



Heart Pump Design for Cleveland Clinic Foundation

Sketch of Lewis/Cleveland Clinic Foundation heart pump showing placement.

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Through a Lewis CommTech Program project with the Cleveland Clinic Foundation, the NASA Lewis Research Center is playing a key role in the design and development of a permanently implantable, artificial heart pump assist device. Known as the Innovative Ventricular Assist System (IVAS), this device will take on the pumping role of the

damaged left ventricle of the heart. The key part of the IVAS is a nonpulsatile (continuous flow) artificial heart pump with centrifugal impeller blades, driven by an electric motor. Lewis is part of an industry and academia team, led by the Ohio Aerospace Institute (OAI), that is working with the Cleveland Clinic Foundation to make IVAS a reality. This device has the potential to save tens of thousands of lives each year, since 80 percent of heart attack victims suffer irreversible damage to the left ventricle, the part of the heart that does most of the pumping.



Photo of Lewis/Cleveland Clinic Foundation heart pump.

Impeller blade design codes and flow-modeling analytical codes will be used in the project. These codes were developed at Lewis for the aerospace industry but will be applicable to the IVAS design project. The analytical codes, which currently simulate the flow through the compressor and pump systems, will be used to simulate the flow within the blood pump in the artificial heart assist device. The Interdisciplinary Technology Office heads up

Lewis' efforts in the IVAS project. With the aid of numerical modeling, the blood pump will address many design issues, including some fluid-dynamic design considerations that are unique to the properties of blood. Some of the issues that will be addressed in the design process include hemolysis, deposition, recirculation, pump efficiency, rotor thrust balance, and bearing lubrication. Optimum pumping system performance will be achieved by modeling all the interactions between the pump components. The interactions can be multidisciplinary and, therefore, are influenced not only by the fluid dynamics of adjacent components but also by thermal and structural effects.

Lewis-developed flow-modeling codes to be used in the pump simulations will include a one-dimensional code (ref. 1) and an incompressible three-dimensional Navier-Stokes flow code (ref. 2). These codes will analyze the prototype pump designed by the Cleveland Clinic Foundation. With an improved understanding of the flow phenomena within the prototype pump, design changes to improve the performance of the pump system can be verified by computer prior to fabrication in order to reduce risks. The use of Lewis flow modeling codes during the design and development process will improve pump system performance and reduce the number of prototypes built in the development phase.

The first phase of the IVAS project is to fully develop the prototype in a laboratory environment that uses a water/glycerin mixture as the surrogate fluid to simulate blood. A later phase of the project will include testing in animals for final validation. Lewis will be involved in the IVAS project for 3 to 5 years.

References

1. Veres, J.P.: Centrifugal and Axial Pump Design and Off-Design Performance Prediction. NASA TM-106745, 1995.
2. Hah, C.: Calculation of Three-Dimensional Viscous Flows in Turbomachinery With an Implicit Relaxation Method. *J. Propulsion*, Sept.-Oct., vol.3, no.5, 1987.