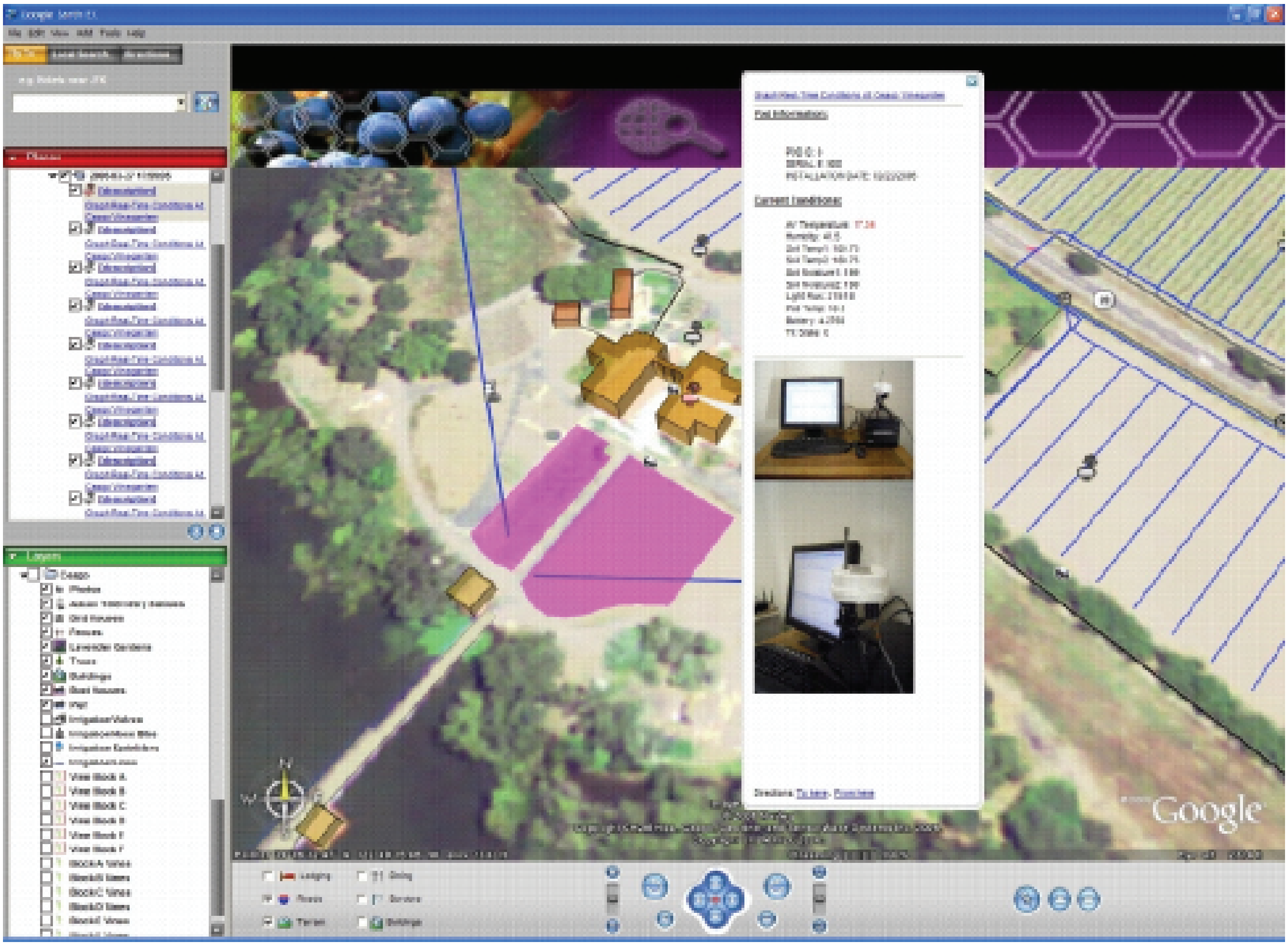
1st Place

Monitoring Crop Yields with Spatial Tools



Nestled in the rolling hills of Northern California along the banks of Clear Lake, you'll find the Ceago Vinegarden, a 220-acre family-run agro-eco-tourism business owned and operated by Jim Fetzer.

The Ceago Vinegarden produces certified biodynamic wines using traditional farming practices that predate organic methods by 20 years. The goal is to create a working farm that uses sustainable agricultural practices that are in harmony with the local ecosystem, and then share the experience with the public.

According to Fetzer, biodynamic farming emphasizes plant health and soil fertility through crop rotation and diversity, composting, integration of plant and animal life, and the scheduling of farm operations with a biodynamic calendar to maximize plant growth (through seasonal rhythms and universal life forces). Synthetic chemicals, herbicides, pesticides, and fertilizers are avoided.

The Ceago Vinegarden uses geospatial technologies to facilitate and document the management of day-to-day activities so that models of ideal growing conditions and practices can be developed. The company that implements these spatial tools is Geovine, a geospatial technology firm that aims "to blend new information technologies and sustainable farming practices to improve crop quality, operating efficiency, and environmental performance of viticulture operations."

