TECHNOLOGICAL ADVANCEMENT: THE CHOICE BEFORE US

James A. Lewis

Marshall Foch, commander of Allied Forces in World War I, is said to have remarked when he first saw an airplane in 1911, that "airplanes are interesting toys, but of no military value." Foch, like most others, did not recognize the destructive potential of the new technology or how it would change military and strategic calculations. Had this been predicted to him, he might well have thought of Jules Verne and of science fiction.

Advances in science and technology create military power. The first wave of advances came from the chemical industry and massive concentrations of high-powered explosives delivered by artillery-changed battlefields and tactics. The second wave was in electronics—first in sensors and then in computing. The third, which we are just entering, is in biotechnology (although this term is too narrow to capture the full range of change) and how it will enhance human performance. Each wave of technological change is layered upon its predecessor, and each wave changes what is required for military power. Biotech will be a major part of the defense industry of the future.

We already know some of the technologies involved: the drugs athletes use to boost strength and endurance or those that students use to boost mental acuity. Some are in testing—exoskeletons that will let humans lift and carry hundreds of pounds. Others are experimental—technologies that will create an "organic-silicon" link, where the tiny electrical impulses created by the brain will feed into computer networks to connect to mechanical devices.

Imagine: a monkey sits in a room. Electrodes are attached to his head. He looks at a screen upon which is pictured a banana. The monkey thinks of picking up the banana and miles away a mechanical arm, connecting to the monkey over the Internet, picks it up.

Other technologies use a sensor-laden helmet to sense the brain's electrical emissions. Organic-silicon linkages combine information and sensor technologies to turn these electrical impulses (already detectable by medical devices, such as electroencephalograms) into digital commands that can be transmitted to prosthetic devices or to a machine connected to the Internet. The first application may be a new generation of prosthetic devices to replace limbs lost in roadside bombings.

New classes of drugs will target pain, fatigue, stress, and the acuity of our senses. Exoskeletons, organic-to-silicon linkages, and drug enhancements are already here and will be deployable in the next few years. A further step would involve genetic enhancements, the ability to change physical performance temporarily by injecting genetic material to modify human traits—one test has already produced "Schwarzenegger mice," and other performance-enhancing genetic manipulations are possible. The research here, however, is at an early stage and, even if progress continues, we may be more than a decade away from being able to safely use this technology.

Like Foch, an initial reaction is that this is science fiction, but not if one considers the history of military technology. Flying, seeing in the dark, using tiny chips to perform complex calculations, or building weapons that rival the sun would have struck earlier generations as science fiction, if not wizardry. Using technology to enhance combatant performance has been the trend since the start of the industrial age. America has led in the development of technologies that increased the mobility and organic firepower of an individual soldier or unit. In the last two decades, technologies have improved decisionmaking and access to information. The result has been increased firepower, mobility, and informational advantage for combatants and commanders that sets a new standard for military performance. Now we are looking at the next wave of technology that will define both military performance and the future industrial base.

Of course, tactics, training, and doctrine must change to reap the full benefit of technological advances. Armies did indeed first use the airplane

Exoskeletons, organic-to-silicon linkages, and drug enhancements are already here and will be deployable in the next few years.

as a kind of flying bicycle, but pilots rapidly changed this by adding weapons. With very few exceptions, the effect of change in military technology has been incremental rather than revolutionary, as tactics and strategies lagged behind the capabilities of the new systems. And problems not amenable to military power—all the post-conflict political problems—require different solutions that advances in military technology will not supply. Civilian use will also require a careful rethinking accompanied by new rules and increased transparency.

The United States may also be unable to reap the full benefit because political problems will block or delay deployment. Political interference in scientific experimentation is commonplace in this country. The risk is not that outcomes will be distorted—we will not see an American Lysenko—but that promising avenues of research may be closed off by political pressure. It is easy to urge caution if you are not being shot at.

No one admits to being a technophobe, but the pace of discovery in America risks being slowed by armies of lawyers, political scientists, and ethicists who fear the consequences of technological change. To cite another historical example, some states required early cars to be proceeded by a walking flagman, waving a red flag because they feared the new technology and its seemingly dangerous speeds. We have many more people saying go slow, and there is some risk that fear will shape our approach to human enhancement, making it more likely that advances will occur somewhere other than in the United States.

This is the flip side of the advantages of human enhancement—the risks that come from fumbling adoption of the new technologies. Making our military more effective provides strategic advantage, but the greater advantage comes from the application of the new technology to commerce and the powerful impetus for growth this provides. The United States, for five decades, gained a unique economic advantage by linking the advances made from government investment in military research to commercial innovation.

The system that generated innovation and growth based on science and technology is broken, damaged by beliefs that government should shrink and that business will invest in public goods like research. The problem with the shrink-government approach is that it cannot sustain the U.S. role of superpower. Big breakthroughs come from government-funded programs. Innovation in the private sector tends to be a new flavor of soap or some new social network app.

In the last 20 years we made economic choices, perhaps unavoidable, that are shrinking our ability to manufacture the "old" technologies of metal chemicals and chips. These changes damage our ability to innovate, to come up with the new products that generate military advantage and economic growth. The damage from this can be reduced if we can take advantage of the "new" biotech industrial base (and if this new industry finally delivers on its long-awaited promise).

The alternative is to see our economic and military capabilities decline and watch the relative balance of power shift in ways unfavorable to our national interest. Power is now determined by the ability to innovate and grow more than it is by the size of a nation's military force. Technology offers harsh choices—our choice now is advance or decline. ■