
Working Group:

# Data Access and Usage: Data Exchange for Mine Software

## 3D Interoperability
## *User Interviews and Common Challenges*

Prepared by
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*Vertex Blast*

“

My experience of moving 3D around — when you’re first doing it, it’s a bewildering pain, but so much a normality now.

…Though not to say [we] shouldn’t improve that.

”

# Why an open standard?

**When clean and accurate data exchange is not well supported by 3D tools and their formats, it is the users who take on the extra work to prevent errors, accidents, and corrupted data.**

Mining companies use multiple applications to manage and manipulate their 3D models. Surveyors, geologists, mine engineers, managers and others all need to engage and contribute to these shared mine assets.

However these users do not all use the same tools, nor it is not our recommendation that one toolset would meet the needs of all users. Users create 3D models, manipulate those models, and pass the resulting files to their colleagues, who will need to open and edit those files, and likely send them back again for further collaboration. This means that 3D model information may need to move:

- *Between different users on the same team, who use different applications for different purposes; Between different teams using different applications, suited to their speciality; and, Outside the company to consultants and vendors, and back again.*

Different users have different 3D applications which best support their area of expertise, or different applications which have been chosen as the standard for their company. Even in a company using a set suite of 3D software, a 3D model may need to be passed and opened in a variety of applications — each application contributing or modifying component information. If they encounter issues, users may spend extra time learning the particular details of the formats they use, and the particular import/export protocols of applications.

**It is the users' checks that ensure models and mine information are not broken as the daily work of information exchange takes place. Their vigilance keeps file errors from manifesting as real life issues at site.**

Many of the 3D applications commonly used in mining have native 3D file formats which are not open. While these applications deal in common primitive representations — lines, polygons, blocks — how those representations are managed may differ between software packages, and the resulting files are not designed for easy transfer outside of the source system.

**The development of an open standard supports users' ability to focus on creating information-rich 3D models — with the format supporting the user, instead of the other way around.** ▪

“

If you’re importing a model from one software to another and not double-checking that the variables are imported correctly, you could totally screw up pit operations.

”

Data Exchange for Mine Software

Open Mine Format

**Data Exchange for Mine Software**

# Project Overview

The GMSG engaged Vertex Blast to conduct short interviews with 5 industry stakeholders to discuss the current state of interoperability in 3D application technology. Vertex Blast interviewed these stakeholders, as well as two additional contacts, and found common challenges across disciplines and between mining companies.

## The Challenge

The Data Exchange for Mine Software Working Group identified the need for a shared open format for 3D data within the mining industry, to allow users to easily move clean and accurate 3D information between applications.

## The Objective

The purpose of the interviews was to determine whether there are common issues in the mining industry in moving data between various 3D mining applications. Interviews included discussion of users' tool use and workflows, to begin identification of current "pain points" and identify common frustrations in the existing framework. The interviews are intended to support unbiased evaluation of how the current state of interoperability affects users, and help to determine the type and degree of improved interoperability which would make the greatest difference to their work.

## The Method

Catherine Hayday (*Consultant, Vertex Blast*) spoke with 5 representatives from mining industry companies, and 2 additional interviews with industry stakeholders. Mining interviewees included employees from: **Barrick Gold**, **Newmont**, **Teck** and **Aranz Geo**. Meetings took the form of 30-60 minute information interviews. Interviewees covered a range of types of users, from engineers to mine managers. Confidential information and examples from specific applications have been redacted for this report.

## 3D Software Applications Referenced

Users reported routinely moving 3D data between the following applications. This is not an exhaustive list, as users also used various internal solutions, and other applications on an as-needed basis.

- Vulcan
- Leapfrog
- MineSight
- GEOVIA Surpac
- Datamine
- GEOVIA Minex
- Deswik
- Xeros
- ar2gems
- Meshlab
- Minestar
- GEOVIA GEMS
- Hexagon
- acQuire
- Jigsaw View
- MS Excel
- AutoCAD
- Various internal solutions

# Current State: Common Technical Challenges

Even with a limited sample size, across a variety of disciplines, the information interviews revealed several common technical challenges faced by users of 3D applications within the mining industry.

