Using Our Best Judgment

Some would argue that the introduction of new information technology tools into geotechnical engineering will soon obviate the need for engineering judgment. Nothing could be further from the truth. **By W. Allen Marr, P.E., F.ASCE**

Today's information technology (IT) developments are providing quantum increases in the capabilities of the tools that help us conduct geotechnical engineering (GE). The question is, will current and future developments in IT supplant the geotechnical engineer the way they did draftsmen and secretaries? As IT tools gain in sophistication and increase the sheer amount of data that they can obtain and present, it seems appropriate to consider where the geotechnical profession may be headed with respect to the applications of IT tools.

First, we need to establish the controlling factors and a framework within which to pursue this assessment. The practices of GE and engineering geology require us to work with very limited data about a complex environment in which conditions can change radically within short distances and short time frames. Geotechnical engineers and geologists use scientifically accepted principles of interpolation, extrapolation, deduction, and inference, along with their judgment, to extend this limited information to a generalized model of the subsurface conditions present at the site of a given project.[1]

The basic properties of geologic materials—strength, stiffness, and permeability—are neither constant nor unique. They depend on the structure of the materials; on the past, present, and future values of stresses, including pore pressure acting on the materials; and on time. No device has yet been developed that measures the properties of these materials for the exact conditions that exist during construction and operation of a constructed facility. Instead, geotechnical professionals must rely on simplified testing devices, conversions, correlations, approximations, and, as previously mentioned, engineering judgment to deduce the material properties that should be used in our analysis and design.

No soil model exists to adequately capture all of these effects. We apply judgment to transform the known information about the geometries and the behavior of the materials into parameters that our analytical methods will accept. We apply judgment to fit the results of the analysis to the unique circumstances of the project and develop a workable design. Because of this complex methodology, experienced geotechnical engineers know that it is necessary to observe the actual performance of the facility during construction and to be prepared to make modifications if required. They also know to evaluate these observations to determine what modifications are appropriate and to learn what to do differently the next time.

In fact, geotechnical engineers can be said to implement five stages in the course of their work: investigation, analysis, prediction, observation, and evaluation. Using the current business modeling concept of process management, it is helpful to view these five steps as a process, one that we can refer to as the GE process. The transition from one step of the GE process to the next involves a very complex set of human actions, namely, thinking. By thinking, we pull together the available information; test it for logic, reasonableness, and truth; form conjectures, hypotheses, and conclusions; and develop arguments to support our conclusions. Thinking involves deduction, induction, and judgment at every step. It also involves the detection of inconsistencies and gaps in the results of earlier steps. Filling in those gaps can introduce feedback loops to one or more earlier steps of the process.

Over the next 50 years, IT tools may considerably change the way in which engineers carry out each stage of the GE process. But one can be sure that the process itself will not change and that thinking skills will be every bit as valuable as they are today. Peter Facione, Ph.D.—a former provost of Chicago's Loyola College and currently the senior director for academic leadership with Keeling and Associates, a higher education consulting firm based in New York City—defined several types of thinking skills in his essay