Digital Data for Engineering Geology: Disaster or Benefit

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Abstract

Is digital data handling for engineering geology a disaster or a benefit? The first introduction of the use of digital data and the work with digital data to make geological and geotechnical models of the surface and sub-surface is some 15 years ago. At the introduction the general feeling was that these tools would largely facilitate the work of an engineering geologist and improve the results of engineering geological and geotechnical modelling. Until now, however, digital interpretation and the use of digital modelling techniques only slowly find their way into engineering geology and geotechnical engineering. The use in day-today practice is fairly limited and, if used, often confined to only visualise the results of the modelling. The benefits of a good presentation and visualisation of data and underground models should not be underestimated, but is only one of the aspects that were expected to be beneficial at the introduction of digital data and computers.

The reasons for this slow penetration into the industry may be many. A major reason is, however, caused by a flaw in the way data is handled in engineering geology and civil engineering. In the old times, e.g. before the 'digital era', the traditional hand-made geological model, interpretations and interpolations camouflaged this flaw.

Before the 'digital era' nobody in engineering geology had much interest in the accuracy of data interpolation and interpretation, and consequently in the certainty of the models made. Data was interpreted to the best knowledge of the engineering geologist or geotechnical engineer taking into consideration the geological environment and the available data (which is often a limited quantity anyhow). It was clear that the certainty of an interpretation could not be quantified by hand and nobody asked for it - strange enough, accuracy of field or laboratory measurements has always been regarded as highly important. Also nobody had much interest in the accuracy of geological maps. The consequence for the average project in engineering geology was that the certainty of the geological and geotechnical model of the underground was largely unknown.

In the 'digital era' the computer does data interpolation and the models are logically also be made in a computer. The accuracy of the interpolation and interpretation are regarded as of major importance, and, consequently, the certainty of the model. One way to solve the (un-) certainty problem in geological and geotechnical models is to increase the

quantity of data to such a number that no expertise of a geologist is required for the modelling, e.g. ‘just interpolate’. The consequence is an increase in costs.

The higher costs could be justified if it would lead to better results. This seems, however, not to be the case. Projects seem not to become a lot better (read: more profitable) if made with interpolation only, even not with large quantities of data.
If, however, no large quantities of data are used, a geological interpretation is necessary. This results in a completely unwanted effect. Everybody, including the clients, who, in general, are civil engineers, seems to find it necessary to ask questions about the certainty of the model. Because a computer is used, the certainty of the model has to be known. In most cases (according to the author: in virtual all cases) the answer can only be: “it looks good, but regarding the certainty: no idea”. This confirms then the existing ideas about ‘geo-fantacy’ (and geologists in general).

Hence, digital modelling in engineering geology leads either to more work and higher costs or we show that geological models cannot be justified mathematically, and have to admit that the models largely depend on expertise.

How to solve this problem?

The geological model is made based on the expert opinion of mostly one single geologist (or engineering geologist or geotechnical engineer). There is no mathematical justification for the model and the certainty of the model is unknown. A considerable improvement would be achieved if it would be possible to use during the making of the geological model the expertise of more experts; i.e. if more than one geologist could be involved in making a model. Obviously, this would be far too expensive for the average project.
An alternative can be the use of expert systems and knowledge bases. The knowledge base includes knowledge that facilitate the interpretation, but especially, includes geological standard models that in a particular geological environment can be fitted to a given set of data. The knowledge base should obviously have the ‘knowledge’ to advise on the likelihood of a model in a particular environment.

If a large team of experts could develop such a database the database would get the status of a reference standard. Apart from reducing the influence of a single geologist, it would also (at least partly) rebut the criticism of non-geologists on accuracy and certainty of the model (the geo-fantasy) because the produced geological model can be referenced to the standard model in the standard database.