## Scripts

**Writing scripts** internally to manage these import-export processes is still very common. This can become one user's de facto responsibility if they show an aptitude for it. This means in addition to their work, they are also supplementing the pipeline to move data cleanly between applications. If changes need to be made, or if they leave the organization, there is potentially a substantial bottleneck or loss of institutional / process knowledge.

Multiple interviewees referenced hiring external vendors to write scripts. Some companies offer programming courses internally to enable better or broader scripting skills.

## ASCII and Flat Files

Some modelling applications will allow for the export of their 3D model file into a less restricted and more portable format. At present there is a shadow system of transferring files via **ASCII**, **DXF**, **CSV**. Multiple interviewees stated they use ASCII to move their data between different applications.

ASCII or other flat-file workarounds then introduced other issues managed by the user — such as previewing, managing security, detail-loss, validation, RAM, and (potentially) longer term storage concerns.

Users who favoured the ASCII solution still pointed out several limitations to the approach. Two of these limitations relate to the large size of ASCII files. This introduces challenges around (1) **security** and (2) **validation**. The large size of ASCII files made it difficult for users to run their standard security checks or previewing techniques. In these cases, additional scripts or workarounds were developed specifically to accommodate validation of the ASCII file.

## Object, Syntax, and Name Conventions

**Naming conventions** and **object definitions** were recurring issues mentioned by interviewees, with different applications and vendors using slightly different names for similar objects. Different 3D modelling applications use different terminology for what appear to the user to be the same structures: Is it a line, a polyline, or a polygon? What constitutes a “subblock”? Are there subtle differences in how applications define objects, which may lead to interface complications in a common format? For example, there is variation between applications in terms of block models, sub blocks, and whether the application can handle a variable block height.

Current State:

- Variable terminology and definitions between applications

## Rotation

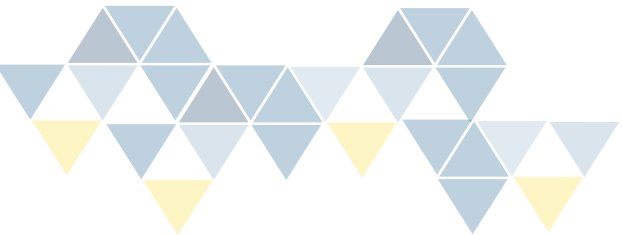
**Rotation** was mentioned by multiple users as a pain point. Some users stated they simply avoid rotation at all costs (which is not symptomatic of a healthy modelling environment). Different software packages consider “a rotation of 90 degrees” to mean different things. As one user mentioned, different models handle rotation off of different points — for example rotating off the lower left centroid versus rotating off the lower left corner of the block.

Current State:

- Users avoid changing model rotation
- Users reverse engineer to determine how an application determines rotation.
- Discrepancies between applications are managed by the user.

Even if the models are a bit cumbersome, we will try to keep them unrotated. If they're not rotated, then the ASCII export will work. If you rotate it, and get it right, it will work, but it can be very tedious.

**A block model, an orthogonal model, will come into most systems without much work. But a rotated model — it really has to be done correctly.**



## Validation (Polygons & Triangles)

**Validity** is a major point of concern for users in moving their model between systems. Users reported that different applications determined model validity differently, which could lead to complications even for supported import/export pipelines. A valid triangulation in one model, exported and brought into another piece of software, is no longer considered valid. This may be the case even if the user has made no modifications to the mesh, as different software determines model validity differently.

Along with different measures of validity, different software packages may also have different **precision conventions.** For example, in block models, some models go to 2 decimal places of precision, and some go to 3.

## Colour Models

Different 3D applications handle **colours** differently. The colours a geologist is using in application A either may not exist in destination applications B or C, or those destination applications have too extensive a colour palette and it is difficult to match the source colour. One user reported having to match the colour exactly or the application would not work properly.

One team of geologists reported changed their colour coding process to a completely **different colour scheme** only because it would transfer properly between the applications they used.

