



WEBINAR

Mastering 3D Structural Mapping with ShapeMetriX

Q1: Is there a way to work with the software (acquire joint orientation, trace length, etc.) using the point cloud directly? For precision purpose, if we want to avoid the surface disruption caused by meshing triangulation.

A1: The existing 3D point cloud datasets first need to be processed into a 3D surface for further structural geologic mapping and/or geometric measurement efforts. ShapeMetriX does not inherently reduce precision or disrupt the surface during 3D model generation. However, the final model accuracy depends on several factors including input data quality, processing settings, point cloud density.

Q2: Already have implemented workflow for 3D photogrammetry that we produce .las or mesh files out of. Is there an option to just licence the SMX analyst module for mapping?

A2: ShapeMetriX license comes as a complete and comprehensive package including components for photogrammetry applications, importing existing 3D point cloud datasets, 3D model editing and structural geologic mapping. Analyst is one of the main components in ShapeMetriX package and it is not licensed separately.

Q3: Does ShapeMetriX integrates with UnWedge?

A3: ShapeMetriX does not directly and seamlessly integrates with UnWedge, due to the foundational working principles of both programs and UnWedge's program assumptions. However, joint orientations obtained in ShapeMetriX structural geologic mapping can be manually entered into UnWedge as input joint orientations. On the other hand, ShapeMetriX works in integration with RocTunnel3, our 3D Rock Stability Analysis and Hazard Assessment program for Underground Excavations. Exported 3D geometries and joint data (orientation, location, size) can be imported into RocTunnel3 for further detailed stability analysis.

Q4: Are you planning on developing tools to measure the P21 of each set for each analysis zone?

A4: This request or suggestion has been added to our wishlist for upcoming versions.

Q5: How does the use of images obtained by lidar sensors affect these studies and if the software supports them without problems or has any considerations in the use of these data in question?

A5: When using images in lidar survey, the camera and the lidar sensor must be tightly connected and calibrated to each other. ShapeMetriX assumes geometrically aligned cameras and lidar sensor when using the e57 format.

Q6: Since you guide the structural information measurement process, how can you minimize the bias introduced during measurement? Features such as the number of planes, size, and orientation are influenced by your interpretation and measuring ability. What strategies or methodologies can help reduce these biases?

A6: Geologic maps are subject to various bias including but not limited to geometric bias and bias of the user. While these bias cannot be avoided, some strategies may help to cope with them. For example, the bias induced by the user can be compensated if other expert users review maps. The 3D model has the advantage of an easily accessible, permanent source of information, and assessments between different expert users can be aligned.

Geometric bias of orientation measurements would result in different densities in the stereographic projection. During the webinar it has been shown how to autocluster a map in a first run, then lock high density clusters, and do a re-run on lower density populations. These latter populations may have been a result of orientation bias. Another strategy to cope with geometric bias is using trace map analyses with different orientations of the projection plane in order to visualize the directional bias of spacing and trace lengths.

Q7: Is it possible to only use ShapeMetrix Structural Geological Mapping and Discontinuity models? We already have flight planning and 3D point cloud analysis software.

A7: ShapeMetriX license comes as a complete and comprehensive package including components for photogrammetry applications, importing existing 3D point cloud datasets, 3D model editing and structural geologic mapping. However, using the photogrammetry component, MultiPhoto, is not mandatory. Users can import external and existing 3D point cloud datasets into ShapeMetriX for processing them into 3D surfaces, and perform further structural geologic mapping and/or geometric measurement efforts.

Q8: Can we export ShapeMetriX in RS3 in future or not?

A8: ShapeMetriX can already work in integration with RS3. Exported 3D geometries (e.g. obj, dxf,) can be imported into RS3, joint data (orientation, location, size) can be used to define joint surfaces and joint set statistics (spacing, orientation) can be used to define DFNs in RS3. Also, more direct and seamless integration between ShapeMetriX and Rocscience 3D programs are in development.

Q9: Does the automatic joint mapping rely on colour/RGB data? Will it be able to automatically map from dark (underground) lidar scans?

A9: Guided traces find the connection between tie points according to the color and contrast of the texture while constraints about the admissible irregularity can be imposed. If no contrast or color variation is present in the photos (such in very dark areas), the trace will connect the two points along the surface closest to a straight line.

Guided areas, the region grow, do not take into account color information at all but only geometric parameters such as relative angles, positions and curvatures. The lighting condition does not play a role for this feature.

Q10: When assessing rock cuts often only a certain area along the toe of the slope is accessible. Physical joint measurements are often taken here. Is there a way to incorporate this data and the joint data generated by ShapeMetriX?

A10: The envision of ShapeMetriX is to offer contact-free and reproducible structural geologic mapping to enable remote and safe data collection, while being time and cost-efficient. Hence, entire road-cuts or slopes (whether they are physically accessible or inaccessible) can be mapped and measured using ShapeMetriX.

