VRT
SYSTEMS

V SUITE
VISUAL WORKPLACE

SOLUTION OVERVIEW

VSUITE VISUAL WORKPLACE

POWERED BY
WideSky

1. VRT SYSTEMS

VRT has been pioneering the provision and support of industrial information solutions since the mid 1980s. We focus on creating solutions with minimum platform variations and maximum through-life supportability. A 'set and forget' approach is not what we're about – we're looking toward the next 20 years, not just the next three. Our future focus and commitment to ongoing support results in less disruption, increased consistency and reliability, and lower costs over the long term. Some of our existing customer relationships exceed 25 years.

VRT Systems' main business is implementing solutions based on real time information to improve operational efficiency and safety, and to reduce risks related to business continuity.

VRT has provided solutions throughout Australia, South East Asia and Japan. We are proud to have relationships with high profile customers such as Anglo Coal, Queensland Rail, Xstrata, Coca-Cola Amatil, BHP Billiton, Asahi Chemical, Australian Department of Defence, Rio Tinto, Vale, Queensland DTMR and Power Reactor and Nuclear Fuel Corporation, as well as many small to medium enterprises.

In order to provide our customers with best-practice technology and solutions, we rely on a number of strategic, long term partnerships, some of which also exceed 20 years.

2. VSUITE

VSuite is VRT's modular approach to systems integration – we have a reference architecture that supports a range of different options, and we select the best fit for your needs. We don't design from scratch for each project, and we don't take a punt on untested technologies.

VRT have rolled out our Vsuite solutions across a range of industries including resources, manufacturing, utilities, transport/logistics and government. Within these industries, we focus on the operational levels of our customers' businesses. The suites delivered span the areas of automatic data collection, automation and supervisory control systems, tracking, energy management and operations management. They are layered with customised integration, on-site and remote support, thorough training and state of the art visualisation.

3. VISUAL WORKPLACE™

Sophisticated graphics visualisations have been well-established in the aerospace, military, and oil and gas exploration industries for many years, and with the lowering cost of acquisition, these technologies are now becoming cost-effective in a broader range of businesses. Against this backdrop we have seen explosive growth in consumer devices with ever more powerful processors and ever more visually-oriented interfaces.

The widespread adoption of these technologies has dramatically lowered the cost of graphics processors, and in turn has also lead to a growing appreciation for – and general expectation of – rich visual interfaces across almost every device we use and system we interact with, including many business and technical applications. Across a wide variety of businesses in all industry sectors, visualisation technology is being used to solve real problems.

Typically, commercially-available advanced visualisation solutions fall into the following categories:

1. High-end purpose-built systems for visualising the complex data-sets from oil & gas exploration, aerospace and defence simulations. These systems are often prohibitively expensive for most business applications.

2. Off-the-shelf business and technical software. In some cases the visualisation is core to the product (e.g. CAD systems), in others it is offered as an add-on module (e.g. stockpile modelling systems, mining scheduling & monitoring software, logistics systems, simulation tools).

3. Enabling toolkits that allow for the creation of custom applications. These are being used by companies every day to create applications for training, for communicating large scale infrastructure development projects to the community and investors, and with additional data connectors, for integrating them with websites, business applications, or even control systems.

VRT's Visual Workplace is different – it can scale to work with large datasets and operate with high-end multi-channel display systems (like #1), it integrates with generic and off-the-shelf software (#2), and it provides an environment for developing tailored solutions that integrate data (like #3). Its key point of difference though is in the way that it integrates with your existing business systems. At the heart of VRT's Visual Workplace solution is a data integration platform that was designed from the outset to deal with the vast diversity of datasets that span your business:

*   real-time point streams (SCADA, BMS, PLCs etc.)
*   Historical datasets (Historians, Energy management systems)
*   video and audio streams
*   location information (2D map position, 3D location, rotation, scale)
*   laser scanner inputs (break beams, 2D profiles, 3D point clouds)
*   weather and climate data (including live rainfall/radar maps)
*   terrain and topology data (survey and photogrammetry)
*   GIS feeds (position and location of assets, drill-back to query GIS)
*   documentation (PDF, web-based document management systems etc.)

In fact anything you can model as an object, the Visual Workplace Object Server can integrate. So what does all this mean, and what sorts of applications need this technology?