## Managing Coordinate Systems

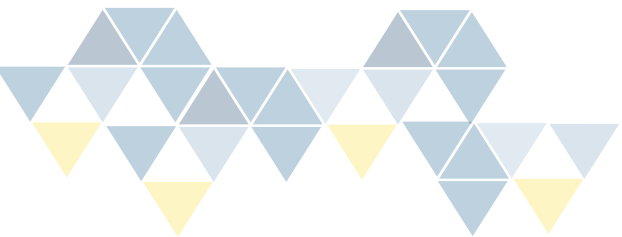
Some issues with moving models around are particular to a site, but which may reveal a deeper issue. One user operates at a site where the **curvature of the earth** becomes an issue in using **coordinate systems**. The curvature of the earth at site causes a 3.97’ discrepancy to occur in their coordinate systems. The way this user manages this is by using multiple grids, changing coordinate systems, and using a truncated **UTM** to have consistent coordinates. This is not a common example, but represents a case of a particular user dealing with real world issues in managing the particularities of 3D modelling. This user has block models for planning, but as they need one centralized haulage model, everything gets converted to UTM. To do that, the site has many scripts written to convert their CAD files to truncated UTM. This all takes significant time to write, audit, and calibrate.

> What we don’t want to do is restrict to a small model because we can’t run it any bigger.

## File Size

Many users referenced using flat files or readable files which get away from the source file system, but which may result in much larger **file sizes** to manage. This can lead to issues with validation, security and previewing.

In another perspective on the large file size issue, one user cautioned against focusing on restricting file size, rather than focusing on “using every trick to make the files smaller and faster”. As they said “If a user wants a billion points, they should have them.”

