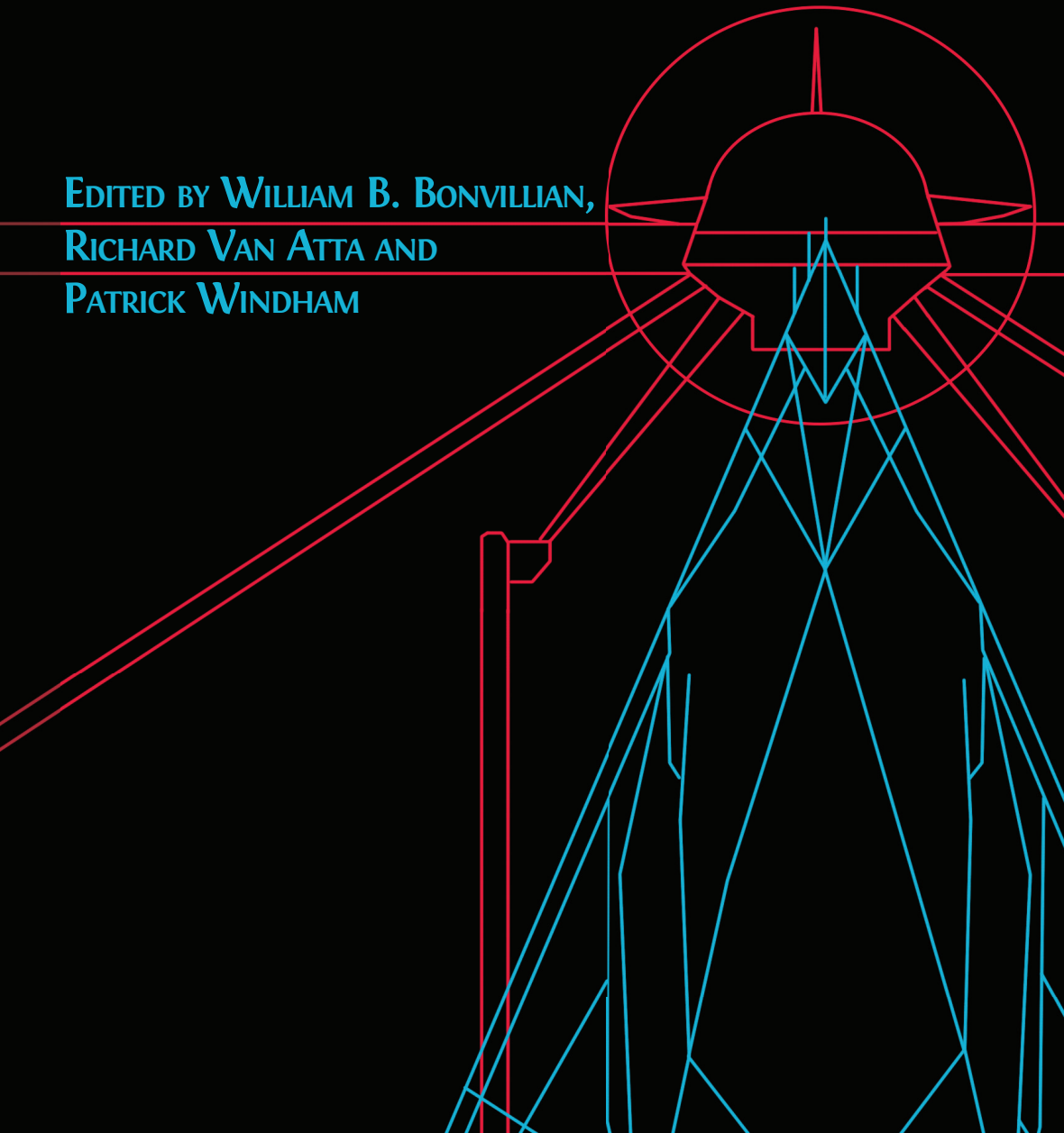# The DARPA Model for Transformative Technologies

Perspectives on the U.S. Defense Advanced Research Projects Agency

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11. Program Management at DARPA

A Personal Perspective[1]

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In this chapter, I provide a perspective on my experiences at DARPA as a program manager. In Chapter 10 above, Jinendra Ranka recounts his experiences as a DARPA program manager. These two perspectives expound highly different experiences. While there are certainly common themes, there is also a large degree of variance.

How does one create programs at DARPA? When I started at DARPA, I had a general charter to work in the area of applying machine learning to robotics, which had not been done to a significant extent up to that time. Before I joined DARPA, I knew machine learning groups at Bell Laboratories, although I had no direct experience in robotics. At DARPA, I was first assigned to take over two programs that were concluding. One program dealt with autonomous navigation, and one program concerned vehicle mobility. For the first six months, I was busy familiarizing myself with these fields: I watched the field tests, paid attention, and asked lots of questions.

During these first six months at the agency, I was able to identify factors that limited the performance of robots, and I then proposed three

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new programs to overcome limitations largely by applying machine learning to robotics.