4. FEATURES

Over the last few years, projects based on the Visual Workplace technology have been completed in the following industries:

- Coal mining (longwall, surface)
- Iron Ore mining
- Materials handling
- Manufacturing
- Energy & Facility Management
- Copper refining
- Transport
- Education

In some of these applications the implementation was fairly straightforward, with simple data integration requirements and the visualisation technology providing most of the benefits. In more recent projects however we are seeing significant interest in using the technology to solve large-scale and complex integration problems, the nature of which are described in more detail below.

4.1. Common User Interface

In most industries, businesses are implementing more and more online monitoring systems to better manage their operations. In some industries the proliferation of these specialist subsystems is introducing new problems, as operators struggle to operate plants through a multitude of user interfaces. For example -

- In mining operations (especially underground) there are automation systems, gas monitoring systems, personnel & equipment tracking systems, communications systems, specialist machine monitoring systems. Some operations attempt to integrate all these into their SCADA or Control system, others present the operator with banks of different control consoles.

- In intelligent transport systems, operators deal with automation systems for the facilities (tunnel ventilation, de-watering pumps, gas sensors, lifts), CCTV, security systems, distress-call systems, timetable and annunciation systems, ticketing, tolling and security systems. In some cases attempts to integrate the monitoring of these systems is tied into the CCTV control system, other times SCADA is used, and yet others just leave the operators to deal with dozens of separate consoles.

- In modern high-rise buildings, the push to embrace "Green" technologies has increased the complexity of operational systems (PV solar, co- and tri-generation systems, smart lighting systems, sophisticated HVAC controls) and the volumes of data being generated (BIM design practices, EMS and BMS data collection, DALI, KNX etc.). Unfortunately the complexity of these systems tends to be managed during construction by separating the commercial packages, and this often leads to the delivery of systems that aren't well integrated together.

- In large campuses, particularly for the likes of hospitals, the facilities managers are faced with the challenge of managing and monitoring power network control systems, building management systems (BMS), security, nurse call systems, and tracking of patients, staff and medical equipment. Again, attempts are sometimes made to integrate all of these into the building management system (BMS), while others leave the operators to deal with separate applications.

In some of these scenarios there may be as many as 25 subsystems that need to be integrated for effective operation, and the approaches being used fall far short of the mark. In some industries the challenge is too great, and so the benefits of achieving high levels of integration are rarely even considered.

Illustration 1: An energy monitoring display for a campus, with data combined from multiple source systems to provide a site-wide heat-map of energy intensity.

4.2. Whole-of-Operation Integration

A key challenge when it comes to integrating disparate technical systems is that the systems being integrated are purpose-built for solving very specific problems, and the types of data they deal with are often domain-specific. Attempts to perform integration for the purposes of providing a holistic view of operations often fall down because a general-purpose monitoring and control system (like SCADA, BMS, EMS, or CCTV head-end) are used, and they are all designed to cope with very specific data types. This means that the effectiveness of the integration is limited by the lowest-common-denominator of the systems being integrated together.

Some businesses have invested heavily in Enterprise Application Integration (EAI) platforms (or ESB – Enterprise Service Bus) and while these are better suited to integrating a wide range of disparate data types than (say) a SCADA system, they are also not usually up to scratch when it comes to supporting near-real-time responses and sub-second updates for large volumes of data, or in dealing with content like video.

When it comes to visualising an entire (and often complex) operation you're going to need a system that is designed for real-time updates from traditional telemetry and control system sources; you're probably also going to want to combine that with data from maintenance, tracking, HR and other systems from the business realm; and on top of that you may also want to start bringing in domain-specific data from sources that neither real-time nor business systems deal well with – CCTV streams, location/positioning data, profile or surface-scanning technologies (point clouds), GIS datasets, core sampling databases, volumetric stockpile models, geological datasets, and so on.

VRT's Visual Workplace Object Server allows you to map out the equipment and environment in your operation, and define data objects to represent the environment, the people, the equipment and the performance data that defines your operation, and then bring that into a single, coherent and dynamic model

of your business. In this context, "model" is being used to describe an object graph representing your operation, and it's a live model in which its properties update in real time as the world around changes and data is fed into the system. It's a model that understands the flow of time and can be seamlessly rolled back in time from "now" to recent or even distant history and replayed – in slow motion, at normal speed, or high speed. It's also a system that recognises that the same object graph representing "your operation" might be used for future planning or what-if scenarios – where the data isn't being streamed in live from the outside world, but is being provided by planning software or a simulation engine.

By taking care of the complexity in this way, VRT's Visual Workplace Object Server enables the creation of applications that truly are whole-of-operation and provide a holistic view of operations to the application users.

Illustration 2: Data feeds from multiple systems drive a unified overview of operation, with status indicators and event records combined seamlessly, and context-sensitive links provided back to the source systems.

