INFUSION

Innovations from the NASA CICT Program

CICT

Computing, Information, and Communications Technology Program

www.cict.nasa.gov

SemanticOrganizer Brings Teams Together

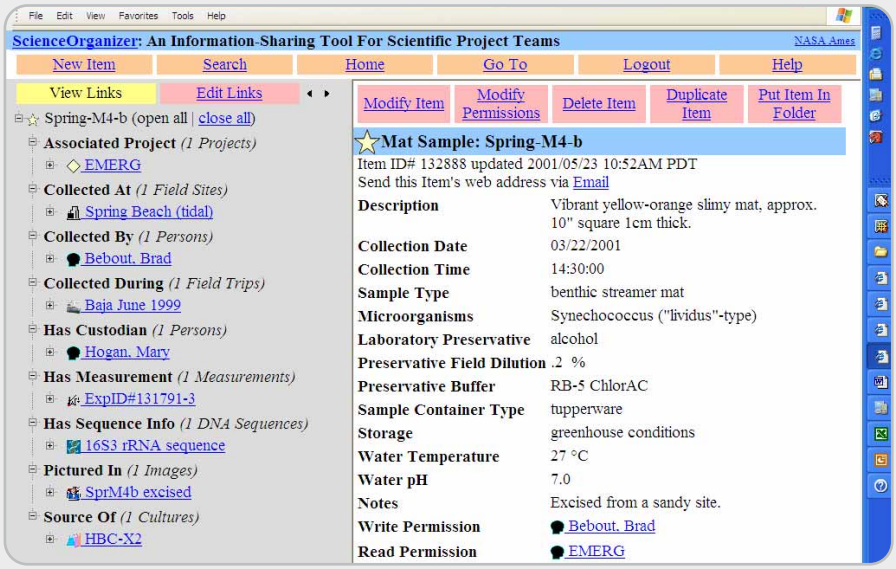
- **Enables researchers in different locations to share, search for, and integrate data**
- **Customizable semantic links offer fast access to interrelated information**
- **Supports real-time instrument data collection and collaborative image annotation**

How can members of a research team who are separated by great distances work together effectively? Take, for example, the Early Microbial Ecosystems Group within the NASA Astrobiology Institute. To help NASA fulfill its mission to search for the origins of life, this group is studying early biological evolution in algae mats. Led by David J. Des Marais at NASA Ames Research Center, the group includes scientists from universities and institutes in several states, as well as abroad. The team also has field sites in Mexico, the Bahamas, and Yellowstone Park. How can this team gather regularly to analyze data and set goals?

"This kind of challenge motivates the scientists developing new Human-Centered Computing technology as part of CICT's Intelligent Systems Project," says Michael Shafto, manager of the HCC subproject. "Our goal is to optimize the performance and communications of mixed human-automation systems."

Richard Keller, a research scientist working for the Computational Sciences Division at Ames, is receiving funding from CICT's HCC subproject to research new tools for information integration and remote sharing. "Much of NASA's research today," he says, "is conducted by large collaborative teams distributed across institutional, geographic, and political boundaries. And the distances will grow, with scientists aboard the International Space Station and those eventually stationed on Mars needing to collaborate with their peers on Earth. Field teams will also work with software agents that monitor and control equipment. To support these distributed, remote teams, and others, we have developed SemanticOrganizer."

continued on next page



The SemanticOrganizer application called ScienceOrganizer displays information about a microbial mat sample on the right and links to related information records on the left.

Technology Spotlight

Technology

SemanticOrganizer—a customizable, collaborative, knowledge management and information-integration tool for distributed project teams of scientific or engineering investigators

Function

Provides intuitive information storage, access, integration and correlation capabilities for a work team's digital information products

Relevant Missions

- Exploration Systems Enterprise missions
- Space Science Enterprise missions
- Earth Science Enterprise missions
- Biological & Physical Research Enterprise missions

Features

- Tracks history of field work, lab work email threads, and associated data
- Semantically interlinks related items
- Numerous collaboration services
- Remote monitoring/control of sensors and instruments

Add-on Modules

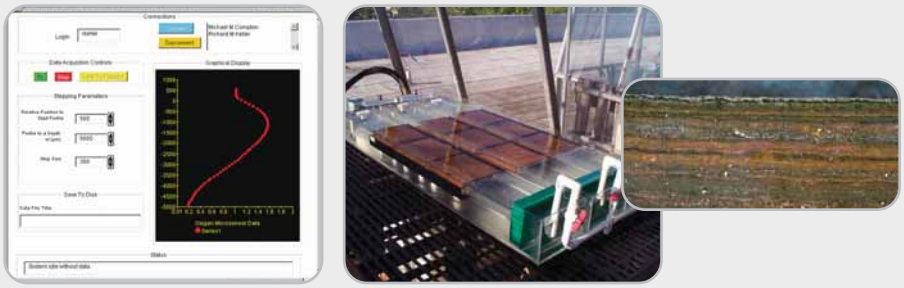
- Collaborative Image Annotator
- Scientific Experimentation System
- Microsoft Office interoperation
- Email distribution, archiving, and hyperthreading

