

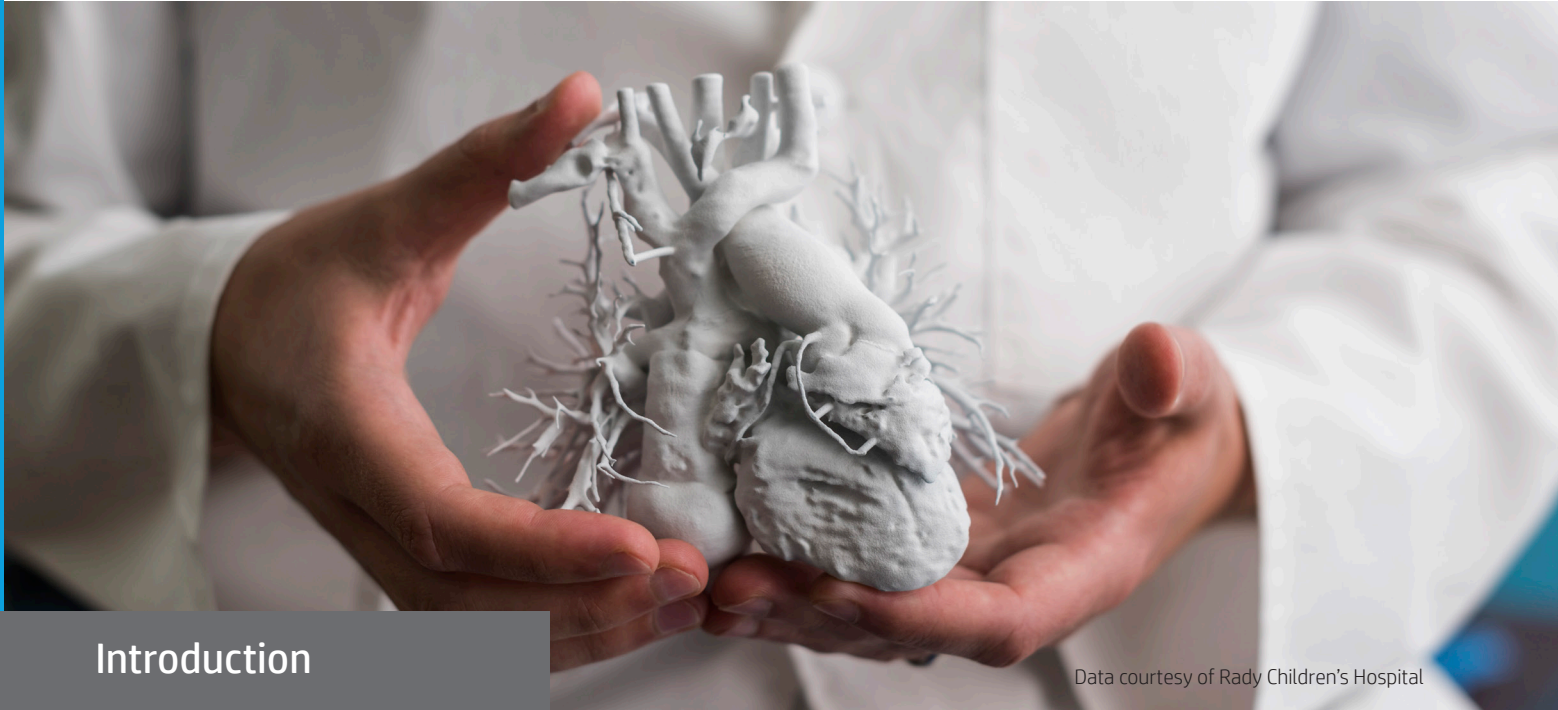
CASE STUDY | RADY CHILDREN'S HOSPITAL

Rady Children's Hospital works toward innovative healthcare solutions with HP Jet Fusion 3D Printing



Data courtesy of Rady Children's Hospital

The **HP Jet Fusion 580 Color 3D Printer** has allowed **Rady Children's** to improve the way they educate and inform clinicians, patients, and families



Data courtesy of Rady Children's Hospital

Introduction

Rady Children's Hospital-San Diego is a pediatric medical and research center that serves San Diego and Imperial counties and southern Riverside County. As California's largest children's hospital (by admissions) and the region's only pediatric trauma center, Rady Children's mission, according to their website, is to "enhance the health and development potential of children through excellence in care, education, research, and advocacy."

