Virtual Volcano 2.0

REU Interns: Jordan A. Borrell, Mandela Magnidjem, CJ Barberan
Mentors: Thomas Parham, Cinzia Cervato, William Gallus

What is Virtual Volcano?
Virtual Volcano is a data-based interactive model of an active volcanic system, which enables students to observe the system as well as to directly control its mechanics to conduct authentic scientific investigations. Using keyboard controls, students are able to navigate around the volcano as well as observe subsurface features and processes. Students actively control the physical processes driving two active volcanoes: Mount St. Helens and Piton de la Fournaise.

Preliminary User Survey
In 2006 the Interactive Visualizations for Earth Science Teaching (iVVEST) team developed the Volcanic Concept Survey (VCS) to diagnose student-held misconceptions of how volcanic systems operate and evolve. The most poorly misunderstood concepts included:

- Where volcanoes form, and their relation to plate tectonics
- Why volcanoes erupt in different styles and the specific hazards a given volcano is likely to produce
- The physical and chronological scales on which volcanic processes operate
- The nature of internal structures and "hidden" subsurface processes

Virtual Volcano was developed to specifically address these difficult concepts (Fig 1, 2).

Proposed User Study
A user study will be conducted by late October 2011. The user study will examine usability of the Virtual Volcano interface for both content experts (geology graduate students) and content novice users (undergraduate students). Field testing will occur at Iowa State and partner schools nationwide.

Rationale for 2.0 Re-Design
Recent user study with Iowa State students during the Fall 2010 semester (n = 65) showed that student users spent as much as 40% of their time with Virtual Volcano 1.0 rebooting or recovering from program instabilities and less than 10% of their time actively exploring the volcano models. Analysis of learning gains showed only marginal gains in understanding of eruptive mechanics and that the model may actually have misinformed students as to the 3D structure of volcanic systems. Student conceptualizations of both the physical scale of volcanic phenomena and the rules of volcanic processes were highly skewed. Moreover, qualitative user ratings of both graphical fidelity of the models and usability of the interface were highly unfavorable.

A full-scale redesign of the platform addressed numerous stability issues while also greatly expanding functionality. The 2.0 interface highlights key information through effective use of color, streamlines navigation tasks (2.3, 2.2), and allows for the implementation of much-needed timescale visualizations (2.2, 2.1). Text has been reduced throughout to reduce cognitive load (2.4). The volcano models have been updated to improve graphical fidelity (1.3, 1.1), provide subsurface exploration (1.3), and allow detailed investigation of volcano structure and scale (1.4, 1.2). Illustration of physical scale also supports navigation tasks and comparison of the extent of various volcanic phenomenon.

Figure 1 — The model viewer provides a full 3D space in which users may explore the structure of each volcano as well as make qualitative observations of eruption events. The Mt. St. Helens model is shown with updated topography, later model prototype, and physical scale bars.

Feature 1.1 – An animated (after model improves upon the original design, which rendered the feature as a series of rolling oblong coin-like shapes. Development of this feature is ongoing, but successful, it should open pathways to much more realistic depictions of both tuff and lava flows.

Feature 1.3 – A "studded" topographic surface presents graph of eruption deposits and should prime users to explore the subsurface space beneath.

Feature 1.4 – Vertical elevation scale controls the perception of depth. Users may toggle both vertical and horizontal (2D scale bars to reduce visual clutter.

Feature 2.1 – Time is further visualized as clock that spins rapidly to represent long time periods and slowly, illustrate near real-time events.

Feature 2.2 – The time slider allows users to explore the multi-stage evolution of each volcano they generate. Each stage is colored as in the animation stage model.

Feature 2.3 – Waypoints facilitate rapid navigation between key locations, which are described in common language terms for clarity.

Feature 3.2 – As the eruption restarts, detailed textual information and statistics are presented on the message board. Linked key terms display more details on an as-needed basis.

Feature 4.2 – At the eruption restarts, detailed textual information and statistics are presented on the message board. Linked key terms display more details on an as-needed basis.

Figure 2 – The Graphical User Interface (GUI) is the control panel through which the user manipulates the physical factors driving the volcano, maintains quantitative observations, and learns more about individual phenomena.

Feature 2.4 – As the eruption restarts, detailed textual information and statistics are presented on the message board. Linked key terms display more details on an as-needed basis.

Figure 2 – The Graphical User Interface (GUI) is the control panel through which the user manipulates the physical factors driving the volcano, maintains quantitative observations, and learns more about individual phenomena.

---

The model viewer provides a full 3D space in which users may explore the structure of each volcano as well as make qualitative observations of eruption events. The Mt. St. Helens model is shown with updated topography, later model prototype, and physical scale bars.