4.3. Cross-Discipline Collaboration

Just as ERP systems enabled unprecedented standardisation and automation of business processes by linking together previously separate functions (Procurement, HR, Payroll, Bookkeeping etc.), the promise of "whole-of-operation integration" for visualisation is in unlocking benefits in the interfaces between your operational functions. Just as maintaining a single organisational structure in an ERP system has flow-on benefits across the other ERP modules; by integrating your technical systems, the information already being gathered by operational systems and being maintained by your technical staff can bring benefits to other facets of your business. A few examples of this:

- In a hospital, the architects CAD (or BIM) models are imported directly, positioning information from tracking systems is integrated, condition monitoring data from the building management system is overlaid, service information from the maintenance system is overlaid and numerous other sources tied together. Information keyed into a maintenance system by a service technician is given context by being displayed on a piece of failed equipment when the tenant in a research facility needs to find out why the hot water has run cold.

- In an intelligent transport monitoring centre, the information being captured and maintained by facilities maintenance and operations staff are able to be blended into the monitoring environment used by public safety and emergency response co-ordinators – they can not only see what's being revealed by CCTV systems, voice-call and security systems, they can see any of the condition monitoring and equipment heath information that might be pertinent in an emergency situation (lifts failed, electric shutter doors closed, ventilation fans inoperable).

- In a mine, the data being maintained by geologists and mine planners can be used to generate a visual mine model, so that your equipment operators can monitor the state and production performance of the machines, in the context of the actual geology. Trainers can run safety training in a mine environment that not only looks realistic, it is an actual model of the mine environment the staff will be working in day-to-day.
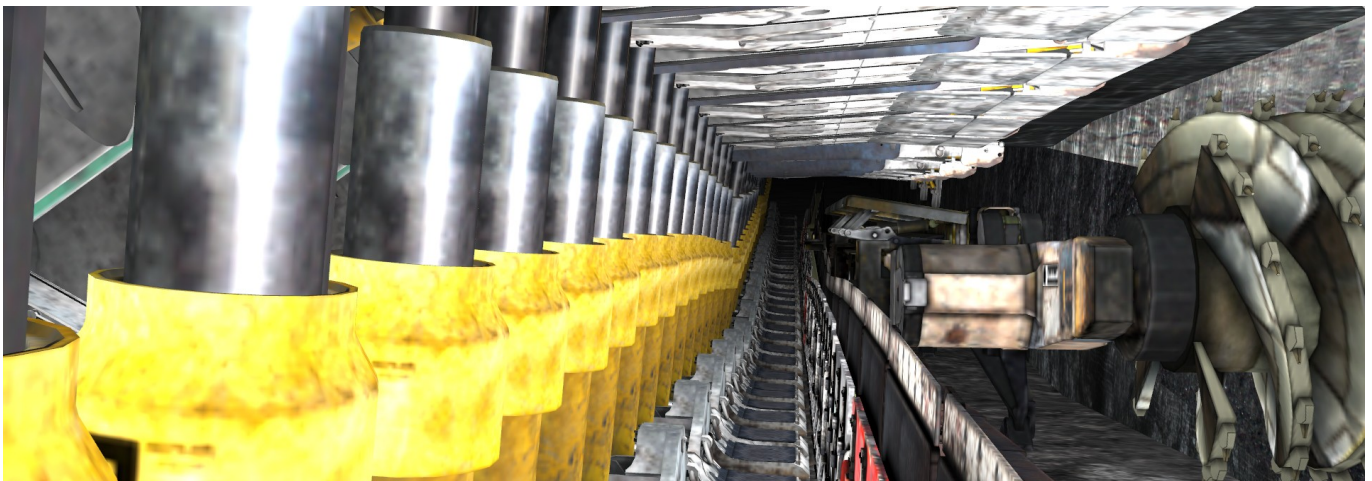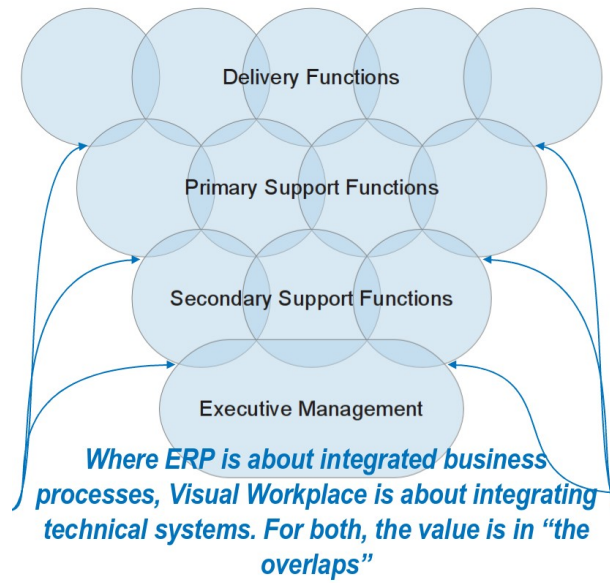

Illustration 3: Underground longwall coal shearer set in actual mine geology, and linked to machine positioning and automation systems.

