

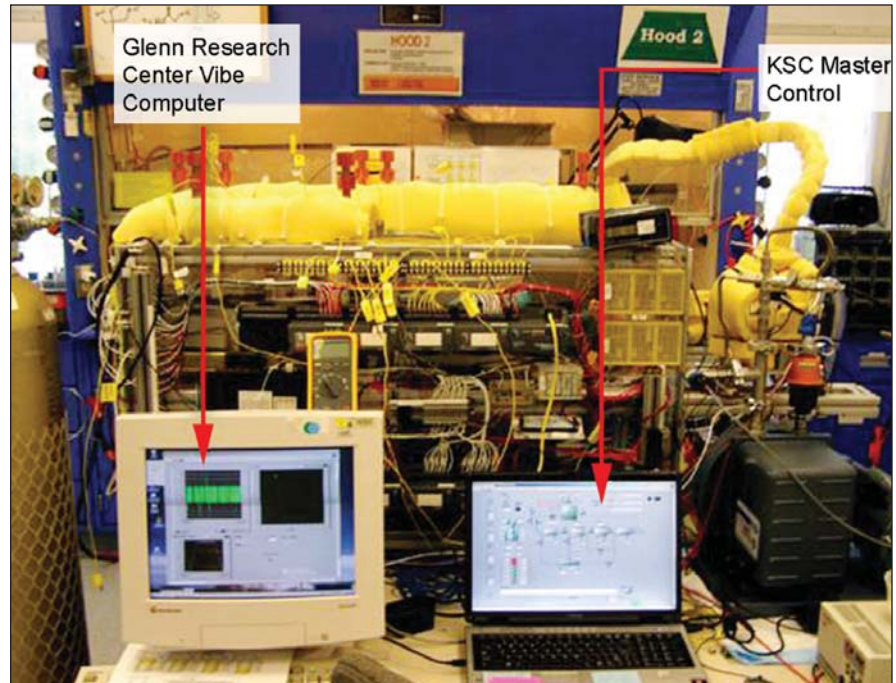
## Software Architecture to Support the Evolution of the ISRU RESOLVE Engineering Breadboard Unit 2 (EBU2)

John F. Kennedy Space Center, Florida

The In-Situ Resource Utilization (ISRU) Regolith & Environmental Science and Oxygen & Lunar Volatiles Extraction (RESOLVE) software provides operation of the physical plant from a remote location with a high-level interface that can access and control the data from external software applications of other subsystems. This software allows autonomous control over the entire system with manual computer control of individual system/process components. It gives non-programmer operators the capability to easily modify the high-level autonomous sequencing while the software is in operation, as well as the ability to modify the low-level, file-based sequences prior to the system operation. Local automated control in a distributed system is also enabled where component control is maintained during the loss of network connectivity with the remote workstation. This innovation also minimizes network traffic.

The software architecture commands and controls the latest generation of RESOLVE processes used to obtain, process, and quantify lunar regolith. The system is grouped into six sub-processes: Drill, Crush, Reactor, Lunar Water Resource Demonstration (LWRD), Regolith Volatiles Characterization (RVC) (see example), and Regolith Oxygen Extraction (ROE). Some processes are independent, some are dependent on other processes, and some are independent but run concurrently with other processes.

The first goal is to analyze the volatiles emanating from lunar regolith, such as water, carbon monoxide, carbon diox-



Integrated LWRD/RVC engineering breadboard unit showing computer controls.

ide, ammonia, hydrogen, and others. This is done by heating the soil and analyzing and capturing the volatilized product. The second goal is to produce water by reducing the soil at high temperatures with hydrogen. This is done by raising the reactor temperature in the range of 800 to 900 °C, causing the reaction to progress by adding hydrogen, and then capturing the water product in a desiccant bed.

The software needs to run the entire unit and all sub-processes; however, throughout testing, many variables and

parameters need to be changed as more is learned about the system operation. The Master Events Controller (MEC) is run on a standard laptop PC using Windows XP. This PC runs in parallel to another laptop that monitors the GC, and a third PC that monitors the drilling/crushing operation. These three PCs interface to the process through a CompactRIO, OPC Servers, and modems.

*This work was done by Thomas Moss, Mark Nurge, and Stephen Perusich of Kennedy Space Center. Further information is contained in a TSP (see page 1). KSC-13353*

## Coastal On-line Assessment and Synthesis Tool 2.0

Stennis Space Center, Mississippi

COAST (Coastal On-line Assessment and Synthesis Tool) is a 3D, open-source Earth data browser developed by leveraging and enhancing previous NASA open-source tools. These tools use satellite imagery and elevation data in a way that allows any user to zoom from orbit view down into any place on Earth, and enables the user to experience Earth terrain in a visually rich 3D view. The bene-

fits associated with taking advantage of an open-source geo-browser are that it is free, extensible, and offers a worldwide developer community that is available to provide additional development and improvement potential.

What makes COAST unique is that it simplifies the process of locating and accessing data sources, and allows a user to combine them into a multi-layered

and/or multi-temporal visual analytical look into possible data interrelationships and coefficients for coastal environment phenomenology. COAST provides users with new data visual analytic capabilities. COAST has been upgraded to maximize use of open-source data access, viewing, and data manipulation software tools.

The COAST 2.0 toolset has been developed to increase access to a larger realm

of the most commonly implemented data formats used by the coastal science community. New and enhanced functionalities that upgrade COAST to COAST 2.0 include the development of the Temporal Visualization Tool (TVT) plug-in, the Recursive Online Remote Data-Data Mapper (RECORD-DM) utility, the Im-

port Data Tool (IDT), and the Add Points Tool (APT). With these improvements, users can integrate their own data with other data sources, and visualize the resulting layers of different data types (such as spatial and spectral, for simultaneous visual analysis), and visualize temporal changes in areas of interest.