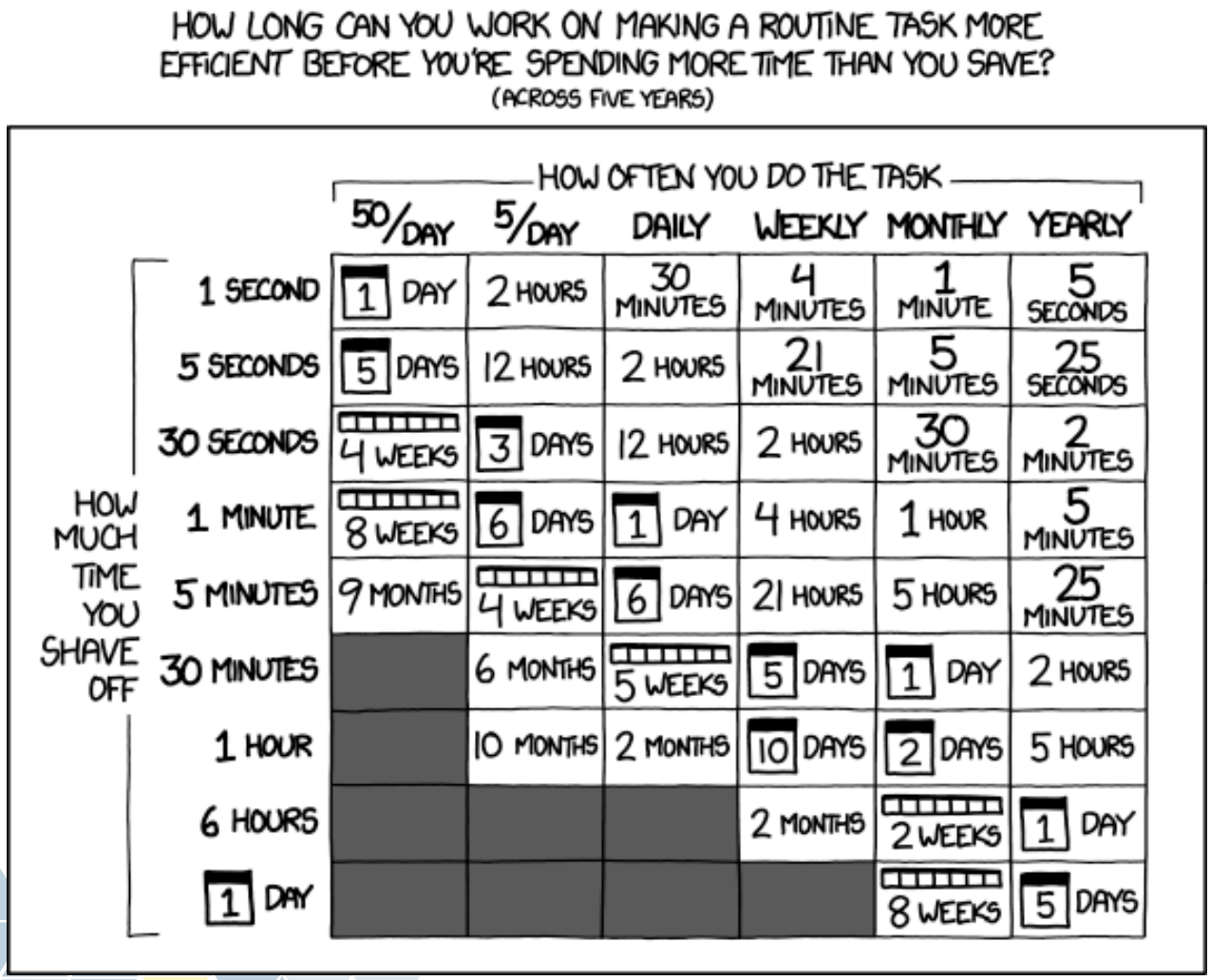


# Current State: Common Process Challenges

## Time Loss

**Time lost** to import/export management was mentioned by multiple interviewees. One user reported regularly spending **2 hours moving files between systems**. This regular investment of time to manage the import/export processes was echoed by other users. In other cases, time spent moving files was mitigated by creating scripts (directly or through a paid third party) to manage portions of the process. Depending on the users' pipeline, even with the use of scripts, the user may still invest time in exporting/importing individual layers, and/or reconstituting and reverifying the model in the target system.

*Online web comic, XKCD: "Is It Worth The Time?"*



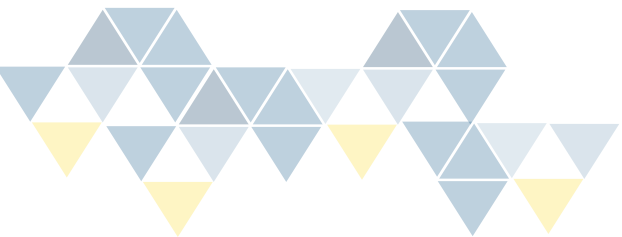
## Reverse Engineering

In workflows which users reported as working effectively, users paid for the API, exported to ASCII, and/or had a good script to manage part of the process. In the reported cases, users required additional format-specific knowledge of how the application managed their model, in order to work with particularities such as specific object handling (e.g. see *Triangles*), colour modelling (see *Colour Modelling*), or rotation (see *Rotation).*

How different applications manage the model is sometimes understood as **"user forensics"**: where a user does explorative work in order to **reverse engineer** how the import/export process works. Users reported drawing pictures and using .csv to understand the conventions between the source and destination software packages. Users also reported that once they determined the answer, they would contact their counterparts with an explanatory note, so that their colleagues would also be able to manage the process without encountering or introducing errors.

## Restricted Use of Available Technology

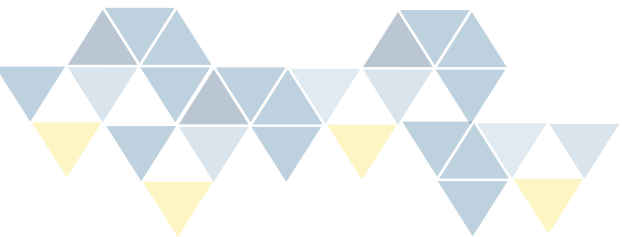
Multiple users reporting **using the software in a limited or particular way** in order to manage the idiosyncrasies of maintaining a useable 3D model across applications. (see *colour*; *rotation*). This is indicative of a workflow which depends on users who understand and manage software package limitations, which is not a workflow which is operating effectively. The full range of features are not functionally available to the user if they avoid using certain core tools. This is evident in the example of the user **restricting** and **changing their use of colour** in the models, and in multiple users' reports of simply **never rotating** their model — whether or not this functionality would be useful in their work.



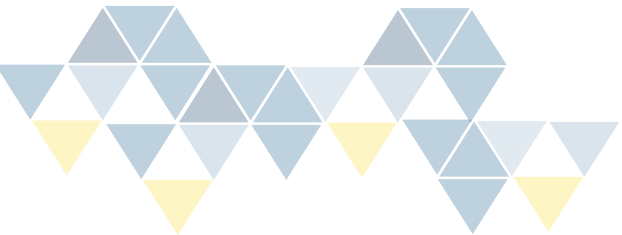
## Additional Costs

Paying for conversion licenses and the development of custom scripts were both identified by interviewees as **additional costs** on top of the 3D applications themselves. Some companies had internal resources who developed scripts, some were explicitly working to build up this capacity in-house, and others contracted script development to third party vendors. In all cases these represent investments in addition to the software license costs, in order to enable the software to match the user's workflow and need to collaborate on the 3D model with colleagues.