Getting New Programs Approved

To get the programs approved, I first worked with the directors of two offices. One of my proposed programs received approval from the director of the Tactical Technologies Office (TTO), which develops prototype systems. I also worked in a second office, the Information Processing Techniques Office (IPTO, now called the Information Innovation Office, I2O), and my office director there helped me with the two other programs that I managed. Once we had developed the briefs, it was the role of the agency director at that time, Tony Tether, to make the final decisions. This was fairly typical, with the office directors coaching program managers and helping them prepare before they seek the agency director's approval.

Soliciting and Reviewing Proposals

After the concept for the program is approved and established, DARPA puts out a document called a Broad Agency Announcement (BAA)—a request for proposals. We would typically get between five and ten times as many submissions as we could fund. I wish to point out that this is not necessarily a positive, because putting together a proposal requires a tremendous amount of work on the part of the proposers. If we only fund a tiny fraction, then many researchers waste a large amount of their time preparing proposals. A better policy has developed in later years in which people submit short papers, known as whitepapers. On the basis of these short papers, program managers encourage those researchers who look likely to be funded to submit larger proposals, and those who look less likely to receive funding are not encouraged to submit full proposals. This saves time both for the researchers and also for the program managers.

In my own case, I had perhaps a hundred proposals to read. This was time-consuming, and, at times, painful, in that it was frustrating to observe the amount of effort people had put into proposals that would not be funded.

In order to pick the proposals that would be funded, I, as a program manager, appointed a team of government employees to read and review the proposals. This is not a peer review process akin to that conducted by the National Science Foundation, in which university professors review the proposals. Instead, a handful of government employees, led by the program manager, conduct the review. Our review was a rank-ordered list of the various proposals. Then we took that list to the DARPA director's office, and he would say: "Okay, I have so much money, I can fund up to this level."

Managing Programs

Next, I want to discuss managing programs.

On the one hand, program managers need humility. When I came to DARPA, I received some advice from my predecessor, who had managed the programs that I inherited. He informed me: "When you're a DARPA PM, you'll be treated like a king by those who depend upon you for funding. Do not act like a king. Stay humble. Your job is to serve the taxpayer". When you become a program manager, you suddenly attract many new friends, and people never contradict you. This can lead to a false impression of your own intellect and ability. It is therefore paramount that you understand that you are not as smart as the people surrounding you pretend that you are. It also means that you have to treat the people who you will fund with respect and must not treat them badly.

On the other hand, unlike NSF, the programs at DARPA are actively managed by the program manager. First, we set clear and realistic goals and schedules. There are milestones that R&D performers have to meet for the program to continue. In addition, we provide technical support and guidance when possible. In the robotics area, for example, I was not an expert in robotics *per se*, but I knew a great deal about machine learning. I would help the performers in their research by giving them suggestions on how to improve the behavior of the robots by incorporating learning. I was also actively involved in testing and evaluation. I greatly enjoyed the fact that, most of the time, I never wore a suit and a tie. Usually, I would be out in the mountains or the desert with hiking boots and blue jeans testing the robots.

For example, one time we brought some of the principal investigators to Fort Carson in Colorado, which is right at the foothills of the Rocky Mountains (where we conducted some of the robot testing). I am an experimental physicist, and this meant that when it came to the testing, I used the methodology that I had learned in physics while testing robots. I was actively involved in planning the actual test. It gave me the opportunity to exercise my pleasure in being a scientist.

It is very rare that programs proceed as the program manager expects: changes must be made to programs to ensure that progress is made to larger goals. In this way, program managers need to learn and adapt, and help their performers learn and adapt. They must, therefore, be both humble *and* active.

A typical program manager will have the necessary technical expertise and research experience. Very often, they will also have managerial experience. It is essential that they have a good understanding of relevant technology, along with the ability to lead a research community.

Independence, Responsibility, and Accomplishments

DARPA trusts its program managers and gives them great independence. In my own case, I was required to report on each program to the upper management about once a year. During the intervals between these reports, I largely had full autonomy in running the programs.

DARPA program managers also have considerable resources. For example, consider Dr. Gill Pratt, who later became the program manager for robotics, the leader of the 2012–2015 DARPA Robotics Challenge, and the person I helped in my subsequent role as a consultant to DARPA. Dr. Pratt had a total budget of about $50 million per year over six years—roughly $290 million in total. With that money, he ran programs in robotics, neuromorphic computing and computer vision. This money was adequate funding to make significant advances in the targeted technology.

One example of where the agency and its R&D performers made progress was the DARPA Robotics Challenge that I mentioned earlier, which was budgeted at $80 million over several years. The goal for that program was to develop robots capable of assisting humans and responding to natural and manmade disasters. Much of the inspiration

came from Dr. Pratt's experience trying to help at the Fukushima nuclear plant, after the 2011 accident there. The Robotics Challenge led to some impressive improvements in robots and became an example of how a DARPA program, with good leadership and adequate funding, can make real progress.