Invited Papers

The Importance of Model Verification and Validation

David Esh (US Nuclear Regulatory Commission)

Model verification and validation are essential, and many times overlooked, steps in the simulation modeling process. Successful deployment of models requires that they solve the equations correctly and solve the correct equations. This talk discusses real-world examples of different modeling failures and their implications to the GoldSim modeler. Different types of errors are presented. Examples of real-world complexity are also provided. Real-world complexity may invalidate the most carefully planned and executed model if the phenomena was omitted from the scope of the evaluation.

David Esh is a Senior Risk Analyst with the Nuclear Regulatory Commission with over twenty years of experience in performance assessment. Prior to joining NRC he worked at Argonne National Laboratory. David is the youngest dual recipient of NRC's highest and second highest awards. He has been a user of GoldSim since before it was GoldSim. He is a proponent of probabilistic analyses, simulation modeling, and assessment of uncertainty. David has four degrees, including a PhD in engineering from the second best school in the Big Ten (after the University of Michigan), Penn State University.

Simulation of Recipient Water Quality for Closure Planning at the Aitik Mine

Ted Eary (Enchemica) and Paul Haby (Stantec)

Aitik is an open pit copper mine located in northern Sweden. Operations started in the late 1960s and will continue to the mid 2040s. The mining facilities currently include two open pits, waste rock storage areas, mill, tailings management facility, clarification pond, and a system of canals and pumps for managing onsite surface water. The permitting process for mine expansion has required the development of detailed closure plans for each of the mining facilities with a major focus on the effects of reclaimed mine facilities on future water quality in the recipient river system around the mine.

A GoldSim model was developed to simulate water quality in the river system to help in the evaluation of closure alternatives. The model was found to provide accurate simulations of water chemistry in the existing river system; hence was extended to represent future water quality over a 200-year period based on predictions of chemical loads from the mine facilities as they progress from operations to reclamation and closure over a 200-year period. The model uses inputs from geochemical models of for the reclaimed tailings, waste rock, and open pits and a future climate change scenario for precipitation and flows in the recipient river system.

The model was found to be very useful for making rapid assessments of different closure approaches for the mining facilities. The model also clearly showed that overflows from the open pits, which will become lakes after closure, convey the largest loads to the river system; hence, the closure planning could be focused on managing the water quality entering the pit lakes prior to the lakes filling to capacity and spilling to the river system.

Ted Eary is a semi-retired geochemist with 35 years of experience in applied aqueous geochemistry and dynamic systems modeling. He holds degrees in geology from the University of Michigan and geochemistry and mineralogy from Penn State University and is a certified GoldSim trainer. He specializes in the use of GoldSim and combined GoldSim plus geochemical models for simulating water and chemical balances for mining operations.

Water in Central Arizona: 5 Million People, 400,000 Irrigated Acres, a Dozen Native American tribes and 8 Inches of Precipitation

Ken Seasholes (Central Arizona Project)

Water is a constant focus of attention in Arizona, but supply and demand are characterized by deep uncertainty and high complexity. To support planning and decision-making, staff at the Central Arizona Project have developed several models in GoldSim, the most elaborate of which simulates over 100 public and private water companies, irrigation districts, Native American tribes, and other entities in the most populated portion of the state. The Central Arizona Project Service Area Model ("CAP:SAM") has over 2,300 GoldSim elements, and models a range of interconnected hydrologic, legal, economic, regulatory, demographic and behavioral factors. CAP:SAM makes extensive use of GoldSim's array functions and data export capabilities, and deploys the graphical environment in ways that highlight the model logic. CAP staff have also developed approaches to manage model development by multiple users, to create attractive user interfaces, and to generate custom visualizations in Excel.

Ken Seasholes is the manager of Resource Planning & Analysis for the Central Arizona Project (CAP), which annually delivers more than 1.5 million acre-feet of Colorado River water. His group is responsible for long-range planning and policy issues within CAP's three-county service area, which includes 80% of the state's population. Since joining CAP in 2008, Ken has contributed to a range of initiatives involving water allocation, water banking, supply and demand modeling, groundwater replenishment, and wheeling new water supplies.

Before joining CAP, Ken was the Tucson Area Director for the Arizona Department of Water Resources, and prior to that was a Senior Research Specialist at the University of Arizona. Ken has a Master's degree in Geography and a Bachelor's degree in Political Science..

Using GoldSim to Evaluate Long-Term Performance of Underground Single-Shell Storage Tanks Containing Residual Radioactive Contamination at Hanford, Washington

Sunil Mehta (INTERA Inc.)

Large volume underground single shell storage tanks (up to 1 million gallon) were built at Hanford, Washington to store radioactive waste generated from chemical processing of irradiated nuclear fuel as part of the national defense starting in 1940's. Currently, one of the tank farms that consists of 16 tanks is undergoing regulatory closure following removal of radiological constituents and hazardous chemicals to the extent practical. However, some residual radioactive contamination is left behind in the tanks due to difficulty in removing the "hard-heel". These underground tanks will be left in place and filled with grout and a thick surface cover (a closure cap) will be emplaced on top at closure.

To evaluate the long-term impact of residual contamination on biosphere a performance assessment was conducted recently using GoldSim. The presentation will illustrate the method and approach adopted in evaluating the system-level performance as the radionuclides travel through the thick vadose zone into the saturated zone and eventually to the receptor. The emphasis will be on highlighting the calculation approach using various tools available in GoldSim contaminant transport module along with comparison to the 3-D process-level fate and transport model.

Sunil Mehta is a hydrogeologist with 27 years of experience in the areas of flow and transport modeling under variably saturated conditions, reactive transport modeling, geochemical analysis, performance assessment, and uncertainty analysis. He has gained this experience on projects involving deep geologic isolation of high-level radioactive wastes, shallow disposal of low-level radioactive waste, and environmental restoration activities. Dr. Mehta has 20 years of experience in conducting process and component modeling (e.g., waste-form degradation and source-term evaluation, unsaturated and saturated zone transport, colloid facilitated transport), and combining these models into comprehensive probabilistic assessment tools used to forecast post-closure performance of storage and disposal facilities.

Simulation of Complex Projects Using GoldSim

Alan Keizur (Golder Associates)

In addition to the most common application areas, GoldSim provides a powerful environment for simulation of complex projects. In particular, projects requiring key decisions to be made despite significant uncertainty related to cost, schedule, or other key metrics, branched logic, and multiple alternatives may be excellent candidates for a decision support model constructed with GoldSim. Alan has successfully performed risk analyses of many large capital projects in a variety of industries throughout his career with Golder Associates, including ongoing evaluations of spent nuclear fuel and high level waste management strategy in the United States. Alan's talk and supporting poster offer some techniques and lessons learned associated with project simulation using GoldSim, including use of some of the software's lesser-known capabilities. We'll look at features such as conditional containers, event-driven triggering, scenario manager, cloning, and correlation matrices and discuss how they can be applied to more general applications.

Alan Keizur

Alan is Principal in Golder's Seattle-area office specializing in quantitative risk assessment for major infrastructure projects and simulation model development. Alan supports public and private clients in a wide variety of industries, including transportation, mining, utilities, water management, and nuclear. He began his career working with GoldSim MS-DOS based precursor codes, and was a member of the original GoldSim software development team.