> "[It] frustrated me …All companies protecting their IP. Making companies pay for licenses to allow them to convert…"



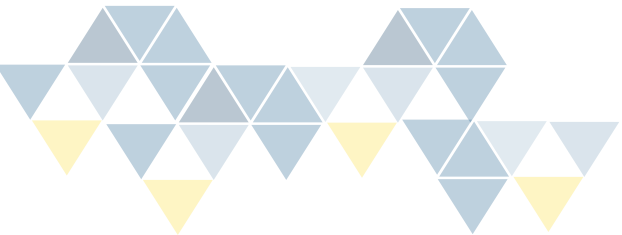
> We do little checks, but it is difficult to do exhaustive checks. So we check a few sections to see if everything looks okay. We will do an interrogation of domain, pit… Check it doesn't have overlapping intervals…
>
> Really basic checks. But you can go a lot further in validity. Check that the results are what they should be. Auditing is very important.



## Increased Risk

One of the **higher risk** points is the cultural dependency on **user-centred validation** of model accuracy. Many interviewees reported import/export workflows that are dependent on tacit knowledge and user experience: users who know how to test for and recognize both large and small shifts in their data.

> Small datum shifts in the model. Usually if the rotation is wrong, it is so bad that you'd have to be very much the amateur not to notice that something is very wrong. And usually you test it. But if it's something small… If the model is a half a block off, you wouldn't notice that.



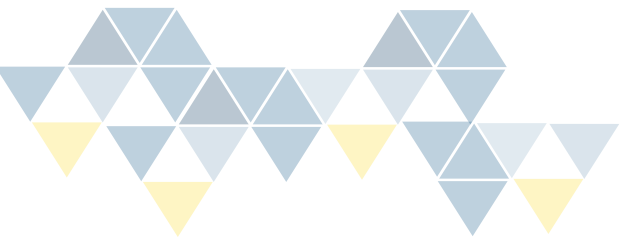
# Recommended Project Guidelines

**The OMF is an ambitious project, as it asks software vendors to cooperate with their competitors and their customers, and asks mining companies to share solutions outside their organization. This is also the scope of the potential for improvement.**

The interviews with users, and the work done by the GMSG to date, reveals many common challenges that currently exist within the industry. These challenges result in: additional costs to build and maintain workaround solutions; significant time lost to manual maintenance of the processes; pervasive latent frustration; and a readiness to move to an improved solution. Work on the OMF is an opportunity to improve efficiency and accuracy within the industry, as well as uncover and recover extensive secondary investments of time and money.

The following section details recommendations to guide continued work on the OMF. Recommended project guidelines include:

- Leverage existing open format solutions to optimize development and save time and money;
- Understand and support open design principles to foster a healthy and competitive software ecosystem;
- Leverage the use of standards and develop common syntax for 3D mining objects;
- Leverage the GMSG's position as a neutral third party, and engage additional technical third parties to act as intermediaries;
- Be platform neutral;
- Be vendor agnostic;
- Work strategically to promote OMF within the "software ecosystem" which will help format adoption.



## Be Vendor Agnostic

All vendors need to feel they have a stake in the open format. If the GMSG continues development of its own 3D open format, it will be imperative that development be vendor-agnostic. The optics of how the OMF format is developed is likely to affect later adoption.  Development by a limited number of vendors, self-managing the project, may be perceived as advancing vested interests. A format which appears biased towards the interests of a particular vendor is not likely to be supported by the broader mining industry. A few companies may be pressured to support adoption later, but only if and after the format is already a success.

This may be managed through a GMSG-appointed technical project manager who is responsible for overseeing format creation and coordinating volunteer contributions. The more the GMSG itself can act as a neutral party facilitating OMF development, the better the perception that the OMF is driven by the industry, and not particular interests.

## Engage Format Architect for OMF Development

Adoption of the OMF format may be improved if the GMSG engages a third-party to architect and manage the OMF format specifications.

