessly intermixed. Dr Bedi concluded that an early intervention was the only hope for the patient. However, the intricate nature of the pathology was expected to cause major problems during the procedure because both X-ray and CT scan images were two-dimensional and didn't give absolute clarity in terms of the exact complexity.

The MRL team, led by Prof Rupinder Singh, decided to use FDM technology to 3D print a prototype of the malformation based on the CT scan images. The MRL team chose the uPrint SE 3D Printer from Stratasys to print the life-size prototype from ABS thermoplastic.

The result was nothing less than outstanding. The 3D printer created the exact replica of the malformation and made Dr Bedi's quest of examining it extremely easy. Dr Bedi could easily rotate the prototype and view it from all crucial angles before the surgery. He studied it closely and understood the nature of its complexity. Armed with crucial knowledge and understanding of the malformation, Dr Bedi performed a minimally invasive surgery on the patient with ease.

The 3D prototype helped Dr Bedi in more ways than anticipated. The surgery otherwise would have taken at least four hours to complete and had the risk of failure because a mistake of even one millimetre could have triggered bleeding, putting the patient's life in danger. But because Dr Bedi knew exactly where to operate, he was able to successfully complete the surgery in just one hour and 30 minutes with only 100 ml of blood loss, which, otherwise could have required at least two units of blood. The surgeon was able to achieve this rare feat purely because of the knowledge he had gathered from the 3D prototype. After the surgery, the patient recovered rapidly and his bluish colour was replaced by a healthy normal pink as his oxygen levels immediately jumped to normal. The patient was discharged from the hospital only two days after the surgery.

Professor Rupinder Singh of the MRL team feels that the marvels of FDM technology can be used in meeting many other challenges in healthcare and believes that it should spread rapidly across the country. Dr Bedi was ecstatic that a complex medical malformation could so easily be understood with 3D printing. I foresee an immense contribution of 3D printing technology in minimally invasive surgeries and precise procedures, which will lead to enhanced patient safety and huge reduction in operation time, he said.

Professor (Dr) JS Grewal Head of the Department of Production Engineering agreed. I think 3D printing is of great help to society and the medical fraternity. We are more than happy to help such patients and are ready to take up more such cases from the medical fraternity, he said.