*This work was done by Richard Brown of Science Systems and Applications, Inc., Andrew Navard of Computer Sciences Corporation, and Beth Nguyen of Delta Computer Solutions for Stennis Space Center. For more information, contact the Office of Chief Technologist at Stennis Space Center, 228-688-1929. Refer to SSC-00357.*

## Generalized Software Architecture Applied to the Continuous Lunar Water Separation Process and the Lunar Greenhouse Amplifier

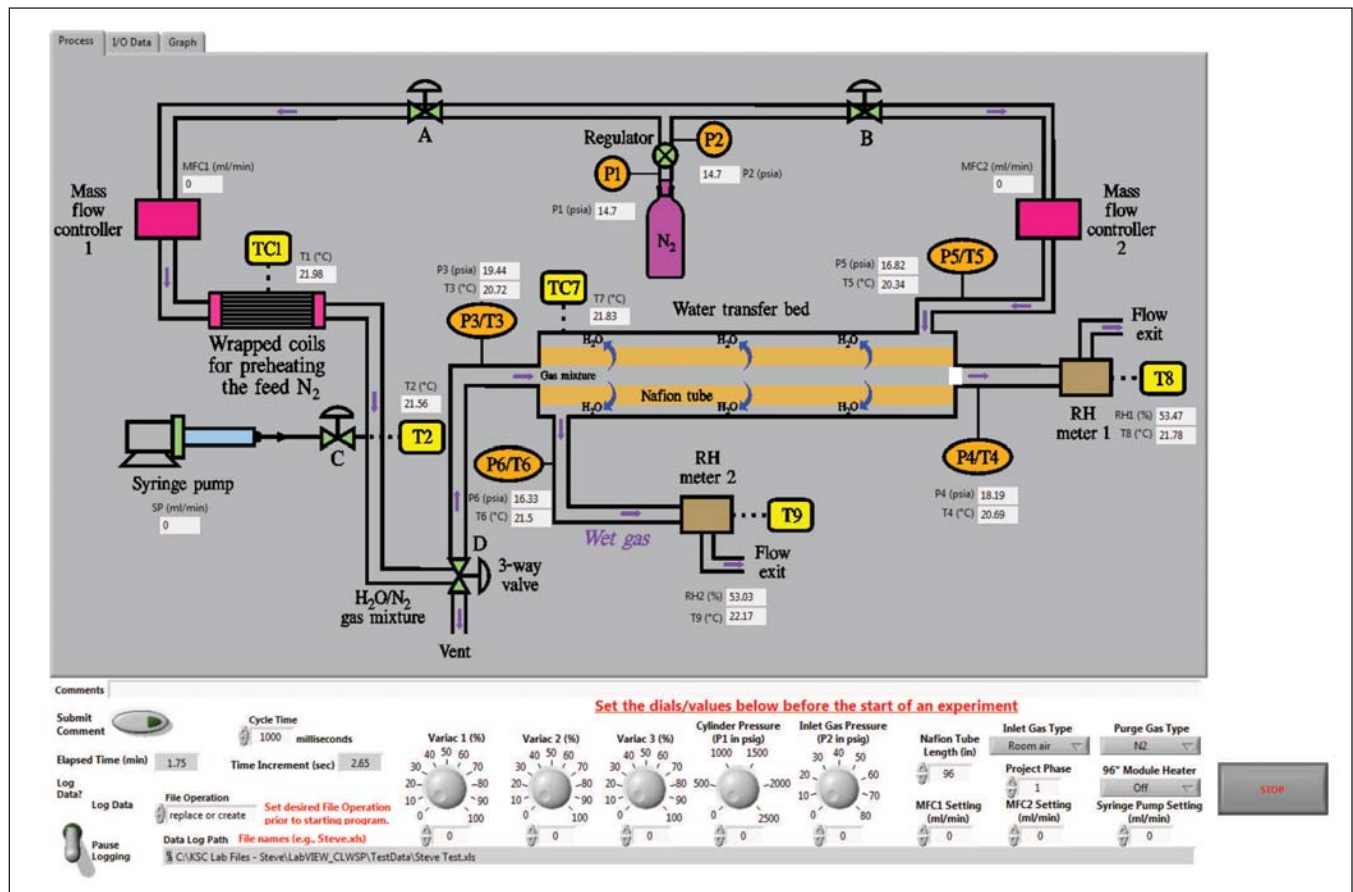
John F. Kennedy Space Center, Florida

This innovation provides the user with autonomous on-screen monitoring, embedded computations, and tabulated output for two new processes. The software was originally written for the Continuous Lunar Water Separation Process (CLWSP), but was found to be general enough to be applicable to the Lunar Greenhouse Amplifier (LGA) as well, with minor alterations. The resultant program should have general applicability to many laboratory processes (see figure).

The objective for these programs was to create a software application that would provide both autonomous monitoring and data storage, along with manual manipulation. The software also allows operators the ability to input experimental changes and comments in real time without modifying the code itself. Common process elements, such as thermocouples, pressure transducers, and relative humidity sensors, are easily incorporated into

the program in various configurations, along with specialized devices such as photodiode sensors.

The goal of the CLWSP research project is to design, build, and test a new method to continuously separate, capture, and quantify water from a gas stream. The application is any In-Situ Resource Utilization (ISRU) process that desires to extract or produce water from lunar or planetary regolith. The present work is aimed at circumventing



Sample Process