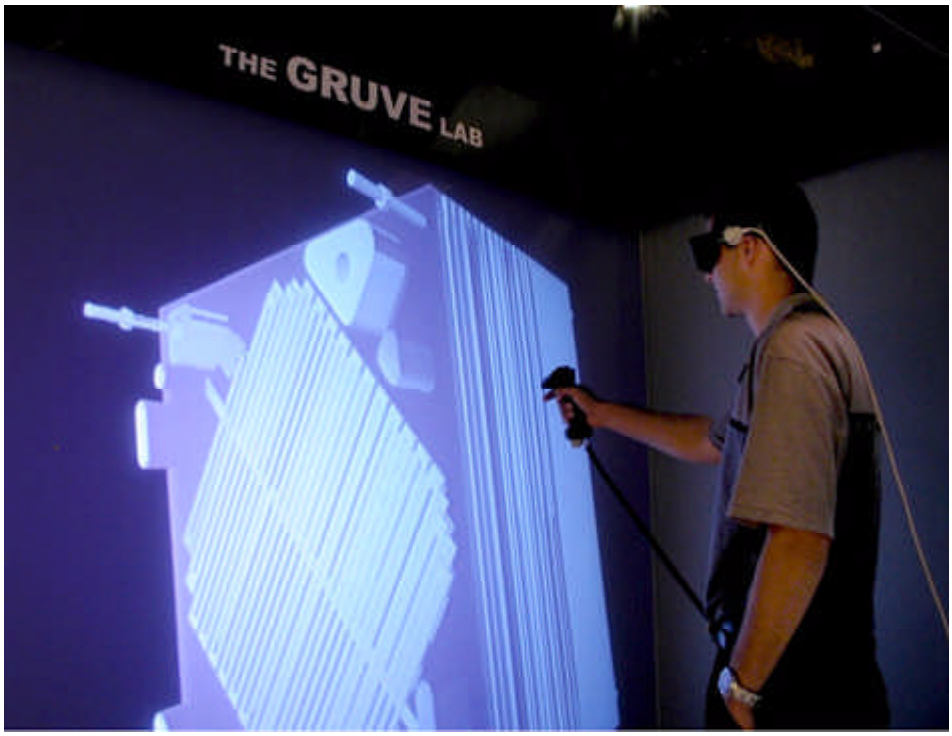
Systems Analysis Initiated for All-Electric Aircraft Propulsion

A multidisciplinary effort is underway at the NASA Glenn Research Center to develop concepts for revolutionary, nontraditional fuel cell power and propulsion systems for aircraft applications. There is a growing interest in the use of fuel cells as a power source for electric propulsion as well as an auxiliary power unit to substantially reduce or eliminate environmentally harmful emissions.

A systems analysis effort was initiated to assess potential concepts in an effort to identify those configurations with the highest payoff potential. Among the technologies under consideration are advanced proton exchange membrane (PEM) and solid oxide fuel cells, alternative fuels and fuel processing, and fuel storage. Prior to this effort, the majority of fuel cell analysis done at Glenn was done for space applications. Because of this, a new suite of models was developed. These models include the hydrogen-air PEM fuel cell; internal reforming solid oxide fuel cell; balance-of-plant components (compressor, humidifier, separator, and heat exchangers); compressed gas, cryogenic, and liquid fuel storage tanks; and gas turbine/generator models for hybrid system applications. Initial mass, volume, and performance estimates of a variety of PEM systems operating on hydrogen and reformate have been completed for a baseline general aviation aircraft. Solid oxide/turbine hybrid systems are being analyzed.

In conjunction with the analysis efforts, a joint effort has been initiated with Glenn's Computer Services Division to integrate fuel cell stack and component models with the visualization environment that supports the GRUVE lab, Glenn's virtual reality facility. The objective of this work is to provide an environment to assist engineers in the integration of fuel cell propulsion systems into aircraft and provide a better understanding of the interaction between system components and the resulting effect on the overall design and performance of the aircraft. Initially, three-dimensional computer-aided design (CAD) models of representative PEM fuel cell stack and components were developed and integrated into the virtual reality environment along with an Excel-based model used to calculate fuel cell electrical performance on the basis of cell dimensions (see the figure). CAD models of a representative general aviation aircraft were also developed and added to the environment. With the use of special headgear, users will be able to virtually manipulate the fuel cell's physical characteristics and its placement within the aircraft while receiving information on the resultant fuel cell output power and performance. As the systems analysis effort progresses, we will add more component models to the GRUVE environment to help us more fully understand the effect of various system configurations on the aircraft.



Fuel cell visualization model in GRUVE lab.

Find out more about this research:
Polymer Energy Rechargeable System--
http://www.grc.nasa.gov/WWW/Electrochemistry/doc/pers.html
GRUVE lab--http://facilities.grc.nasa.gov/gruve/gruve_quick.html

Glenn contacts: Lisa L. Kohout, 216-433-8004, Lisa.L.Kohout@nasa.gov ; and Dr. Jay G. Horowitz, 216-433-5194, Jay.G.Horowitz@nasa.gov
Author: Lisa L. Kohout
Headquarters program office: OAT
Programs/Projects: Propulsion and Power, RAC