In an effort to tie all of Ceago's geospatial practices together, as well as facilitate the ongoing monitoring of grape yield and vine quality while reducing production costs, GeoVine partnered with a global employee-owned environmental engineering firm specializing in geospatial planning, development, and implementation. At the outset of the initiative, Ceago provided project specifications, all relevant Ceago data layers (such as field, row, roads, etc.), prototype National Aeronautics and Space Administration (NASA)/Jet Propulsion Laboratory sensor equipment, and commercial weather feeds that monitor microclimatic parameters. The environmental engineering firm compiled a team of experts specializing in GPS survey,

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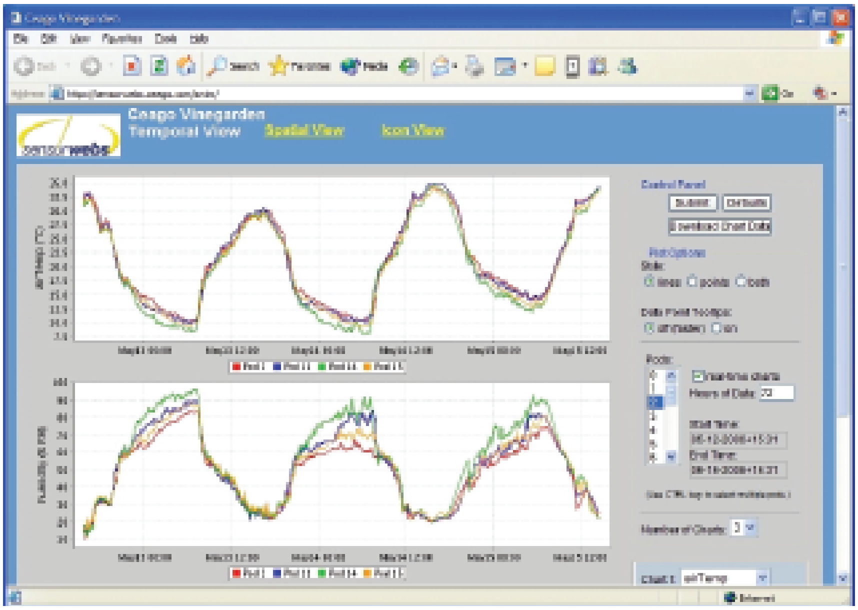
Web services, wireless architecture, GIS, environmental science, and mobile application development for this effort.

Tracking growing methods, weather conditions, and times to harvest were important components of this initiative. Ultimately, the components led to the development of six project requirements: a detailed survey of all relevant vineyard assets; field data collection using Radio Frequency Identification (RFID) tags; installation of the real-time microclimatic solar sensors (sensorware pods); integration of Web services with the real-time climatic sensors; Google Earth visualization; and ongoing attribute maintenance through mobile data collection.

The project team used a GPS receiver with a Bluetooth-enabled handheld data collector to map the ranch's infrastructure at approximately 1-foot accuracy. The information was collected using a customizable data dictionary and proprietary field software. This approach allowed for a detailed microclimatic picture of the entire vineyard. RFID tags were attached to vine rows and scanned using a compact flash RFID scanner that was inserted (along with a Bluetooth card) in the top of the handheld data collectors. The winemaker uses this same data-collection configuration for the customized data-maintenance application.

To determine optimal harvest times, in-field chemistry results were logged by vine and synchronized at the desktop. Resulting graphs show sugar level and pH lines converging prior to frost, ultimately providing a history of season variation. The mobile application also provided reminders for irrigation intervals and calculation of irrigation costs. The radio frequency wireless mesh network of NASA sensorware pods were placed throughout the vineyard in areas of high variability to monitor air temperature, humidity, soil temperature, and moisture at depths of 12 inches and 24 inches, as well as ambient light and battery charge state. The near–real-time readings were provided as Web services with algorithms to provide predictive e-mail "push" notifications of critical values such as frost, heat, and mold warnings. E-mail "pulls" were achieved via cell phone PDAs that included pod readings for times when Web browsers were not available. In the future, the predictive push notification is expected to reduce water use and irrigation costs by allowing for a more detailed representation of vine-moisture requirements. A more accurately managed water supply may result in reduction of mold as well.



To date, visualization capabilities and Internet accessibility are achieved through the use of the Google Earth enterprise client. High-resolution aerial photos of the vineyard and the detailed GPS asset survey of relevant GIS layers can be queried at the click of a mouse to pull up information about a vine row or individual vine, including information about vine varietals, plant dates, rootstocks, clone numbers, and overall vine vigor.

Once data for several seasons are compiled, the project team expects that trends indicating the climatic conditions favored by specific varietals will emerge. The handheld data collection and maintenance approach allows for the quick and continuous update of attribute information during the course of typical fieldwork (also reducing labor costs associated with re-keying field notes). The GPS receiver provides the subfoot accuracy required for this project.

Future initiatives may include microclimate soil mapping, which would allow for the precision application of organic fertilizers. Precision guidance of tractors through GPS and on-board chart plotters may also serve to reduce fuel and wear-and-tear costs while concentrating fertilizer application to areas that are in most need of nutrients.

Ceago Vinegarden, **Geovine**, and **CH2M HILL** used temperature and moisture feeds from **SensorWare Systems**. The team conducted field surveys using **Trimble** GPS Pathfinder ProXH receivers with Bluetooth-enabled Trimble Recon handheld data collectors that ran Trimble's TerraSync data collection software and **Socket** Compact Flash RFID readers. **ESRI**'s ArcGIS software was used for all GIS data layer creation and editing. **Google**'s Google Earth Enterprise Edition and enterprise servers were used to fuse and host higher-accuracy data for the project Web site.

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