Artificial heart shows breakthrough potential

The artificial heart now beating in the chest of Dr. Barney Clark is, in every sense of the word, a spinoff of research and development at the National Aeronautics and Space Administration. It is a monumental demonstration of the impact which the space program has had throughout the economy. It is also a foretaste of the immense effect that the beam weapons program, particularly the X-ray laser, could have on basic biology and aging research.

In 1963, at the height of the Kennedy-era enthusiasm for landing an American on the moon by 1970, Congress voted up funding for drawing up an overview prospectus on artifical heart research. The National Heart Institute went to what was then the center of technical and engineering expertise, NASA. There, Lowell Harmison, a nuclear engineer, and Frank Alturi, a mechanical engineeer with nuclear background, agreed to coordinate a large task force of consultants from various fields, under the auspices of the private consulting firm Hittman Associates.

The summary Hittman report, completed in 1966, envisioned the full development and testing of a completely implantable artificial heart before 1980.

The main problems to be solved were these:

- **Energy source:** the device must ultimately have a fully implantable and long-lasting energy source. The heart must produce a power of 2.5 watts, and pump or contract 30 to 40 million times per year. From the beginning, the most likely source was nuclear. Alturi was involved in developing the plutonium pellets used as electrical generators for some of the earliest space probes. In fact, all of the necessary features which would be needed for human implantation, to guard against spillage in case of a violent event such as a plane crash or a gunshot impact, have already been fully developed by NASA. The heart used in the Utah implantation runs on an external air pump, but can be switched to implanted energy sources as they become available.
- **Geometry of the heart chambers:** clotting occurs if the blood flow pattern is such that some blood pools and remains in an area of the ventricle for a long period of time, or if there is excessive turbulence of the blood as it is pumped. Blood flow dynamics, termed rheology, is a special application of hydrodynamics, and the heart program has relied heavily on experts in the field borrowed from the aerospace industry.
- **Materials:** most of the materials used in artificial hearts are polymer plastics, such as the polyurethane in Barney Clark's Jarvik-7 heart. The space program provided an additional impetus to extend the range of these substances and their characteristics.
- **Monitoring and control devices:** NASA pioneered in the area of automatic computer-controlled sensing of biological parameters such as blood pressure and heart rate, in the course of monitoring the condition of astronauts in space. The computer miniaturization needed for a fully-implantable device is also a product of space research.

Contrary to the predictions of the 1966 Hittman report, the level of funding by the National Heart, Lung and Blood Institute for research around the country has not been $50 million annually, but more in the range of $7-10 million. Despite this severe limitation in funding, which has caused the program to "put many of its eggs in very few baskets," according to a NHI spokesman, the major engineering problems have been solved.

At current funding levels, spokesmen foresee testing implanted energy sources in humans in three to four years, having a dependable implanted energy source in five to six years, and completing final phase testing with large numbers of humans preparatory to mass marketing of the device in another six to seven years. However, since the engineering problems are basically solved, increasing the funding to the orginally charted $50 million per year would predictably shorten the entire rest of development to marketing phase to a total of only **three years**.

The increased longevity and prolonged working lifetime possible with the artificial heart would more than repay society for the social cost of the program. For example, with mass production the cost of the device itself could be brought down to $1,000 easily. Further in the future the device could become the standard treatment for people who survive their first heart attack. Since heart disease is responsible for more than half the 2 million deaths annually in the U.S.A., and since more than half of these people reach a hospital before dying, the potential for the device is enormous.

The long range goal of heart research should of course be non-surgical treatment and ultimately prevention. The development of space-based defense beam weapons involves the production of the X-ray laser, which would revolutionize biology by making possible the microscopic examination of macromolecules such as genes and proteins at far greater magnifications and over far shorter time intervals than is currently possible. It may be possible to observe the action of genes, functioning within living tissue, with a resolution of atomic distances. This would add immeasurably to an understanding of the "unknowns" and guide research not only in atherosclerosis but in cancer and many other areas as well.