DOE Artificial Retina Project
Fact Sheet

Overview of the DOE Artificial Retina Project:

The Artificial Retina Project's goals are to develop an implantable micro/nanoelectronic medical device that will restore useful vision to blind patients. The team, lead by Dr. Mark Humayun, consists of researchers at Doheny Eye Institute at University of Southern California, 5 Department of Energy laboratories, a company whose sole mission is developing and marketing a retinal prosthesis (Second Sight), and other university partners, including UC Santa Cruz and NC State University. The project made history when the first device of its kind was successfully implanted in a patient who has been blind for more than 50 years. Since then 5 more patients have been implanted, all with encouraging results. The first implant, made by Second Sight, is a 16 channel or pixel implant and allows the otherwise blind patients to see images transmitted from a tiny camera mounted on a pair of glasses. The goal of the project is to enhance the resolution (increase the pixels) and decrease the surgical complexity of the procedure so that this device will provide the patient with unaided mobility, as well as enable patients to recognize faces and read.

When and How Did the Artificial Retina Project Begin?

The project began 17 years ago because of the failure of medical and surgical treatments to help the large number of blind patients in the world. At the time of the project's inception, diabetes had robbed Dr. Humayun's grandmother of her vision. She helped raised him and this personal loss further fueled his desire to seek a cure for blindness. Dr. Humayan joined forces with Dr. Eugene de Juan (both were at Duke University at the time) to pursue the development of a retinal microelectronic implant for the blind. Dr. Humayun then obtained the necessary training in Ophthalmology as well as Biomedical Engineering and dedicated his career to the development of such an implant. 15 years later he and his team were able to implant the first of these devices into the eye of a patient.

How Did DOE Become Involved?

In 1999 DOE issued an announcement requesting research proposals for high-risk, high-impact bio-medical engineering research projects. The Artificial Retina Project was one of 17 projects selected by a peer-review panel to fund. Over the past years, the project has grown from a pilot project to a $20 million project that involves five DOE National Laboratories, three universities, and an industrial partner. The unique resources and expertise at the DOE National Laboratories, particularly in engineering, microfabrication, materials sciences and microelectronics, are ideally suited to address the technical challenges of developing a complex artificial retina device that will enable the blind to see.

What is the Current State and Capability of the Artificial Retina Implant?

Second Sight's current Model 1 implant, implanted in 6 patients, consists of a 16 channel microelectronic device in a one inch package that allows the implanted electronics to wirelessly communicate with a camera mounted on a pair of glasses. It is powered from a battery pack worn on a belt. It allows patients previously without light perception to distinguish objects within a forced choice test environment. These patients are now able to locate a chair, differentiate between a cup, plate, and knife, and trace out large 1.5 foot letters that are two feet away. A smaller Model 2 implant with more channels is under development.

Current Numbers of Patients Implanted with an Artificial Retina Device

A total of six patients have received the Model 1 - 16 electrode device to date.

Who should interested patients and members of the public contact for more information?

The phone number for the artificial retina hotline is (323) 317-9393

Purpose and Goal of the CRADA

The purpose and goal of the Cooperative Research And Development Agreement is to advance the science, technology and clinical success of the field of artificial sight using the broad range of unique facilities and resources at the DOE National Laboratories. The CRADA team will develop an advanced multielectrode array that can be used for partial sight restoration to people who are blind due to age-related macular degeneration or retinitis pigmentosa. Second Sight Medical Products Inc. has been chosen as the DOE's commercial CRADA partner because the company is the only company in the world who has successfully implanted patients with elementary first generation electrode devices which provide them with discernable visual sensations. Second Sight also has a second-generation device currently in development. A third generation system being developed in cooperation with DOE-funded science and technology program will provide blind patients a higher level of vision and is the key goal of this CRADA.

Future Advances in the DOE Artificial Retina Technology

Our future goal is to develop an artificial retina device with high enough resolution to enable not only mobility but the ability to read and recognize faces. This device will also be small enough to fit in the eye cavity, greatly simplifying the surgery.

How may the technology also be adapted for use treating other neurological diseases?

Much like the ocean, our bodies naturally have a corrosive effect on any implanted electronics. In addition, our bodies have biological mechanisms which reject foreign objects. The implantable technology we are developing will allow micro and some day nanoelectronic devices to be placed safely within the eye. These prosthetics will be able to send and retrieve information wirelessly and will some day open the window to a number of remotely controlled therapeutic and diagnostic instrumentation. The damaged nervous system has a limited ability to repair itself. Implantable microelectronic devices, like the artificial retina, will be useful to treat a wide range of neurological disorders. Other examples of neuroprosthesis presently in use are cochlear implants for deaf individuals and spinal cord stimulators for the treatment of pain.

Project Partners

<u>University Partners</u>

- Doheny Eye Institute. The lead organization for coordinating the team members and performing clinical testing of the electrode array implants.
- University of California, Santa Cruz performs bidirectional telemetry and chip design for stimulating the electrode array.
- North Carolina State University performs electromagnetic and thermal modeling.

Second Sight Medical Products Inc.

- Second Sight is a medical device manufacturer and is the private sector CRADA partner responsible for the integration and production of devices under FDA regulations and the eventual commercial distribution to patients.

DOE National Laboratory Partners

- Argonne National Laboratory performs packaging and hermetic seal research for protection of the retinal prosthesis using their R&D 100 award-wining research on ultrananocrystalline diamond technology.
- Lawrence Livermore National Laboratory performs conformable electrode development by applying photolithographic technology to soft conformable materials.
- Los Alamos National Laboratory performs imaging and modeling of retinal function.
- Oak Ridge National Laboratory performs neural electrode materials science research for the safe injection of electrical charge and long-term stability of the electrodes.
- Sandia National Laboratories performs microfabrication and materials research for the development of spring-loaded conformable electrode arrays.