Different software teams can arrive at different solutions to the same problem (e.g. 3D object representation) for good reasons. This reasoning needs to be well-understood when reconciling format discrepancies. The person(s) managing the OMF architecture should have an understanding of the types of decisions and trade-offs that go into format development, and have the experience to understand the discrepancies between different software vendors' solutions. The format architect should be able to recognize when two solutions can be reconciled, as well as when more than one solution is needed, and be able to understand and justify where the OMF will not or should not encompass particular features offered by some vendors.

If creating a common file format had one answer, different software teams would frequently arrive at the same solutions to represent the same objects. But as each piece of software has different technical requirements, and perform slightly different functions, their formats and modes of representation differ. Even competing software which superficially appears to do the same thing, may be solving the problem in different ways.

*For example:* There are many details in managing primitive objects which need to be agreed upon, and a depth of experience is required to anticipate and/or recognize what those issues are — e.g. how are floating point numbers represented on different

systems; the different ways of representing parametric primitives (lines, curves). Small implementation details will affect whether a shape looks the same in one piece of software as another. The standard will need to be well-specified and well-designed to be effective.

## Account for Idiosyncratic File Data

Idiosyncratic file data may affect vendors' willingness to use a common format. In every piece of software, when a user saves a file, the software endeavours to capture every piece of information that it needs to reconstitute what the user was doing when they open the file again. On opening the file, the user expects to get back to exactly where they were.

It is challenging to manage this process while being software agnostic, because each piece of software needs to capture its own particular information as well as the primitive shape representation and management data. For instance, in a trivial example, this could include how the in-application cameras are laid out relative to the object.

This settings data may have nothing to do with mining, and may be architected out of the shared file format. But if the user wants the piece of software to open the saved file and have the settings as they were when they left off, that information needs to be stored somewhere. If that information is split from the storage of the primitives data, then the settings information is now stored separately from the object information. This introduces a new challenge of keeping that information in sync. If the geometry is exported and modified in another piece of software, that geometry file has now changed, but the settings file has not. The split information now needs to be reconciled without introducing new issues. Issues such as these are resolvable, but represent some of the details in managing open formats which will need to be identified and addressed in file format creation and management. Addressing how this will be managed would be part of the role of the format architect, and a part of engaging the vendors.

## Manage Format "Ecosystems"

There is a social/political side to software development as well as technical, and involves understanding the full software ecosystem. Each software vendor has multiple parties involved in creating and managing their solution: the technical team, the sales team, and the business/strategy teams. When multiplied by multiple vendors, and a user base encompassing multiple disciplines and companies, it becomes especially

important that the process be managed with an understanding of the complexities in advancing a new format for adoption. Format creation is only one component of adoption, and without adoption, the format will not be useful. The project team will need to engage the users and technical teams, but also be able to engage the business side, to build support and consensus, and ensure sustained support of open format adoption.

## Target Ubiquitous Vendors to Include OMF as Standard

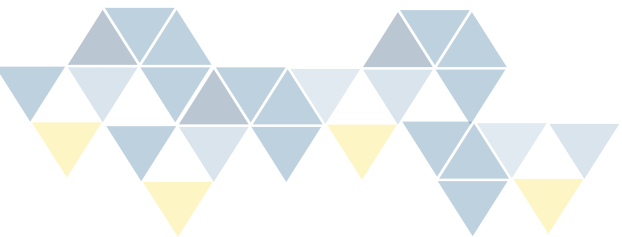
The OMF project will be advanced significantly by publicly engaging with the largest software developers operating in the 3D-for-mining space. Some mining companies expressed continued support of the OMF project, as they see inherent value in the project, while others expressed skepticism in the viability of any project which does not have the most dominant software publishers at the table.

To mitigate these issues, vendors with a significant presence in the market should be included as explicitly as possible. Industry users should be polled directly for which vendors they feel must be present in order for the project to proceed. The GMSG is also advised to leverage their connections to these vendors to involve them in OMF proceedings. If those vendors are not interested in direct participation, as an open standard, the GMSG could also continue to include them by publicly publishing the OMF findings, and any standards development work in which they engage.

Engagement with these vendors may be expedited by working with a trusted third party software architect or an intermediary with ties to the GMSG governing body itself, but which does not operate through any particular member company.