While ERP was mentioned as a point of comparison above, by contrast the approach taken with VRT's Visual Workplace is very different. There is no need to displace existing systems, and we can gather data on demand. This is not an all-in-one replacement for your existing systems (as ERP is), but rather a "veneer" of visualisation layered over your existing operationally-focused technical systems and data.

Delivery Functions

Primary Support Functions

Secondary Support Functions

Executive Management

Where ERP is about integrated business processes, Visual Workplace is about integrating technical systems. For both, the value is in "the overlaps"

5. APPLICATIONS

5.1. Smart Building

In 2012, QUT completed the construction of the innovative Science and Engineering Centre (SEC). The SEC is the centre of the University's teaching and research activity across the science, engineering, maths and technology (STEM) disciplines. It is home to state-of-the-art analytical facilities, next-generation teaching space, and The Cube.

The Cube is the world's largest digital interactive learning environment. Over two storeys high, The Cube includes 48 touch panels and 14 high-definition projectors covering nearly 190 square metres, attracting hundred of visitors a week.

Beyond The Cube, the Institute for Future Environments have embarked on The Sensing SEC research and development program to explore new techniques to better understand how buildings perform and how occupants and operations teams experience and manage them with greater effectiveness and efficiency. The program encompasses activities of open data publishing, visualisation, IT infrastructure improvements, STEM education, facilities management, and of course solutions for industry.

The project engages VRT's expertise and implements the Visual Workplace solution provided by VRT.

The latest delivery from Sensing SEC is an interactive 3D model rendering data from inherent building and energy systems in real time leveraging the expertise of VRT Systems and the Visualisation and eResearch software development team.

A video showcasing this project can be viewed online at http://vimeo.com/112243939.
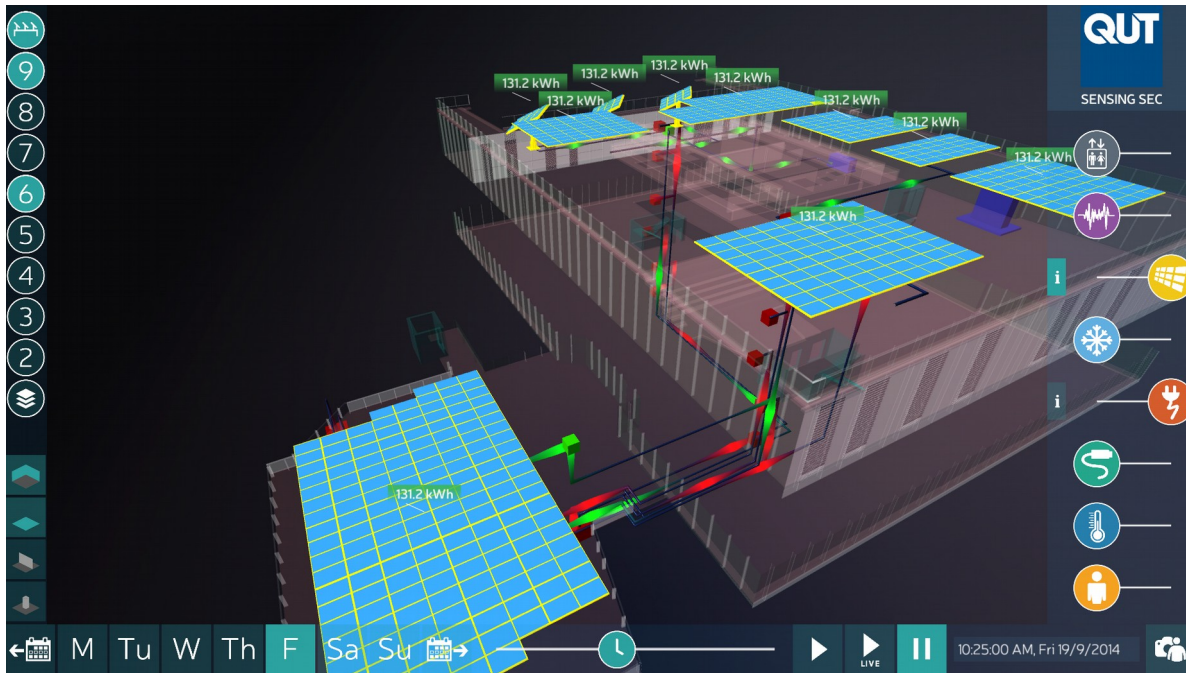
First, our focus is on a platform that is highly connected to your business applications, but does not replace any; bringing together normally disparate datasets in a new ways, to unlock value that isn't present in the individual datasets alone. In some cases this is through applications that facilitate better communication and understanding between technologists, planners, operators and managers, and in other cases it comes about through applications that reveal new insights or enable new approaches to operations.