Rady Children's is recognized nationally for medical excellence by U.S. News & World Report, for nursing excellence by the American Nurses Credentialing Center, and for technological

advancement, named one of the country's "Most Wired" organizations by the College of Healthcare Information Management Executives.

Justin Ryan, Ph.D., joined Rady Children's in June 2018 as director of the hospital's new 3D Innovations (3DI) Lab, the first lab of its kind in Southern California. As part of the hospital's collective initiatives, the 3DI Lab uses 3D printing technology as a comprehensive tool for surgical and procedural planning, education, and research to improve outcomes for patients.

• Industry

Healthcare

• Sector

Hospitals

• Objective

To simplify and accelerate the design and production of anatomical models by adopting HP Multi Jet Fusion technology.

• Approach

After years of relying on outsourced 3D printing services, Rady Children's brought the technology in-house to more quickly and efficiently create 3D printed medical models.

• Technology | Solution

HP Multi Jet Fusion technology, HP Jet Fusion 580 Color 3D Printer

• Material

HP 3D High Reusability¹ CB PA 12

1. HP Jet Fusion 3D Printing Solutions using HP 3D High Reusability PA 12 provide up to 80% powder reusability ratio, producing functional parts batch after batch. For testing, material is aged in real printing conditions and powder is tracked by generations (worst case for reusability). Parts are then made from each generation and tested for mechanical properties and accuracy.

Challenge

For a few years, the orthopedics department at Rady Children's Hospital had been 3D printing anatomical models using FDM printers, and the cardiology unit often outsourced 3D printing projects. These departments ultimately wanted to bring more 3D printing technology in-house to reduce turnaround time and enable new innovations in the medical domain.

Outsourced projects could take at least 2 weeks to complete and often could only be delivered during business hours. These projects included 3D printing anatomical models for procedural and surgical planning; educational tools for medical students and fellows; and educational models to more clearly explain a medical condition or surgical procedure to patients and families. Due to the lengthy production

schedule, Rady Children's was only able to complete about one to two outsourced projects per month.

The costs of outsourced 3D models were also a burden for the hospital: A small FDM model could cost between \$600 USD and \$700 USD, and larger models could cost in excess of \$1,200 USD.

Bringing 3D printing technology in-house offered an opportunity for cost savings and new projects. Therefore, when Dr. Ryan joined Rady Children's to start hospital's new 3D Innovations (3DI) Lab—which was launched in July 2018—he sought solutions that would best enable these benefits as well as innovation across all departments in the institution.

Solution

Rady Children's developed an interest in HP Multi Jet Fusion technology when the medical staff learned about its ability to produce delicate and resilient structures, which had been a challenge with the hospital's former binder jetting technology. Therefore, the 3DI Lab made sure to include the HP Jet Fusion 580 Color 3D Printer in its new facility.

Rady Children's installed its HP Jet Fusion 580 Color 3D Printer in October 2018. Since then, Dr. Ryan has been using the printer to produce anatomical models.

The process for creating a 3D printed anatomical model starts at patient diagnosis. Radiologists acquire medical images via a computerized tomography (CT) scan or a magnetic resonance imaging (MRI) scan, the image datasets of which are essentially many slices of images that are stacked on top of one another in a computer. After processing these images with specialized software, the doctors end up with a three-dimensional computer model of the patient's anatomy.

Depending on the ultimate goal, the computerized 3D models may require further refinement. For example, anatomical

models for surgical planning may need to be color-coded or virtually cut to reveal deeper structures, while parts of educational models may need to be simplified or exemplified to display different types of anatomy or pathology.

Then, once the anatomical model is 3D printed, it is delivered to surgeons or specialists who can review it during conference, which is when surgical plans are conceptualized before a procedure.

