Fact Sheet

Defense Advanced Research Projects Agency

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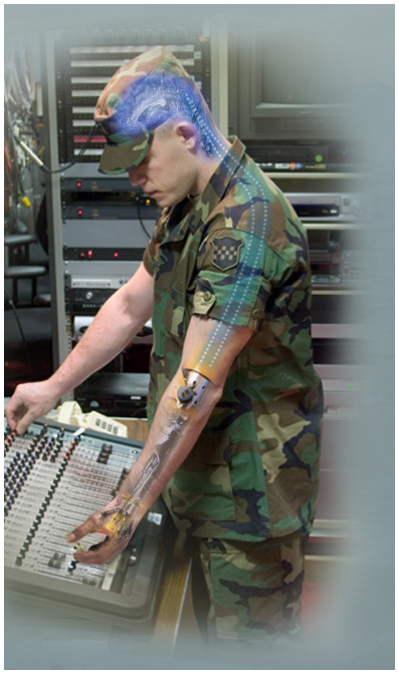
REVOLUTIONIZING PROSTHETICS PROGRAM

Throughout history, the battlefield loss of limbs has been the major driving force for technological progress in the field of prosthetics. For example, formation of the American Orthotic and Prosthetic Association resulting from the post-WWII leadership of Dr. Norman Kirk, Surgeon General of the Army, helped launch the modern era of prosthetic research in the United States. Current operations in Iraq and Afghanistan emphasize the urgent need to accelerate this progress with the goal of providing amputee soldiers with pre-injury levels of function and the ability to return to activities of their choice either within the Services or civilian society. The driving goal of DARPA's Revolutionizing Prosthetics initiative is to utilize and drive advances across disparate scientific disciplines for the benefit of the amputee soldier.



The human arm and hand is capable of extremely complex and varied movements and enables functional interaction with one's environment. DARPA's Revolutionizing Prosthetics initiative is focusing on the tremendous technical challenges of duplicating these abilities in an upper-extremity prosthetic device. DARPA expects that the technologies it develops will be readily adaptable to lower-extremity amputees, and expects civilian amputees to benefit as well as amputee soldiers.

In a speech given at DARPA's 24th Systems and Technology Symposium in August 2005, DARPA's Revolutionizing Prosthetics program manager, COL Geoffrey Ling, M.D., Ph.D., noted, "DARPA has undertaken the monumental task of fulfilling our pact to our Soldiers by embarking on an effort to provide fully integrated limb replacements that enable victims of upper body limb loss to perform arm and hand tasks with [the] strength and dexterity of the natural limb. . . . In four years, we anticipate having a prosthetic arm that will be controlled identically to the way that we control our biological arms." The full text of the speech is available at http://www.darpa.mil/body/news/2006/ling.pdf .

There are two separate programs that fall under DARPA's Revolutionizing Prosthetics initiative, Revolutionizing Prosthetics 2009 and Revolutionizing Prosthetics 2007. Each program has a lead contractor, and includes a large team of researchers. DARPA issued a press release in February 2006 (http://www.darpa.mil/body/news/2006/prosth.pdf) with information on each effort, the names of the lead contractors, and the names of some of the supporting research organizations.

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Revolutionizing Prosthetics 2009

The four-year Revolutionizing Prosthetics 2009 program will create a neurally controlled artificial limb that will restore full motor and sensory capability to upper extremity amputee patients. This revolutionary prosthesis will be controlled, feel, look and perform like the native limb. At the end of the four-year program, the resulting prosthesis will be ready for human clinical trials.

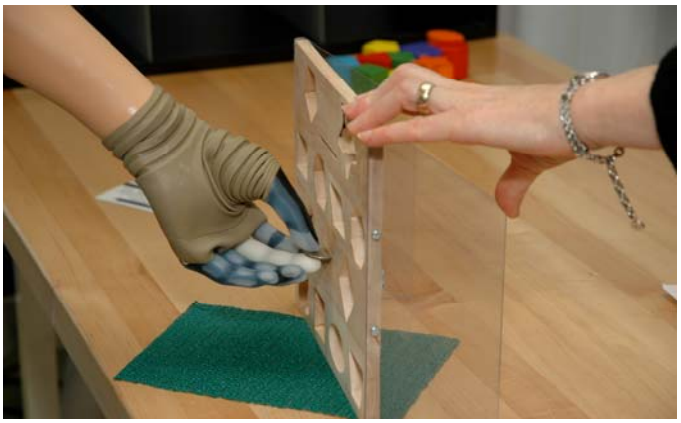

Photo courtesy of the Rehabilitation Institute of Chicago

The goal of this program is to produce a prosthetic that will be able to function as well as a normal human arm. Key to this is a prosthetic that has: sensors for proprioception (the ability to sense the position of the arm and hand relative to other parts of the body), touch, temperature and vibration; power that will allow at least 24 hours of normal use; mechanical components that will provide strength, environmental tolerance (heat, cold, water, humidity, dust, etc.); and, durability such that the device will last at least 10 years with normal use. The intent is that the amputee will be able to tolerate the prosthesis without any adverse affects for 18 hours/day of use.

