(As published in The Oak Ridger's Historically Speaking column the week of July 16, 2018)

Benita Albert brings us the conclusion of her two-part series featuring Oak Ridge High School alumni, Bill Nowlin.

There was a knock at my Oak Ridge High School classroom door late one afternoon in 2005, and as I welcomed in the tall, handsome gentleman, it was his voice and his big smile that cued me to his identity. He was a former student, Bill Nowlin, returning to my classroom twenty-three years after I had the privilege to teach him.

Bill told me, what seemed a fantastical story at the time, of his career as a designer of robots to perform human surgeries. I marveled at such an invention and thrilled over Bill's claims that his work was much about mathematics; that the foundation for his design work began in Calculus at ORHS.

Then again in November of 2006, I learned that Bill would be back in Oak Ridge, meeting with Methodist Medical Center officials and surgical doctors who hoped to raise funds to purchase a daVinci Surgical System. Bill's (Intuitive Surgical's) robot was coming to Oak Ridge!

Along with his many already scheduled meetings in Oak Ridge, I prevailed on Bill to make some time to meet with ORHS mathematics students. Bill met spoke to two different class periods of students, a total of more than 200 enthralled and curious young minds.

Bill's engaging, down-to-earth presentation style and his demonstrations with a robot arm, allowing students the chance to work with it, made it problematic to move students out of the room for their next class period. The students had so many questions and ample enthusiasm for what they were seeing. Bill mentioned to the students that the full robot was on display at the hospital, and that provoked a virtual stampede of the hospital immediately after school the same day.

The students not only wanted to see the robot but also to manipulate it. It was Bill's 'Pied Piper' personality, his obvious passion for his work and his encouragement and advice to the students that made this experience truly special.

Remembering the impression, he made on students that day, I recently asked Bill for advice to high school students who were seeking a STEM career or specifically a career in robotics. He said, "Understanding math or physics or computers...is really only part of a successful career. There are so many other aspects, particularly the ability to communicate clearly in all media, spoken or written, quickly or formally, one-on-one or one-to-many.

Communication gets more important as technology keeps advancing, because as a technologist, you must cross tribal boundaries to get anything 'real' done. And you must be able to talk outside your area of deep expertise in order to judge whether another's work is worth your investment. When I graduated from high school, I was a poor writer, but I was at least a student of human behavior. I mean, every nerd has to be a student of human behavior because it doesn't come to us easily like it does to the cool kids. We're awkward, and we have to overcome that."

Bill has "overcome," excelled and is making life better for human health with his creative and disciplined mind. His career in technology is ever changing and offering him new challenges and dreams. This is evidenced in the chronology of his career to follow. I will quote his words extensively in describing the technical aspects of his work, allowing you, the reader, to enjoy his clarity of communication.

After receiving his doctorate from Harvard, Bill joined SRI International in California. It was an SRI scientist, Phil Green, working on an Army project, who first conceived of a robot that could remotely operate on wounded soldiers. Bill says, "The SRI team's invention was very complex, with a stereoscopic camera and wrist manipulators. The idea was to have a surgeon operate from a distance."

Eventually, Intuitive Surgical, a Silicon Valley Company created by three investors, teamed with SRI to develop this technology. A first plan was to "Improve upon the laparoscopic gall bladder surgeries of the 1980s by adding greater precision, more intuitive operation, improved vision and an ergonomic working environment for the surgeon in the room."

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Bill hired into this new company as the seventeenth employee. Bill says his early responsibilities were to "define the controller requirements for the hardware specifications. I had another skunkworks project to make working on a beating heart appear as if the heart were still...But the accelerations of a beating heart far outstripped what our manipulators could produce at the time, so while we do beating heart surgeries, we adopt the conventional technique of stabilizing a local area on the heart so it doesn't move much...I did get a cool patent out of it."

