CiSoft Corner

Stepping Ahead: Discovering New Possibilities with the SEA Project

The Smart Engineering Apprentice (SEA) Project is an advanced artificial intelligence model that aims to predict the future failure of rod pump units. Innovative and modern, this novel technology provides a new approach to the maintenance of rod pumps through a system that increases efficiency while decreasing costs.

The SEA Project was originally a blue sky proposal headed by Professor Raghu Raghavendra and Professor Ke-Thia Yao of the USC Viterbi School of Engineering. The project focuses on the use of advanced technology to predict the future failure of rod pumps. The predictions are based on the past experiences of experts who maintain rod pump functionality. Experts continuously make decisions and enter the data into computer software as they would normally do in their daily operations. Generally, each individual encounter by experts presents unique signature characteristics that indicate the status of rod pumps. Thus, as time goes by, the accumulation of data within the computer software from different situations allows the computer to make sound predictions on the condition of rod pumps, as well as make predictions of the approximate time of failure for rod pumps that show signs of impaired functioning. “In a sense, the computer system is the apprentice of field experts, and ‘learns’ from experts through their past experiences in maintaining rod pump functionality,” states Raghu Raghavendra, a Professor of Electrical Engineering and Computer Science at the USC Viterbi School of Engineering. In this way, predictions on when certain rod pumps will fail can be made without having to physically examine each individual rod pump unit.

In addition, data entered into the computer software can act as a historian for all rod pump failures, the data already present in the software can act as a template for repair that have occurred in a specific oil field. New employees who do not exactly know how to solve the problem due to a lack of past experience can rely on the computer system as a point of reference for how to approach the problem.

The SEA Project is an exciting new approach to rod pump maintenance that not only minimizes costs but also increases efficiency, which makes it a valuable tool for increasing overall production. Since the software gives an estimated time for rod pump failure before the failure actually occurs, experts can make the necessary adjustments to rod pump units in order to prevent the imminent failure from occurring. This provides the possibility of fixing the problem before serious damage occurs in the pumps, significantly reducing repair and maintenance costs that would have been incurred. Even more, preventions would also increase the amount of usable oil retrieved from each well by the installed rod pump unit therefore maximizing production. Such proactive maintenance and prevention practices can reduce total downtime of rod pump units by identifying the problem before it gets too severe. “The alternative to using predictive analytics computer modeling would imply waiting for a failure mode to progress or drives to the oil fields to physically examine multiple rod pump

units, which requires significant man-hours, as well as lost production which could potentially be prevented.

Back row: Heejin Choi (student), Shuping Liu (student), Yintao Liu (student), Dinesh Chinnapparaja (student), Cauligi Raghavendra (professor), Vega Sankur (Chevron), Ke-Thia Yao (professor), Front row: Burcu Seren (Chevron), Tracy Lenz (Chevron), and Sanaz Seddighrad (student)

Currently, the technology being developed by the SEA Project has been used on hundreds of wells, and the statistics for the success of the technology further reinforces the advantages of employing such a system. As represented in the diagram below, 2 trials were performed. Trial #1 monitored 391 wells in the McElroy field from September 2009 to February 2011. The system categorized 205 to be normal functioning pumps and recognized 47 pumps would fail. The actual data revealed that 11 of the 205 pumps that the software categorized as normal, in fact failed. Also, of the 47 pumps that the software recognized as failures; 4 turned out to be normal functioning, giving the system an accuracy rate of 94.9%. Similarly, Trial #2 reflects the SEA software's ability to predict the future failures of pumps in the oil field. Of the 391 pumps examined, 52 were identified as going to fail in the future. 13 of these 52 pumps did not end up failing. The results exposed 80% predictive accuracy, once again reinforcing the software's significance in the rod pump unit maintenance process. "Think of the computer software being developed as a qualified doctor. A good doctor takes in the signs of sickness from the patient, such as coughing, and makes a sound diagnosis of the health of a patient, while taking the precautions necessary to prevent the possible sickness from getting any more severe. Similarly, the computer software we are developing performs the same responsibilities as a doctor would for the status of rod pump units. The key is to recognize the warning signs of failure ahead of time so that we can fix the problem sooner," states Yintao Liu, one of the graduate students involved in the SEA Project. Shuping Liu, and Sanaz Norouzi are also USC graduate students who are currently participating in the SEA project. "It's exciting," said Yintao, "and I am very proud to be a part of this great project." Yintao also took part in a unique CiSoft Internship at Chevron that made a significant contribution to the SEA Project. "MCA ifield recognized the potential capability applying the modeling capabilities of SEA for

failure prediction on rod pumping systems; in April of 2009 we initiated efforts to evaluate SEA and develop a predictive analytics solution for rod pumps. We have made significant progress since then, with the first production version of SEA scheduled for release in October 2011. SEA will be integrated with the Artificial Lift Systems Optimization Solutions already developed for Chevron's MCA Business Unit's Well Performance Decision Support Center (DSC) located in Midland Texas, and we look forward to deriving anticipated value from its application in the DSC's work process" states Lanre Olabinjo, Chevron's CiSoft Alliance Coordinator.

	Normal (true)	Failure (true)
Predict Normal	254 (77.9%)	13 (20.0%)
Predict Failure	72 (22.1%)	52 (80.0%)

Trial #1 Statistics for the detection of current status of rod pumps in a certain oil field (09/2009 - 02/2011)

	Normal (true)	Failure (true)
Normal	205 (94.9%)	4 (7.8%)
Failure	11 (5.1%)	47 (92.2%)

Trial #2 Statistics for the prediction of the future status of rod pumps in a certain oil field (09/2009 - 02/2011)