5.1.1.   Interface

The user interface of the Sensing SEC application has been designed to run on most platforms; desktop, mobile, and large display walls. The building model is fully interactive and views are customisable, enabling building components, data sources, and plant to be hidden or revealed as needed. This allows the user to visualise any combination of the data sources on each level of the building. The system can be played in real time, or historical data can be loaded and replayed if desired.

5.1.2.   Immersive Experience

In addition to providing a rotating view of the entire building, the user can also move in to a game-like 1st and 3rd person experience with the ability to move an avatar around and view the model from a totally different perspective. This visual aspect lends itself to using some of the rapidly developing virtual reality technologies such as the Oculus Rift. This aspect of augmented reality can produce extremely intuitive displays and significantly improve collaboration between people with different disciplines or perspectives.

5.1.3.   Power Monitoring

Visualising the abundance data available through the Energy Management System was one of the first goals, with the increasing focus on energy efficiency and renewable sources. The interface informs visitors to the building about the innovative PV and Tri-Gen systems which would usually go unseen. For example, the user can instantly make the comparison of PV cell array size and the amount of energy being produced.

5.1.4.   Occupancy

One of the more innovative concepts being visualised by the system is occupancy awareness. People moving throughout the building can be identified using the CCTV cameras and displayed as avatars in the model. This is an extremely powerful technique: Combining two completely separate data sources (CCTV and LAN) has allowed a more data rich occupant model to be established. It is important to note the occupants anonymity is maintained by only representing them with avatars and not showing any personal information.

Alternative forms of identification and location technologies are available and may be more appropriate in other circumstances, e.g the preponderance of mobile devices with built in WiFi and GPS, as well as SIM card based ID, can provide a rich set of data that many mobile apps already use. Such data sets can also be made available in the Visual Workplace environment where benefits warrant, e.g. duress, personal safety situations in public parks. (Note: these techniques are not being employed in the QUT project.)

5.1.5.   HVAC & Temperature

Combining interdependent data sources on a single interface can create valuable visuals. For example, presenting a HVAC system layered with data from various temperature sensors enables greater analysis and optimisation of a given system to maintain comfort or address problems.

Arguably this may be a narrow area of application, and similar things are possible in terms of other data sets from other types of facilities, e.g. hospitals have a wide variety of data sets: spatial, multimedia, business (relational/transactional), etc. Enormous value can be derived from sharing such disparate data sets between the different disciplines/roles in this highly intuitive manner.

5.1.6.   Vibration & Network Traffic

Vibration sensing and network traffic are two very specific data sources that aren't relevant in a wide range of situations, however the techniques used here for the visualisation of this data could be easily adapted for other applications.

With respect to structural sensing, particular pillars in the SEC building had a vibration sensor installed during construction. With this information being rendered real-time it would show when the building is under stress from high winds or large crowds moving through the building.