Bill has now worked with four generations of the daVinci Surgical System. He describes this evolution in fascinating detail. "The first generation had three arms on a tower near the patient, and a surgeon's console with two joystick-like Input devices. It was modestly successful, but we realized that a fourth arm on the patient side would really help the surgeon. In surgery, one needs 'traction and counter-traction' when one is dissecting. One arm is pulling the tissue one way, and a second arm is providing delicate counter-traction to expose the tissue plains, and a third arm is doing the actual dissection. And of course, a fourth arm is holding the camera. I led the project to retrofit a third manipulation arm onto our then current project. It was a big win for the technology.

The second generation redesigned the patient-side arms to be much narrower and with much greater range of motion. There were many interesting trade-offs. The arms lost their very low friction, but we found a way to make them backdrivable. The reduced size eliminated collisions in tight spaces, enabling more and different kinds of surgery. The additional range of motion enabled us to vastly simplify the passive degrees of freedom in the tower arms that held the manipulators. This made set-up prior to surgery much less of a cryptic art and more of a reproducible science. The third generation redesigned the surgeon's console and brought true High Definition vision.

The fourth generation redesigned the patient-side system. The manipulators got even smaller, with even more range of motion. But more importantly, the camera was redesigned and shrunk to be just like one of the other instruments. This meant that our four patient side arms could be identical, which meant that we could accomplish something called 'four quadrant surgery,' which is where the camera has to approach from radically different directions during different parts of the surgery.

What used to require backing the patient cart away from the patient and driving it around to the other side, we could now do by moving the camera to another arm. Now daVinci is ready to tackle all of general surgery, which is the largest segment of surgical procedures in the world."

Bill's work has obviously never been static. As he describes new work assignments, "I graduated from designing and tuning control systems to using my signal processing background to design and perfect safety systems that monitored the thousands of signals racing around the system." Later job assignments in management of the controls group and the software team ensued, followed by his creating and managing a stand-alone Quality Department.

His latest challenge is in data and analytics. He says, "da Vinci records tons of information about what and how it is doing (nothing about the patient or the surgeon), just like a jet airplane's black box. My job now, in part, is to link that data to the rest of our company data, and to provide data-driven products for our surgeons to help them do surgery better."

I asked Bill to provide a future perspective on his work, his hopes and dreams and also practical considerations, to which he replied, "I do see tremendous opportunity to expand the science of surgical technology way beyond the design of a surgical robot. The robot is the platform on top of which another revolutionary generation of technology will be built. And I don't mean self-driving robots.

I am not a fan of self-driving cars...Our goal is to make every surgery, no matter what the comorbidities or prior conditions of the patient, be executed absolutely as well as the very best on the easiest patient, and perhaps, most urgently, to drastically reduce the time and the number of procedures that it takes a surgeon to get from good to great...All these problems are at the cutting edge of complex interactions between human and machine and between human and human, and all are amenable to attack with the tools of machine learning and data science."

Bill's final advice to students mirrors what his career has been: Collegiate studies should emphasize critical reasoning, gaining basic skills for the knowledge worker economy and opening your eyes to the immense amount of knowledge that is out there."

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He continues, the grad school experience should "...teach you how to learn on your own and teach you to never stop learning. The technology will change out from under you, but the language of cooperative learning and problem solving never changes. Who knows what life-changing coming together of technology and opportunity will land in your lap?"

Wow, really WOW! What a snapshot of the future Benita has brought us. Each of her selected Oak Ridge High School alumni she has chosen to feature has been outstanding in their field. We Oak Ridgers should be most proud of her AND what she has been able to do for her students. Who knows what to expect next...and WHO KNOWS what to expect next of Bill Nowlin!!!

I asked Bill to send some recent photographs to illustrate this second part of Benita's series. He responded with several. I have selected some I think you readers will enjoy.



Benita Albert with the daVinci Surgical System

Bill Nowlin, Part 2 (As published in The Oak Ridger's Historically Speaking column the week of July 16, 2018)



This has to be a favorite. Bill says, "I've tried pizza all over, and I still believe that Big Ed's is the best there is."

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Bill is an avid cyclist



Bill says of this photo, " From an exhausting but fun day this past June in France."

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Bill Nowlin