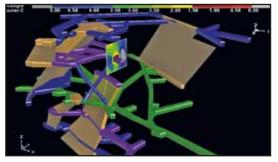# Dr Terry Wiles

Dr Terry Wiles received a PhD in Civil Engineering from the University of Toronto and went on to work for Inco in Sudbury contributing to some pioneering work on rockburst alleviation measures. He left INCO to develop Map3D, a fully integrated three-dimensional layout (CAD), visual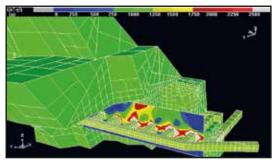isation (GIS) and stability analysis package (BEM elasto-plastic numerical modelling stress analysis). Map3d has been commercially available since 1990. Wiles has been solely responsible for all technical developments and innovation in Map3D.

A complex 3D mining example from Map3d

Map3d has been the industry standard since 1990 and has been continuously enhanced to provide a powerful engineering design tool. Map3d numerical models have been used worldwide for underground excavations, rock slopes, open pits, tunnels, to account for the presence of fractures and surface infrastructure loads. The stress analysis models can simulate yielding (non-linear) zones of different moduli (e.g. stiff dykes or soft ore zones) and loads due to steady state thermal/fluid flow. Excavations can be intersected by multiple discrete faults (nonplanar and gouge filled) that slip and open. Map3D can simulate ground support elements such as arches, steel sets, props, thick liners, chalks, backfill etc. "What sets Map3D apart from other analysis programs is its ability to accommodate a very wide range of problems in 3D. Large, complex, fully 3D problems can be built with ease using the built-in CAD functionality. Combined use of both FF and DD elements allows for simulations of 3D excavations with intersecting fractures or shear planes. The various versions of Map3D fully support plastic Fault-Slip and 3D rock-mass plasticity, featuring compatible input files for all versions thus providing a clear upgrade path as upgrades to advanced capabilities are required by the user."

In terms of further functionality of Map3D: "Map3D has the ability to simulate everything from simple tunnels and tabular shapes to detailed 3D excavation shapes and large scale mine wide problems. The difficulty users will encounter in model construction and interpretation depend on the amount of complexity required for the simulation at hand. While simple tabular models or single tunnels are fast and easy to construct in Map3D, complex three-dimensional problems are more difficult to work with and interpret."
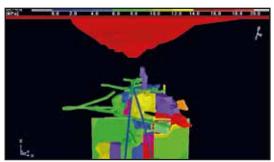

3D non-linear yielding between drifts

Wiles's Map3D in-depth overview

Map3D has a completely self-contained CAD facility. One of the keys to the ease of use is model construction using either conventional surface elements or the built-in solid modelling technology. This permits users to build models using a series of three-dimensional building blocks. These blocks, which can be any desired shape or size, are used to construct excavations and accesses, as well as to define large or irregular shaped non-homogeneous zones (ore zones, dykes and yielding zones). All of the material outside the model boundary is assumed to be a solid host material.

The program automatically builds intersections between excavations, faults and multiple material zones. By coupling this capability with the built-in Boolean operations, complex multi-step mining sequences can be constructed with ease.
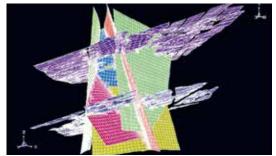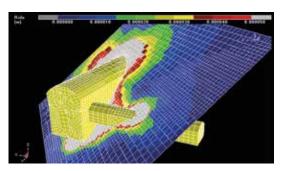

Open pit and underground workings

Special features have been implemented to allow fast construction of tabular mining shapes. The user need only specify the perimeter of each mining step and Map3D automatically builds the required elements. The perimeter does not necessarily have to be planar. In fact any bounding polyhedron of three-dimensional points are acceptable. Complex, multi-reef, non-tabular (rolling or offset) mining is readily simulated. Intersecting faults or three-dimensional dykes can be simulated. The tabular mining can be extruded into 3D blocks then back into tabular mining if desired. This allows construction of detailed development to be completed very quickly. Also different parts of the model can be simulated using the tabular approximation while details can be obtained in areas of interest by using true 3D shapes.

Open pit and underground workings

Wireframe mine plan outlines and excavation geometries can be digitised from within Map3D or imported from several sources including AutoCAD-DXF and a universal ASCII PNT format. The user can interactively build a model comprising 3D blocks and planes using the built-in CAD capabilities of Map3D. Based on the geometric outlines or free-hand drawing, the user picks corners of blocks and planes to complete construction of the model. All of this is done graphically using the comprehensive set of tools available in the CAD interface.

Multi-reef tabular mining with intersecting dykes and faults

A model comprises one or more connected or unconnected blocks and/or planes that can be mined and filled in a specified sequence. Surfaces of blocks and planes are subsequently discretised into a number of boundary elements by the program. Extensive error checking assists the user in identifying whether the geometry is topographically valid or not. The same input data can be used for elastic, thermal/fluid flow or non-linear analysis. Analysis results can be contoured on element surfaces or on a series of used defined field point grid planes. These later planes can be positioned at any desired location and allow contouring of stresses, strains, displacements, strength factors or any desired combination of these components. "Line contours and/or colour filled contours can be generated with options for labels, trajectories, transparency, grid lines and more. Results can be exported in many formats including raster screen dumps, vector screen dumps or selected grid or surface locations with user configurable format."

The influence of Map3D

Since its introduction, the software developed by Wiles has been the most widely used stress analysis software at mines sites worldwide. It is currently used by many hundreds of mining, civil and geotechnical companies, consultants, research centres and universities around the world including Armenia, Australia, Austria, Belgium, Botswana, Brazil, Bulgaria, Canada, Chile, China, Columbia, Democratic Republic of Congo, Egypt, El Salvador, England, Finland, Ghana, Guatemala, India, Indonesia, Ireland, Italy, Japan, Kazakhstan, Korea, Mali, Mexico, Namibia, Nedlands, Nicaragua, Papua New Guinea, Peru, Philippines, Saudi Arabia, South Africa, Sweden, Switzerland, Tanzania, Turkey, UK, USA, Zambia and Zimbabwe.

Competence in the use of Map3D is often a prerequisite for employment in rock engineering in most deep and high stress mines and consulting firms. A further indication of the impact of the software is that there has been a direct industry driven need for continuous training at mine sites worldwide. This has resulted in more than 100 Map3D courses disseminated by Terry Wiles in Australia, Canada, Chile, Korea, South Africa and Sweden. These courses have been attended by close to 1,000 practicing rock engineering specialists.

The accessibility of Map3D has made it the reference tool in both industry and academia. This is reflected in the International Conference forums in Rock Engineering and Deep and High Stress where a large number of publications and presentations refer directly to results obtained using Map3D. Wiles received the 2011 Rock Mechanics Award of the Rock Engineering Society of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM). As indicated at the citation at the time "….developed what is arguably some of the most utilised and practically-applied modelling software that currently exists at mine sites."