Comparison of Revolutionizing Prosthetics 2009 Goals with State of the Art at Beginning of Program

Specification	*Current SOA*	*Final Goal "Human Capabilities"*
Neural Connection		
Interface	Myoelectric, visual, & stump interface	Direct closed-loop neural control
Reflex Control	None	Local
Sensory Capabilities		
Fingertip Discrimination	None	Complete
Two-point	None	1mm
Pressure	None	0.1 N/fingertip
Temperature	None	(± 4ºF)
Proprioception	Deficient	Full (± 1º)
Power & Actuation		
Strength	2.2 lbs	Natural capability
Elbow Lift		40 lbs
Grip		8 lbs
Wrist Extension		10 lbs
Endurance	24+ Hours	Human-like
Mobility	Low speed motors	Simultaneous use of many joints
Prosthetic Device		
Degrees of Freedom		
Hand	1 DOF	21 DOF
Wrist	2 DOF	3 DOF
Fit	Crude	User specific weight & shape
Survivability	Environmentally vulnerable	Full survivability

In short, this revolutionary mechanical arm will have the properties of a biological limb. With this new prosthetic, an upper extremity amputee would be able to feel and manipulate objects as that person would with a native hand. Research will focus mainly on advanced neural control strategies to allow the user to operate the arm in a near-biological manner. Ideally, the device would grant an amputee the fine motor control necessary to thread a needle, use a computer keyboard, play a piano, or perform fretwork on a guitar.

Revolutionizing Prosthetics 2007

At the end of the two-year Revolutionizing Prosthetics 2007 program, a prosthetic arm system will be ready for human clinical trials.

The Revolutionizing Prosthetics 2007 program will leverage recent research advances in a variety of fields to develop a prosthesis that will dramatically improve the capability of upper extremity prosthetic limbs beyond those that are currently available commercially. It will incorporate the best possible technologies and the most revolutionary short-term developments into a highly advanced, neurally interfaced[1] prosthetic arm. The focus will be on providing near-human strength in a prosthetic limb, and creating a prosthetic arm that is both functional and similar in appearance to the native limb. The new prosthesis will have increased range of motion, strength, endurance, and dexterity, and will significantly improve the ability of the arm amputee to perform the activities of daily living.

Additional Resources

- DARPA media contact: Jan Walker, (703) 696-2404, or jan.walker@darpa.mil
- American Forces Press Service article, February 2008: http://www.defenselink.mil/news/newsarticle.aspx?id=48987
- DoD Force Health Protection and Readiness magazine article, Winter 2008 issue, http://fhp.osd.mil/fhp_online/prosthetics.jsp
- For more detail on contractor activities and to request images, contact our contractor teams. For Revolutionizing Prosthetics 2009, contact Paulette Campbell at Johns Hopkins' Applied Physics Lab at 240-228-6792 or Paulette.Campbell@jhuapl.edu. For Revolutionizing Prosthetics 2007, contact Kerri Maxwell at DEKA Research at 603-669-5139 or kmaxwell@dekaresearch.com

[1] We use the term "neurally controlled" in the Revolutionizing Prosthetics 2009 program to mean that we expect most of the control of the prosthesis to come from high-fidelity neural signals. The plan for the Revolutionizing Prosthetics 2007 program, on the other hand, is a neurally interfaced prosthetic arm that would use low-fidelity neural signals complemented by more traditional control strategies such as surface EEG.

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- Low-resolution image (please credit DARPA): http://www.darpa.mil/body/news/2006/images/prosthetics.jpg .
- Johns Hopkins University Applied Physics Lab press release (April 2007) (includes high-resolution images): http://www.jhuapl.edu/newscenter/pressreleases/2007/070426.asp
- Johns Hopkins University Applied Physics Lab has a press kit available upon request.
- Walter Reed Army Medical Center has a very robust prosthesis department and is fitting soldiers today with advanced devices. Contact the Army Medical Department public affairs office at (210) 221-7105 or Walter Reed's public affairs office at (202) 782-7177.
- Physics Today article (Sept 2006): http://www.physicstoday.org/vol-59/iss-9/pdf/vol59no9p24_25.pdf
- Johns Hopkins University Applied Physics Lab press release (Feb 2006) (includes list of their team members): http://www.jhuapl.edu/newscenter/pressreleases/2006/060209.asp)
- DoD news article (Feb 2006): http://www.defenselink.mil/news/newsarticle.aspx?id=14914

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