5.2. Longwall Coal Mining

Following are some shots from an application where we have an accurate mechanical model of the wall, and connections into the mine plan, geological models (seam strata, faults, boreholes), and longwall flight paths:
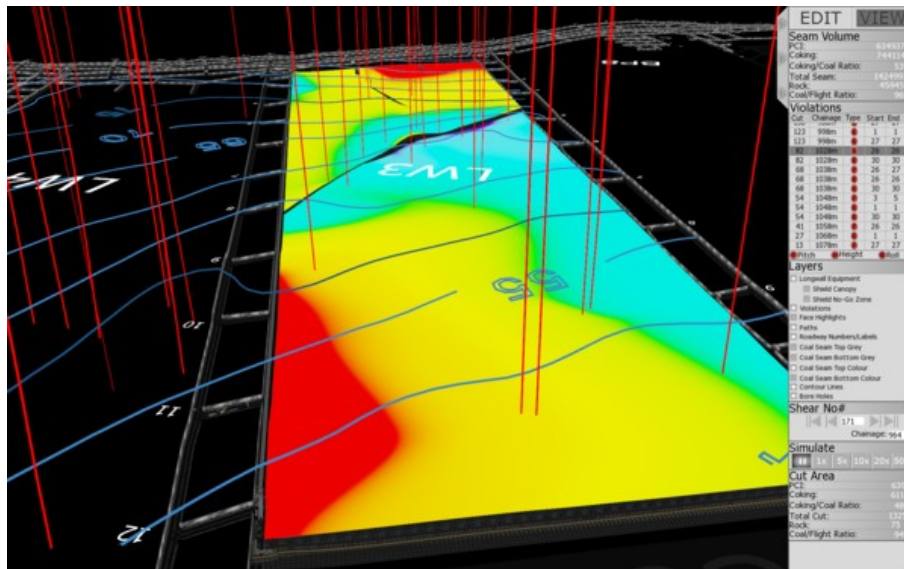

The whole model is live, and at any time you can drop down from the overview and walk around in the virtual mine to get a first-hand look in detail:
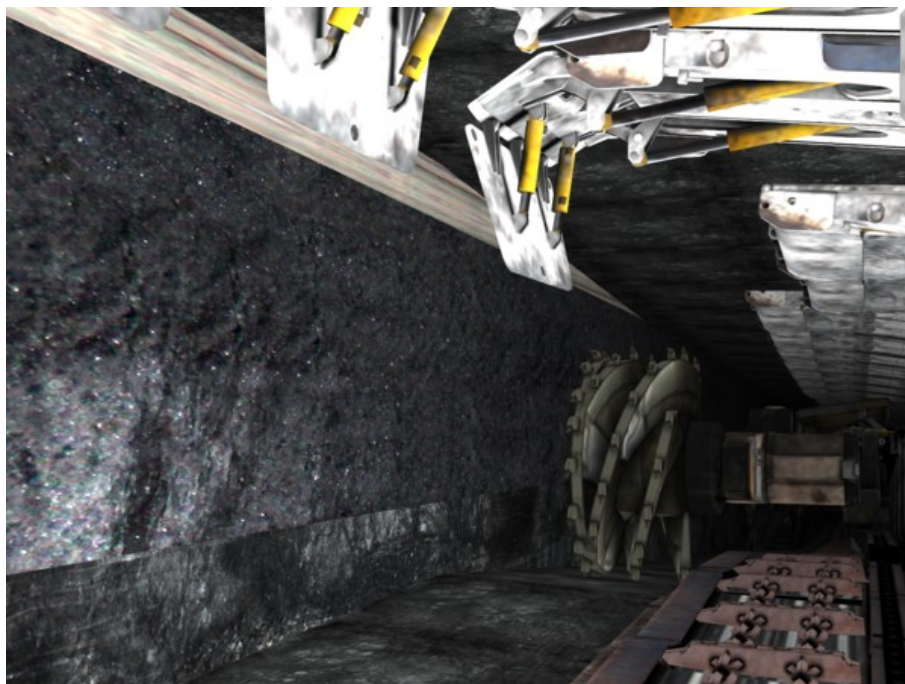
With the imported flight path, and an accurate longwall machine model, we're able to provide facilities to validate flight paths to ensure they remain within the machine design limits. In the sample below the grid represents the flight path, with red spots highlighting violations where you're most likely to break dog bones:
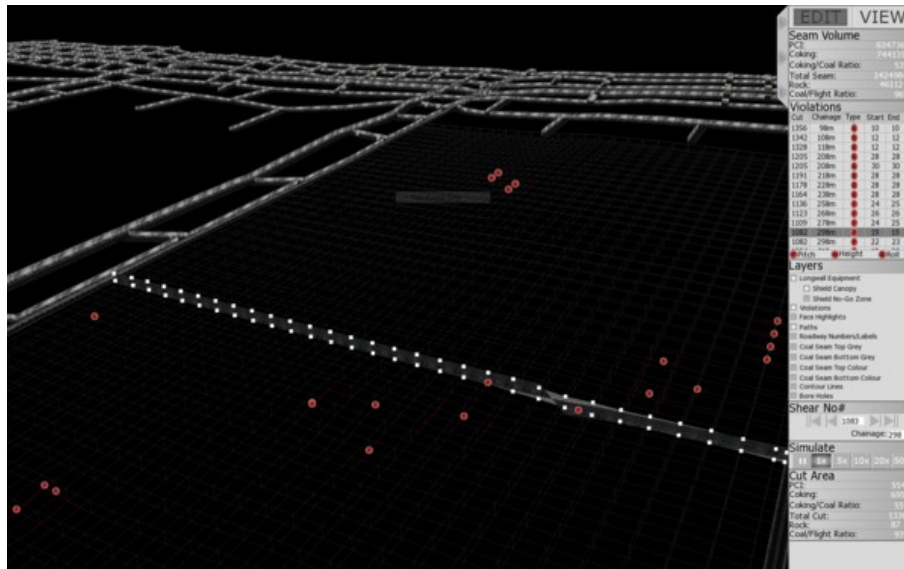