## Work as an Industry

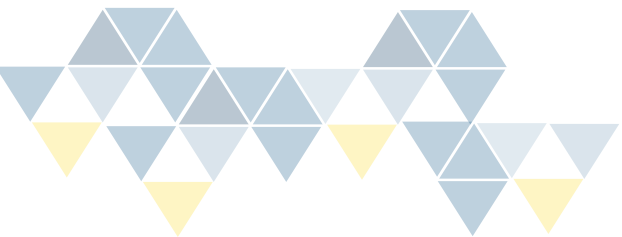
No single mining company has sufficient leverage to effect change on the 3D software industry. But multiple companies working with the same mining software suites and facing common challenges can form a more substantial interest block, and consolidate their efforts to get their challenges resolved. Consolidating efforts may lead to improved processes overall through sharing of best practices, and/or sufficient group leverage to improve the source systems themselves. See also: *Recommended Next Steps: Open a Shared Script Library and Host Online Solutions Forum.*



## Work with Other Industries

The Working Group is strongly advised to consult with subject matter experts outside of mining, where 3D model manipulation and file exchange is more commonplace. Sample industries include videogame and film studios, manufacturing companies, architectural and design studios, and military agencies and vendors.

Managing 3D assets through complex film and game pipelines is a recognized issue in the entertainment industry, with staff explicitly tasked with managing the process. There are experts in other industries who may have very relevant best practices to share with the mining industry, to manage their similar challenges. See also: *Recommended Next Steps: Summit on 3D Solutions Outside of Mining Industry.*



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The biggest software applications only have a base of 3-4000 users. In software terms, that is above a plankton, maybe a big minnow. Not the serious sized fish in the software world.

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**[Mining software companies] invest their human capital on trying to do things their users want rather than put together the systems underneath.**

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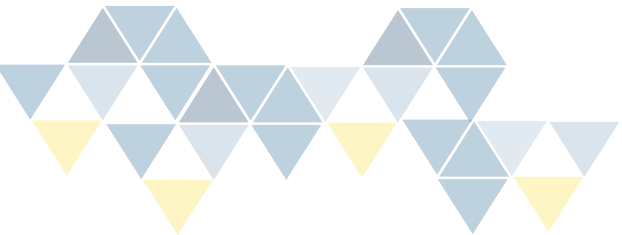


# Recommended Next Steps

The following are recommendations for proceeding with development on the OMF format, as well as recommendations for immediate supports for member users.

## Develop Common Syntax for 3D Objects in Mining

Development of an open standard is the stated objective for this GMSG working group. However the interviews conducted for this report revealed that there are currently variations between companies and applications in how 3D objects are referenced. This should be defined and reconciled before proceeding with the open format, with agreed terms as a precursor for format design.

Differences in how 3D objects are defined is a root cause of some of the validation and import/export issues as reported by users. Development of common definitions for the 3D objects as used in mining may improve the compatibility of mining software packages, e.g. adoption of a common definition of a block model. The discussions supporting creation of these standards may also uncover the underlying reasons for some of the incompatibilities between applications, particularly if vendors can be engaged to present their rationale for how they represent and define 3D objects, and make explicit the implicit parameters used by their formats.

## Research Existing Open 3D Formats

There are a variety of open 3D formats which already exist in the open source community.

- COLLADA (.dae), is a file interchange format for 3D applications;
- OBJ (.obj), a geometry definition file format (as a reference);
- geoTIFF, a public domain metadata standard which allows georeferencing information within a TIFF file;
- X3D, an XML-based file format that describes 3D scenes and objects

Individually, these formats (and formats like them) may not resolve all of the mining industry's requirements for an open format. However, exploring the current capabilities of these formats, and building off of them, may provide the GMSG with: 1) a base format architecture from which to work, and 2) an established developer base and open source community to support further format development.

COLLADA in particular is recommended as a potentially viable solution.

## Summit on 3D Solutions Outside of Mining Industry

The GMSG may benefit from hosting a solutions summit on 3D pipeline challenges as they are addressed outside of the mining industry. Managing 3D assets is a challenge which is not unique to the mining industry. As mentioned, other industries which deal extensively in 3D assets (e.g. film/game) manage moving their objects between multiple applications as a matter of regular operation. Subject Matter Experts (SMEs) within these industries may have solution or pipeline advice which is applicable to the mining industry. These industries manage many users and massive data sets, with high performance and time constraints. A meeting with a selection of SMEs from within these industries may help to reframe the problem and expose the mining industry to other solutions.

