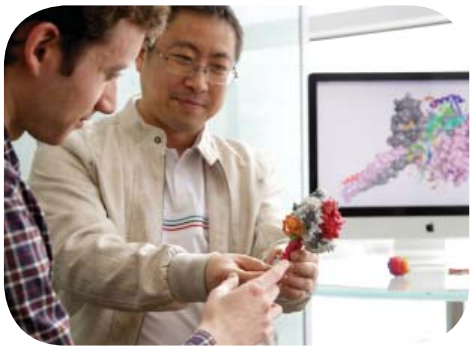

Nationwide Children's Hospital, Research Institute

ColorJet Printing helps vaccine research by providing physical full color representations of the Respiratory Syncytial Virus (RSV)

"The 3D printed models of the F protein has helped us see RSV in enough detail to develop new intuitions about how it works and how it doesn't. This last dimension provides researchers with critical information. Even with prior access to stereo-3D monitors and professional graphics cards, nothing compares to a full color, physical 3D model***."***

Dr. William C. Ray
Principal Investigator and Faculty Member
The Battelle Center for Mathematical Medecine

Full color 3D printing has been available for a few years now, much to the delight of design and engineering communities. Professionals in these fields rely on color in their concept models to help them evaluate and modify their final product, which has caused architects, product designers, film producers and footwear manufacturers to jump at making the most of this technology. But what if your focus is not on constructing something physical? What if instead you are interested in deconstructing something unknown to chase down the inner workings of a virus and find a cure? Can full color 3D printing aid the development of vaccines?

That is exactly what Principal Investigator and faculty member of The Battelle Center for Mathematical Medicine, Dr. William C. Ray, is trying to find out in his work at the Research Institute of Nationwide Children's Hospital.

Dr. Ray is up against Respiratory Syncytial Virus (RSV), the leading viral cause of lower respiratory tract infection in infants and children worldwide. RSV has an estimated annual global disease burden of 64 million cases and 160,000 deaths. RSV is the most common cause of bronchiolitis and pneumonia in the United States for children under 1 year of age, and each year 75,000 to 125,000 children are hospitalized due to RSV infection, most under 6 months. It is estimated that more than 8.5 million adults (including those over age 65) are also infected annually. In the United States and Europe, approximately 900,000 hospitalizations result from RSV each year. Taking hospitalizations, lost work days and mortality into account, RSV costs billions of dollars annually. There is currently no approved vaccine for the prevention of RSV.

A tremendous problem facing Dr. Ray and his fellow researchers is that no one is sure how RSV actually works. One thing that has become evident about the virus, however, is that a critical part of RSV's lifecycle involves a molecular machine (the "F protein") that is used to stir together the viral envelope and the targeted cell membrane. This results in the deposit of a viral payload into the cell. Putting a wrench in the gears of this machine would stop the infection process, but because the gears of this metaphor have not yet been located (i.e. we still do not know how it works), past attempts to find a vaccine have failed.

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To determine the true colors of this machinery, Dr. Ray set out to study the F protein using 3D printing. With a background in computational graphics, Dr. Ray knew relying on 2-dimensional pictures would not yield the degree of insight required to solve the challenge of RSV, but he believed color 3D printed representations of the virus would benefit his research. Thus, when his center was awarded funding to invest in new technology to support its research, Dr. Ray jumped at the chance to obtain a full color ZPrinter® from 3D Systems.

William and his team, including noted virologist Mark Peeples, as well as William's wife and longtime collaborator, Joan Ray, modeled the RSV using computer graphics and computational physics tools. They then 3D printed models of the F protein, so they could hold it in their hands and gain visual access to the elusive third dimension of its molecular machinery. This has helped them see RSV in enough detail to formulate new intuitions about how it works and how it does not. According to William, this third dimension provides researchers with critical information. Even with prior access to stereo-3D monitors and professional graphics cards, nothing compares to a full color, physical 3D model.

Though Dr. Ray is quick to emphasize that a cure for RSV is still a ways off, he says ready access to color 3D models has moved research substantially forward and inspired new ideas about how RSV functions. 3D visualizations have also been instrumental in debunking former disruptive myths about the virus that had been leading researchers down unproductive paths.

Yet even for sophisticated users with extensive experience in photoreal graphics, 3D visualizations can do a poor job of conveying uncertainty. Though portions of models containing calculation error may be colored differently to indicate this distinction, uncertain parts are still just as real on the screen as the parts that are certain. This disconnect is exacerbated with solid 3D prints, as speculative parts of the model are just as solid in your hand as high-confidence portions. Therefore, at least until new technology allows us to print models with variable flexibility to tactilely represent uncertainty, the knowledge-transfer benefits of 3D printing are paired with the responsibility to remain ever cognizant of the reliability limitations of our current models.

This realization notwithstanding, the research community now has another tool in its arsenal to assist it in its quest to isolate, understand and resolve harmful pathogens and threats to our health. Full color 3D printers can cost between $29,000 and $114,000, but for the advancement of our physical wellbeing and the knowledge of modern medicine, the investment is well worth it. After all, if a picture is worth a thousand words, a full color 3D model is all but priceless.

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