However, if there already exist joint measurements physically taken from the joints along the toe of the slope, they can also be mapped and reproduced in ShapeMetriX to incorporate this data into structural geologic map. They can be used to compare and validate the reproduced measurements, by cross-checking the physically measured joint orientations with those measured in ShapeMetriX. Please keep in mind that, there were several attempts to compare field measurements and measurement from 3D model. One important outcome was, that field measurements of different people show more variations than different measurements from 3D models. Another result with ground truth showed typical deviations in the range of 0,5 - 1,0°

Q11: Will there be another webinar about the integration of ShapeMetriX and RocSlope2?

A11: There may be a webinar in the future on how both programs can be used together for practical applications. You may follow our social media channels for any announcements on future webinars.

Q12: Does ShapeMetriX allow importing point clouds generated from photogrammetry or 3D laser scanning?

A12: Yes, ShapeMetriX allows importing existing 3D point cloud datasets in E57 laser scanner and OBJ file formats.

Q13: Q13: How is ShapeMetriX seamlessly integrated into FragMetriX? How is it affecting the final particle distribution curve?

A13: 3D models generated in ShapeMetriX can also be used in FragMetriX if they show a suitable muck pile or the like. For the time being there is no direct integration between discontinuity mapping / rock mass parameters to the obtained particle size distribution. Using rock mass parameters for predicting particle size distributions is an interesting topic and it is on the wishlist.

Q14: What point density is considered good for joint mapping?

A14: It totally depends on the application and project needs, the size of the minimum rock feature to be mapped, size and visibility of the joints, etc. So there is not a definitive answer for the ideal point density.

Q15: Is ShapeMetriX able to import .las or .laz data formats?

A15: ShapeMetriX allows importing existing 3D point cloud datasets in E57 laser scanner and OBJ file formats.

Q16: Could you extract joints automatically or do you have to extract them manually as shown during the webinar?

A16: Fully automatic joint mapping is not currently offered in ShapeMetriX. ShapeMetriX offers manual or semi-automatic joint (and trace) mapping features using its Trace, Guided Trace, Area and Region Grow tools.

Q17: I'm guessing Pix4D would have output file formats that could be used in ShapeMetrix for mapping.

A17: An OBJ file export from Pix4D can be imported into ShapeMetriX 3D model reconstruction and structural geologic mapping.

Q18: How are you dealing with the totally automatic identification and automatic recognition of discontinuities from 3D point clouds? Mainly in case of planar structures and secondly with the linear or trace automatic identification?

A18: Fully automatic joint mapping is not currently offered in ShapeMetriX. ShapeMetriX offers manual or semi-automatic joint (and trace) mapping features using its Trace, Guided Trace, Area and Region Grow tools.

Q19: Will you be sharing the structural mapping slides and the video recording with the attendees?

A19: The webinar recording will be available on our YouTube channel shortly.

Q20: Does ShapeMetriX have tools for vegetation filtering in point clouds? If so, what methods does it use to differentiate vegetation from terrain or rock surfaces?

A20: ShapeMetriX does not offer vegetation filtering. It takes external data as final. Trimming of imported 3D models is possible though.

Q21: Is there any recommendation to the file size of point clouds to optimize performance in ShapeMetriX?

A21: Assuming that file size correlates with the number of points and/or image sizes in the file, it depends on the use case, the required level of detail (volumes need less level of detail compared to fragmentation analysis), and the available processing hardware. Optimisation should take place already in the field works to tailor the campaign to the requirements of the project/task. During processing the user can also choose different levels of detail in the final model such as Fast, Normal, and High.

Q22: Do you have a single slide that shows the workflow from data collection to final analysis?

A22: Yes, the standard user workflow in ShapeMetriX (inputting digital images, 3D model generation, structural geologic mapping and geometric measurement, respectively) is discussed in the webinar as well as the alternative workflow (importing external 3D point clouds, 3D model generation, structural geologic mapping and geometric measurement, respectively). The slides including these workflows can be seen in the webinar recording on our YouTube channel.

Q23: Do you plan to include other distributions of rock discontinuities besides Fisher's, such as Kent's distribution?

A23: This request or suggestion has been added to our wishlist for upcoming versions.

Q24: What is the procedure for using ShapeMetriX in underground applications? What is the difference for using it in underground and surface applications?

A24: The fundamental principles such as photogrammetry, 3D model generation, external 3D point cloud data import, structural geologic mapping and geometric measurements remain the same for both surface and underground applications. Usually, the same steps and workflow are also followed, which are data acquisition (image capturing), image processing or external 3D point cloud data import for 3D model generation, structural mapping and geometric measurements, data export and reporting in order.