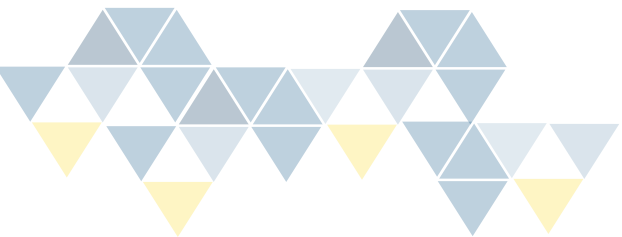
## Continued Challenge Capture: Workflows and Open Survey

The work done to date by the GMSG in 2017 establishes there are common challenges within the mining industry in managing the movement of 3D mining assets between software applications. It also establishes that those challenges have many and significant safety and financial consequences, e.g. asset corruption; security risks; reliance on tacit knowledge; increased overhead for workaround solutions.

As the project proceeds, the GMSG is advised to gather additional information regarding the challenges faced by member companies' 3D software users, as well as to continue validating and detailing the common challenges. It may be beneficial for the GMSG to engage a sample of users for a detailed pipeline mapping exercise, where the daily workflow and application use is observed and documented by a third party. This would allow the GMSG to capture the workflow in a way which captures the rote activities which users are not aware they are performing. This would also provide the OMF development team with additional use cases against which to test their format.

Conducting an open survey where users can report their challenges with 3D formats may also reinforce current challenges, and potentially identify new areas to be addressed.

The GMSG may also wish to consider technical demonstrations of the current capabilities of OMF, as it is developed, to demonstrate the potential of the open format, as well as providing a framework for user input and response. Showing how the format actually carries data between applications would provide users with a structure for



response, to more readily articulate how the OMF does, does not, or could in future, meet their needs.

## Develop Formal Workplan for Format Development and Validate with Users

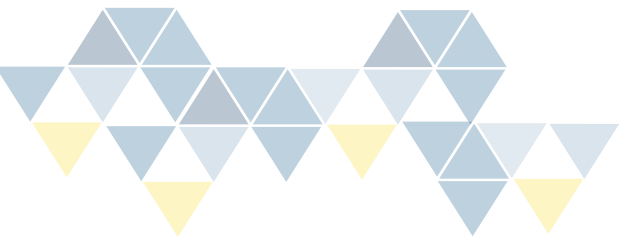
Current users of 3D mining applications can be engaged on the proposed next steps for development of the OMF, by presenting them with a formal workplan for the next features to be developed into the OMF format (pending research into other open 3D formats). This would give them a shared point for discussion and response, and would support an iterative development cycle, with users consulted and engaged in test cases as the OMF is developed. A formal and published structure for the OMF development team, and calls for specific code contributions, may also make it clearer how GMSG member organizations can contribute to development of the format.

## Open a Shared Script Library and Host Online Solutions Forum

Users reported extensive use of scripts to manage their current import/export processes. The GMSG may add present-day value to users' workflows if it is able to create and manage a shared open repository for these scripts. As many mining users in different companies use the same tools, there may be crossover and duplication in the content of scripts being generated internally by mining companies. A shared repository hosted by the GMSG may add value to many users' current workflows.

It may also be possible to identify areas where creation of one script would benefit multiple mining companies, and the cost of development could be split between them.

The GMSG may also benefit from hosting a user forum space, where users can post their issues in moving 3D data around, and other users can post their solutions. Many software vendors host user forums on their sites, specific to use of their applications. The GMSG forum would have the added benefit of addressing the crossover issues in working with multiple applications, acting as a neutral third party host. This forum would be especially useful if vendors could be encouraged to participate as expert contributors. Forums such as these have direct benefit to vendors, as GMSG would be managing the hosting responsibilities usually managed by the vendor, as well as providing a rich source of user data, and an ongoing beta/feature testing audience.




The Global Mining Standards and Guidelines Group facilitates global mining collaboration on solutions to common industry problems, needs and technology through standards, guidelines and best practices. GMSG operates on the five principles of inclusivity, collaboration, innovation, optimization and technology.

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