UP TO CODE

With SBIR and RIF funding, company builds machine learning program to sketch composites from DNA samples

T t's technology straight out of science fiction.

What if, using only a small sample of DNA (from a bit of saliva, say, or even just a fingerprint), we could create a composite sketch of a human being—accurate down to the color of their eyes and hair?

That's exactly what Parabon NanoLabs, a tech company based out of Reston, Virginia, has managed to do. With help from the Department of Defense (DoD) Small Business Innovation Research (SBIR) program, and critical follow-on support from the Defense Rapid Innovation Fund (RIF), the company has developed its Snapshot DNA analysis program, a cutting-edge forensic tool that delivers phenotype (i.e., trait) and extended kinship predictions for law enforcement and military agencies. Wife and husband team Paula and Steve Armentrout teamed with Dr. Michael Norton to co-found the company in 2008 as a spinout of the couple's supercomputing business. In the beginning, they said, the idea was to apply computational power and tools to applications involving DNA.

"At our core, we're a software shop," Paula Armentrout, the company's vice president, said.

In 2009, the company identified an SBIR solicitation from the Defense Threat Reduction Agency

(DTRA)—an arm of the Department of Defense (DoD). In order to more readily track down enemy combatants, the agency was searching for a company that could develop a way to identify characteristics from DNA left on improvised explosive devices in combat zones.

Many of the companies that offered proposals attempted to

tackle the issue with chemistry, Paula Armentrout said, but Parabon took a different tack—computation and software.

"We're used to seeing people on TV upload crime scene DNA into a DNA database, finding a match, and then making an arrest, 1-2-3. But for DNA from an IED in a war zone there aren't any databases," Steve Armentrout, the company's CEO, said. "What is DNA

good for in such a scenario? We looked at the question and said this is a machine learning problem, an AI problem."

At the time, he noted, there was "no playbook" for what genetic sequences coded for certain phenotypes (things such as hair color or face morphology). So the company decided to build its own system, using a machine learning algorithm and known examples



Steve and Paula Armentrout

processed with medical DNA scanners that were far different than those used by the forensics community at the time. Eventually, their software could reliably connect a gene sequence with a phenotype.

"By having enough people with blue versus green versus brown eyes in the database, these algorithms can go in and learn what genes are responsible for different eye colors," Steve Armentrout said.

Parabon proved the feasibility of its technique through the Phase I SBIR, which eventually led to a

"We wouldn't have had the resources to go in this direction without the SBIR and RIF programs," Steve Armentrout said. Phase II in 2012 to develop the Snapshot program. The company launched the program to crime agencies beginning in 2015, and it was *not* an immediate hit, the pair said.

"People were incredulous," Steve Armentrout said. "Prior to Snapshot, detectives used DNA at the beginning of the investigation, but they would never think

about it again unless they received a call that they had gotten a hit in a state or national DNA database. We had to open everyone's eyes to the possibility that DNA could be used in a new way to generate leads and narrow suspect pools...and over the course of a few years it began to catch on." In 2018 Parabon added a genetic genealogy (GG) service to its Snapshot suite of services. GG is a revolutionary and complementary capability to

> Parabon's pioneering efforts, which ties DNA to genealogy and family histories. The combination of Parabon's technology and skilled GG investigators has proven effective in generating leads.

> To date Parabon's Snapshot Advanced DNA Analysis Services have assisted in the solving of more than 100 cases that, on average, have been cold for more than 25 years.

> > "Traditional DNA



The DNA analysis technology pioneered by Parabon Nanolabs, Inc. has revolutionized the potential ability for warfighters and first responders to identify individuals of interest.

analysis treats DNA like a fingerprint, useful for identification. But Snapshot treats it like a blueprint for how to build a human, and we're just using that genetic information to help solve these cases," Steve Armentrout said.

On the military side, Parabon is deploying modules of the Snapshot technology at the Armed Forces DNA Identification Laboratory (AFDIL) to aid in the identification of fallen soldiers from past conflicts.

In 2016, Parabon was awarded a RIF contract as a Phase III follow-on to its DTRA SBIR for Snapshot to develop a new software platform for forensic analysis of DNA evidence. That platform, Parabon FxTM, represents the "next generation" of DNA analysis, with the ability to read an entire

gene sequence, allowing for extremely fine grain analysis, according to the company.

The platform-agnostic technology means that, with Parabon Fx, "you can analyze data from any DNA analysis instrument," Paula Armentrout said.

All of this work, Steve Armentrout said, was facilitated with seeding from the SBIR and RIF programs and sponsored by the DoD Office of the Deputy Assistant Secretary of Defense, Emerging Capabilities & Prototyping, the Armed Forces DNA Identification Laboratory, and the Army Research Office.

"It's difficult to overstate. We wouldn't have had the resources to go in this direction without the SBIR and RIF programs," he said.

"If you look at what this tech has done in the forensics world, it's really revolutionary," he added. "Sometimes, it takes industry outsiders to

> push the boundaries and help people realize what is possible."



Modernization Priorities: Artifical Intelligence (AI) and Biotechnology

RIF Award: 2015 OSD RRTO: "Bioinformatics Platform for Forensic Analysis" (W911NF-16-C-0085) – SBIR Phase III Enabling SBIR: DTRA topic DTRA102-007 "SNAPSHOT: A System for Predicting Human Physical Traits from Sample DNA" (Phase II contract: HDTRA1-12-C-0075)

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