Small County: Development of a Virtual Environment for Instruction in Geological Characterization of Petroleum Reservoirs ED51B-0526
Bryan Banz, Dept. of Electrical Engineering and Computer Science, University of Kansas
Geoffrey C. Bohling, Kansas Geological Survey, University of Kansas
John H. Doveton, Kansas Geological Survey, University of Kansas
http://www.kgs.ku.edu/Hydro/SmallCounty

Abstract
We have developed an environment for interactive instruction in the geological aspects of petroleum reservoir characterization employing a virtual subsurface closely reflecting the geology of the US mid-continent, in the fictional setting of Small County, Kansas. Providing geology students an opportunity to gain experience in interpreting drilling records and petrophysical logs from wells. Stochastic simulation techniques are used to generate the subsurface characteristics, including the overall geological structure, distributions of facies, porosity, and fluid saturations, and petrophysical logs. The student then explores the subsurface by sitting exploratory wells and examining drilling and petrophysical logs obtained from those wells. A version of the application aimed at students in introductory geology courses implements a simpler exercise in which students search for the peak of an anticlinal structure, providing experience in the interpretation of contour maps and the improvement in informed decision making from data points (wells) added. We have developed the application using the open-source Eclipse Rich Client Platform, which allows for the rapid development of a plug-in for existing educational software. The Small County application is fully agnostic application with a rich graphical user interface. Building the Small County application allows it to be versatile and extensible. The core subsurface generation framework on the Rich Client Platform allows it to be portable and extensible. The core application framework includes a set of predefined methods for selecting and exploring the simulations: a brief overview of the land surface, along with tools for displaying contour maps of selected subsurface horizons; a cross-section view following a user-selected path through the subsurface; and a data-log view for analyzing the properties of the subsurface at a given surface location. The framework is extended by customizing the behavior of the simulations either by setting parameters on a detailed model or by implementing new algorithms. Educational goals are met by creating exercises tailored to suit students’ abilities. Exercises are built by providing plugins to the framework that specify the application story-board and include custom evaluation criteria and displays.

Subsurface Simulation
The subsurface is generated using a stochastic property generator whose model parameters are defined in an exercise configuration file. First the elevations of the major intervals are simulated at the well location. When the simulation process completes, the student is presented with the Well Log View (Figure 4). Here the student’s task is to interpret the presented data and identify the correct lithology at each depth as well as mark the tops of the major intervals. Additionally the student may select prospecting “zones” to perform for production upon completion of the well. After labeling lithologies and picking the interval tops, the student indicates that he or she has finished by selecting a toolbar button. An interpretation “score card” is presented summarizing the student’s performance (Figure 5). A table depicting the difference between the actual interval tops and the student’s picks is shown at the top of the window. This is followed by a summary of the picked and missed pay zones.

Advanced Undergraduate Version
The primary intention of the advanced undergraduate version of Small County is to provide students with experience in interpreting geophysical well logs, using those logs to identify interval tops, lithologies, and zones of significant oil saturation (pay) in each well they drill. The student is first presented with an overview map of the county (Figure 2). From here, the student can view contour plots of either the elevations or thicknesses of the major intervals. Initially interpolated from a set of pre-existing wells. These maps are updated to reflect the information obtained from each well that the student drills. The student may also view data associated with an existing well. Clicking on a well’s icon populates the Well Summary View with elevations and relative thicknesses of the intervals for the selected well’s location. In addition, the student can view cross sections of the interval tops elevated (Figure 3) by either drilling on a sequence of wells and then selecting the Cross Section tab.

Introductory Geology Version
In the introductory geology version, the student’s task is to find the peak of an anticlinal structure in a single horizon, on the presumption that the best prospects for oil production would be in the vicinity of this peak. This version does not involve well log interpretation. Instead, the contour map of the horizon elevation immediately updates to reflect the “well” elevation in any new well that the student drills. Thus, the student’s task is to interpret the contour map and cross-sectional display to locate the anticlinal peak. After drilling five wells (in addition to ten pre-existing wells), the student is presented with a dialog box indicating how close he or she has gotten to the actual peak (Figure 6).

Acknowledgment
Small County is funded by a grant from the National Science Foundation's Course, Curriculum, and Laboratory Improvement Programs.

Development Platform
The Small County application is based on the Eclipse Rich Client Platform (RCP) (http://www.eclipse.org/rcp). This enables rapid development of an application that runs on multiple operating platforms (Windows, OSX, Linux/GTK) while retaining the feel of the native user interface. The RCP provides a framework for plugging in and modeling tools that allow the developers to focus on the applications domain without much concern for low-level implementation details. Another benefit of the RCP is that the application is easily extensible by adding new plugins. The application is therefore easily extended and its components are reusable.

Figure 1 - One possible realization of major horizon elevations in the Small County subsurface. Elevations of the 9 horizons range from roughly 1500 feet below sea level to 1000 feet above sea level and the areal extent is 30 miles in each direction.
Figure 2 - County Overview with set of wells for cross section (Figure 3) selected.
Figure 3 - Cross Section view.
Figure 4 - Well Log view.
Figure 5 - Well log interpretation evaluation.