Using the model, **“surgeons can discuss the specific size and shape of the anatomical defect, and it gives them more information for a better procedure intended for a specific patient,”** says Dr. Ryan. **“Since they know very intimately what the anatomy looks like, they perform the surgery with greater confidence and under less time, which has incredible implications: If you can reduce surgical time, you in fact reduce anesthesia time and bypass time, which has a direct correlation to reduction of complications—especially stroke events.”**

Results

Rady Children's staff have reaped the host of benefits provided by HP Multi Jet Fusion technology, particularly in terms of efficiency, quality, and cost.

“With some of the other technologies, we would print duplicate models knowing that one might not make it—one or two might break,” says Dr. Ryan. **“We haven't had to do that with HP. This is really due to the ideal mechanical properties.”**

With in-house production capabilities, Rady Children's staff can save time that used to be spent outsourcing projects. Instead of waiting 4 days or more for an anatomical model, they now can produce a model for a critical patient and have it ready to review the following day, or even the same day. With HP MJF as an integrated point-of-care process, Rady Children's has noticed savings in both time and expenses compared with outsourcing.

Dr. Ryan further highlights the potential decrease in costs: **“Operating room (OR) time has a correlation to cost. Mayo Clinic reports that one minute of their OR time is between \$80 and \$150 USD², so if you can save a few minutes of operating time by having a model better educate a surgical team, that’s going to be a great way to save on resources.”**

According to Dr. Ryan, HP Multi Jet Fusion’s benefits encapsulate accuracy, potential for color, mechanical properties, and consistency: **“You can’t just have one of those elements and sacrifice other ones,”** he says, **“especially for a hospital where consistency and accuracy are critical.”**

HP Jet Fusion 3D Printing Solutions’ color potential presents additional benefits for clinicians and patients alike.

“Color has become a previously unforeseen critical need in our care here,” Dr. Ryan says. **“It not only helps to communicate complex anatomy between disciplines, but it is also critical in explaining to families who may not have a medical background. A color 3D printed model means that clinicians can provide that same information in a concise manner. We ensure that all of our families have true informed consent; these color models ensure everyone understands the inherent medical complexities.”**

With HP Multi Jet Fusion, **“I have better peace of mind than with our other current technologies. It’s been great in terms of its consistency, and that’s something that I come to expect from the HP name.”** says Dr. Ryan.

A patient’s story

At Rady Children’s Hospital, to-scale heart models serve not only to educate patients and their families regarding the complicated anatomy of the heart but also provide surgeons with the opportunity to inspect the patient’s specific condition or anatomy, develop a surgical plan, and even test the plan in advance of the actual surgery to ensure accuracy and limit the chances for complications.

Leanne Wilbert’s son exemplifies one such case: **“We found out that our son had a heart condition called transposition of the great arteries, where the two main arteries are switched,”** she said. **“We knew pretty far in advance that he was going to need open-heart surgery when he was born.”**

After researching hospitals and interviewing surgeons throughout Southern California, Wilbert and her husband chose Rady Children’s Hospital as the site for their son’s cardiac surgery. The team at Rady’s obtained an image of Wilbert’s son’s heart from a CT scan, and after creating a computerized 3D version of the heart, they were able to print a to-scale 3D model using HP MJF technology.

“Specifically, with HP Multi Jet Fusion, it captures the anatomy very well,” says Dr. Ryan. **“The spatial resolution and mechanical properties are great, especially compared to competing technologies.”**

With the 3D anatomical model in hand, the surgeon was able to try different surgical approaches to achieve a successful result. In closely inspecting the 3D part, the surgeon was even able to identify a second ventricular septal defect (VSD), also known as a hole in the heart.

“We knew [our son] had one [VSD], but once we had that imaging, we were able to see that there was another small one,” Wilbert says.

“[The surgical team] could know in advance exactly what they were going to be facing and exactly what they needed to do to make sure that it was done smoothly without any complications,” Wilbert added. **“We feel that this should be in every single hospital; everyone should have the opportunity to have it done.”**

2. Morris, J. (2018, April). Rise of Point-of-Care Manufacturing: Impacting More Patients with 3D Printing. Keynote presented at RAPID +TCT, Fort Worth, Texas.

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