We have a layering system that allows a wide range of contextual information to be overlaid, such as highlighting lines for the face to show the extents of the coal seam, flight path, and highlight the penny-band (that operators in this mine rely on to navigate):
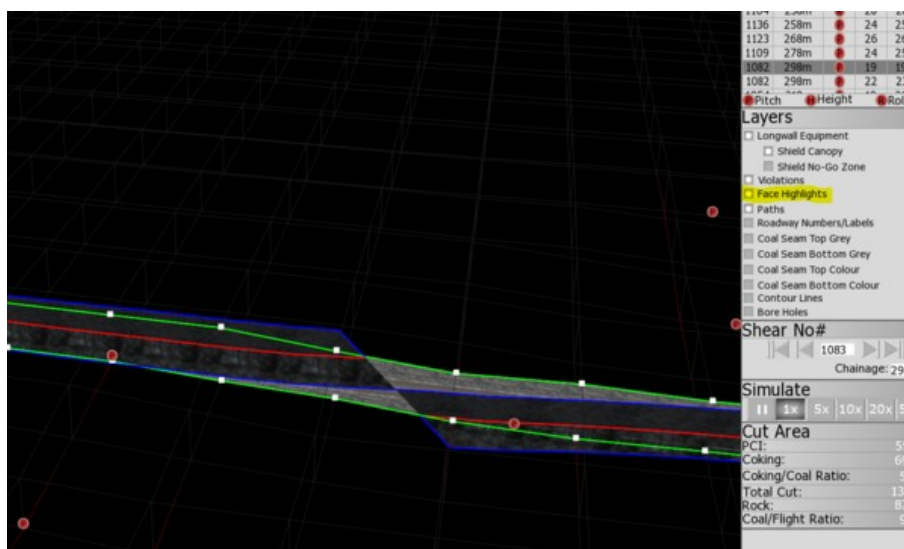
The flight path editor allows the path to be adjusted to remove violations (future plans to automate this) and increase amount of coal extracted:
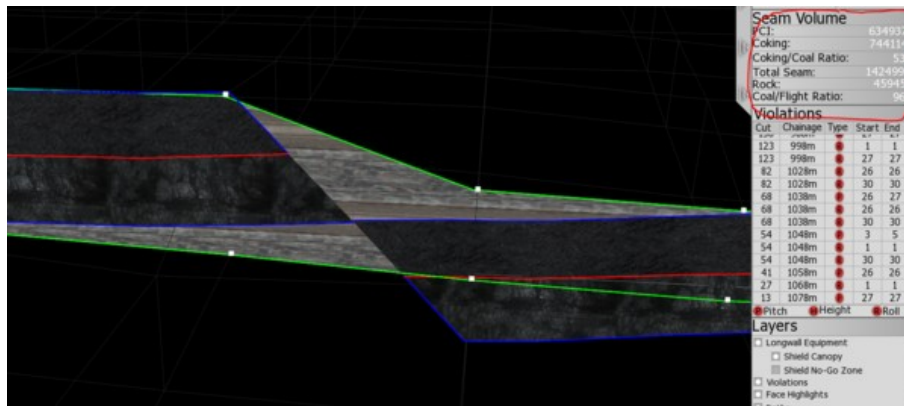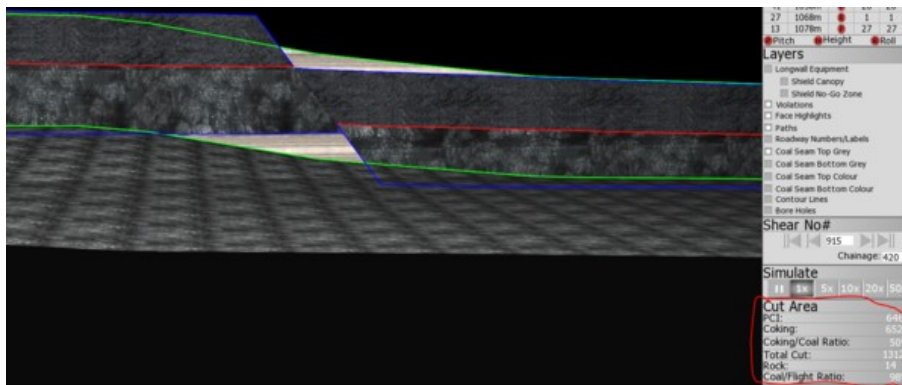

