BY SCOTT DELP, PhD

Moon Shots in Biomedical Computation

The world changed when Neil Armstrong set foot on the moon in 1969. Humans could survive outside the earth's atmosphere! Science and engineering could achieve great things! And the nerds at the Mission Control Center in Houston were so cool. As I watched this event on TV, my brothers and I decided to order our first Heathkit, an educational electronics kit, launching us as a family of nerds.

The project of putting a man on the moon was a powerful, galvanizing force in science and engineering. The goal was challenging and clear and captivated the minds and hearts of the American public. Achieving the goal required an extremely talented and dedicated team.

Today, science needs more moon shots—projects that achieve important breakthroughs through the heroic efforts of many people. Projects that captivate the public and inspire a new generation of kids to pursue science and engineering.

What is a moon shot for biomedical computation? Fortunately, plenty of projects could fit the bill. In my own spectrum, three come to mind. The first would provide simulations that improve treatment outcomes for persons with movement disorders. Young children with cerebral palsy, for example, undergo a variety of orthopaedic and neurosurgical procedures to improve their mobility. While some experience dramatic improvements in their functional capacities, others are left with weak or dysfunctional limbs. Developing computational models that represent the neuromuscular system with sufficient accuracy to predict the outcome of these interventions and provide consistent positive results for individuals with movement disorders is a scientific and engineering challenge not unlike going to the moon. The development of these models would require collaboration among biologists, physicians, computational scientists, and bioengineers across the globe. While I was thrilled by the television images of one giant step for mankind, this could not compare to the thrill of watching a child taking his or her first steps unencumbered by disease.

A second moon shot is designing life. Almost nothing in biology is currently designed. By contrast, almost every complex product we use is designed with simulations. Dishwashers, cars, aircraft, and cell phones are all designed in software before they are implemented in physical reality. Working together, biologists, computation scientists, and design engineers could apply the same engineering capacity to design proteins, molecular machines, implantable devices, and drugs. That would be a moon shot. The ability to engineer and design biology would change the world.

Third, a collaboration among biologists, physicians, computational scientists and bioengineers could produce a digital human—a computational model of human form and function with the complexity and range of behaviors similar to a real human. A digital human would be used to study the mechanisms of disease, design biomedical devices, and predict the outcome of treatments. It could be used to teach anatomy, test drugs, and probe the basis of human behavior. A moon shot for sure.

These are just three examples that come from work in my own laboratory and from the mission of Simbios, a National Center for Biomedical Computing based at Stanford University. I encourage each of you to develop your own personal moon shots. As leaders and participants of an effort to build an infrastructure that enables biomedical computing on a broad basis, it is incumbent upon us to define clear and challenging goals that will dazzle the world. □

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