The main difference between surface and underground applications are usually image capturing and georeferencing related due to more challenging conditions for underground applications such as limited lighting and confined spaces.

For example, proper artificial lighting is required for underground environments since they lack natural light, while natural light available for surface applications but shadows can be an issue in that case. Also, in underground applications, confined spaces limit camera movement and positioning, but surface applications allow more flexibility for camera positioning and also drone use. Scale bars or georeferencing targets are also more essential for underground applications due to lack of GPS.

Q25: Considering underground survey, which equipment do you need? Do you support any laser scanner?

A25: When looking at data gathering with pictures, the best set-up is a quality camera with a light-sensitive full-frame sensor (ideally). The camera should be mounted on a tripod in order to avoid shake, ideally remote triggering is used. The area of interest needs to be illuminated by flood light, e.g. LED Arrays. At least two light sources should be used to minimise shadows. Flashlight should be avoided at all because it usually compromises picture quality severely. Hand-held cameras pose the risk of blurred images. Cell phone cameras from some manufacturers (not all) can also be used, the obtainable quality is usually good as well, even though not stellar.

As for laser scanners, there is no preference unless they deliver sufficiently good data. The supported file formats with textures should be generated. Possibly lighting necessary for sufficient texture quality.

If texture is not important, any laser scanner which generates obj or e57 can be used.

Q26: The contemporary drones have advanced GPS systems. Are they sufficient for to be used in ShapeMetriX applications? Or do I always need Ground Control Points to georeference and scale my 3D model?

A26: Yes, most of the latest technology drones are equipped with advanced GPS systems provide high-accuracy positioning, but they might not always sufficient for precise georeferencing and scaling in ShapeMetriX applications. Most commercially available drones use RTK (Real-Time Kinematic) or PPK (Post-Processed Kinematic) GPS, which improves accuracy to some 2-5 cm compared to standard GPS.

On the other hand, reliable and precise ground control points (GCPs) ensure absolute accuracy by providing fixed reference points with known coordinates, correcting any GPS drift or errors from the drones. Depending on the usage and application, GCPs can be more essential when high precision and positional accuracy is required. But if the user only needs relative accuracy, and absolute accuracy is not critical, then drone GPS may be sufficient, and the user can use a well-calibrated RTK/PPK drone without GCPs. For high-precision models, using GCPs are always recommended for the best accuracy. In underground environments, drone GPS will also be ineffective due to the lack of satellite signals, so GCPs or scale bars must always be used.

Q27: Aside of using reference points on the ground, does ShapeMetriX support other ways of registration of 3D models?

A27: There are multiple other registration alternatives

Using camera GPS (drone GPS) and align reconstructed camera positions with GPS camera positions

Attention on whether normal or differential (RTK, PPK) GPS is used. Currently, one single control point on the ground is still required for accurate results

Using a Range Pole (vertically set-up scale bar with targets at a known distance) and Compass Reading / Known Azimuth (azimuth of a user defined reference line)

Using Distance between two points and a base plane as horizontal reference

Q28: Can ShapeMetriX generate cross sections, and in which formats they can be exported?

A28: Yes, ShapeMetriX can generate cross sections. A cross section in ShapeMetriX is a planar polygonal line formed by the intersection of a cutting plane and the 3D model. The cutting plane is defined by its position and orientation, and the user can edit the section type (such as vertical, horizontal and an arbitrary oriented section), the position and the orientation subsequently. The sections can currently be exported in csv or dxf data formats.

Q29: Is ShapeMetriX limited to geologic mapping, or can you obtain other data as well?

A29: Other than the structural geologic mapping tools, there are other geometric measurements:

Cross sections, Volumes, Coordinates, Contour lines, Colour overlays, Tape measure and profiles (e.g. roughness). Annotations such as water ingress marks or other occurrences. It is also possible to import displacement maps from radar monitoring.

Q30: Can you elaborate on the link between ShapeMetriX and RocSlope3, and Fragmentation?

A30: ShapeMetriX and RocSlope3 work in seamless integration which streamlines the 3D block stability and hazard assessment analysis workflow, starting from data acquisition in the field. First, the 3D model geometry generated in ShapeMetriX and the mapped joint data are exported as RocSlope3 readable files (.3grs for model geometry and .3gdps for joint data). Then, the 3D model geometry file will be imported into RocSlope3 where the surface reconstruction will be performed automatically. Finally, mapped joint data will be imported into RocSlope3 as measured joints, using ShapeMetriX structural mapping file. The rest of the workflow will be defining additional model settings and parameters in RocSlope3 before computing the block stability.

Regarding the ShapeMetriX – FragMetriX integration, 3D models generated in ShapeMetriX can also be used in FragMetriX if they show a suitable muck pile or the like. Using rock mass parameters for predicting particle size distributions is on the wishlist.