Benefits

- Web-accessible, no software installation required
- Distributed teams can share data and work together online
- Can quickly find related items
- Can conduct remote experiments
- Can annotate images and data

Contacts

- Richard.M.Keller@nasa.gov
- Michael.G.Shafto@nasa.gov



The Scientific Experimentation System (left) is an add-on module that supports intelligent monitoring and remote control of experiments. The red line shows oxygen at various depths of a microbial mat (far right) in the Astrobiology Greenhouse (center).

Knowledge management
SemanticOrganizer enables project teams to collect and maintain the results of research conducted over several years by multiple distributed teams. They can also share remote facilities, even instruments, and measure, record, compare, and connect scientific data with hypotheses. Team members (or even software agents) can create and store information in a Web-accessible repository, defining metadata properties, associating files with them, and establishing semantic links between them. SemanticOrganizer also supports add-on components with additional functionality that can be customized for use by different disciplines.

"SemanticOrganizer's approach is radically different from standard hierarchal information management systems that track and organize data in traditional nested-folder structures," says Keller. "SemanticOrganizer enables and encourages users to capture the semantic information and links between data, using a network structure. SemanticOrganizer combines the functionality of a database, a document-sharing system, and a 'hyper-linked' navigation and search system. It serves as an organizational memory and collaborative work space for remote teams."

ScienceOrganizer
SemanticOrganizer is a general framework that can be customized to meet different needs. ScienceOrganizer, an application currently used by several NASA teams, including the Early Microbial Ecosystems Group, demonstrates how the system works. It contains nodes with information about research sites, people, experiments, devices, measurements, samples, cultures, and more. These nodes contain metadata tags that store information and enable search functions and cross-linking. For example, the node "Microbial-Culture-123" may contain metadata tags for the genus, the cultivator, the growth medium, the date isolated, and more. The information node can also contain attached files, such as images, documents, and data sets.

Semantic links define relations between nodes. For example the link "cultivated-from" may connect "Microbial-Culture-123" to another node called "Microbial-Mat-Sample-654. The link "pictured-in" may connect to a node containing all data about the image of "Microbial-Culture-123," such as who took it, when, where, and how.

Add-on modules
ScienceOrganizer supports add-on modules, such as an Agent-assisted Scientific Experimentation System for intelligent monitoring and remote execution of experiments. Scientists in the Early Microbial Ecosystem Group use the system to remotely activate an experiment in their Greenhouse Laboratory via a Web browser. A scheduling agent gets the data it needs from the repository and, at the scheduled moment, spawns another agent that requests a measurement or image to be taken by the Greenhouse's Microbial Mat Table, which then sends results to the agent for logging and storage in the repository.

The Collaborative Image Annotator module enables scientists to annotate an image for all to see in real time. The email distribution and hyperthreading module lets you create lists of team members whose messages and attachments are automatically distributed to the list and archived within the repository.

InvestigationOrganizer
Keller and Tina Panontin, the chief engineer at NASA Ames, are being funded by NASA's Engineering for Complex Systems Program to develop InvestigationOrganizer, a new application of SemanticOrganizer that was used to support the Shuttle Columbia Accident Investigation Board.

Award winner
SemanticOrganizer was a finalist in the 2003 NASA Software of the Year Competition and won a Space Act Award for significant technical contribution.

"As for the future", Keller says, "we've already begun to apply ScienceOrganizer to store data products generated during simulated planetary surface exploration missions conducted by the Mobile Agents Project. We're also working with the Space Science Enterprise's MARTE Mars analog drilling mission to support their collection and dissemination of science data. New features may include enabling users to create 'workspaces' that partition the information space for specific tasks; having the inference engine automatically integrate new nodes, links, and metadata; giving users a speech interface for verbal queries; and enabling system modelers to more easily create new versions of SemanticOrganizer."

—Larry Laufenberg

For more information or stories online, see **www.cict.nasa.gov/infusion**

NASA CICT Program Office
Ames Research Center
650.604.2494

Program Manager
Butler Hine

Deputy Program Manager
Bill Van Dalsem

Infusion Editor
Larry Laufenberg
llaufenberg@mail.arc.nasa.gov

CICT is part of the NASA Exploration Systems Enterprise's Human and Robotic Technology Theme which represents NASA's commitment to investing in the technologies and capabilities that will make an ambitious and sustainable 21st century space exploration program possible.

www.cict.nasa.gov

CICT