And then spin around from the other side, and roll a simulation of your shearer:
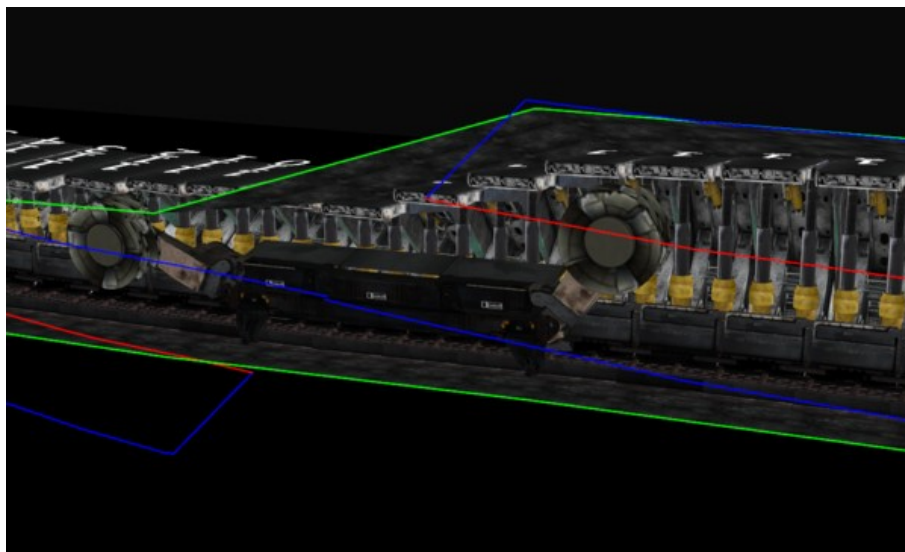
Once the plan is locked down, you have a tool for briefing operators on the shift ahead (note the shield canopy switched off to get a better view):

Whether from above, or as a face map when things get tricky (note the face map metrics at the bottom right):

This is a very narrow area of application, and similar things are possible in terms of continuous miners, integration of CM gate road flight path planning with optimal longwall paths, as well as integration of real-time data from LASC to monitor compliance to plan during operations. We have interfaces to NLT for the reverse tracking, gas monitoring and a whole host of others.

## 5.3. Development Miner Monitoring

A natural extension to the longwall mining application described above is the monitoring of development mining activities performed by continuous miners. The example below shows a miner with active subsystems highlighted in green. This application utilises telemetry from the machine to develop a time utilisation model for miner performance monitoring.

The application uses the 3D model in a variety of different viewpoints to assist in understanding not only the miner performance, but its compliance to plan in terms of time utilisation and cut profile:

The time model across the bottom of the image above shows conformance to plan for each of the shift changes, highlighting lost time in red, and gained time in green. The extent of the deviation is indicated by the width of the bar. An alternate view comparing crew performance over the week is shown below:
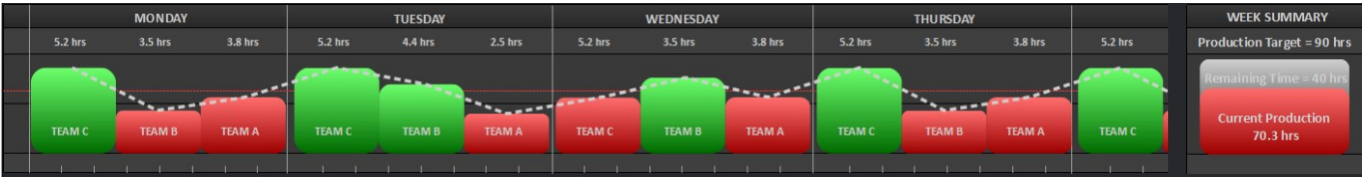
Sometimes a simple 2D view is all that's needed, and because the scene can be rendered in any projection, it's just a click away (as are isometric or plan views):

6. VISUAL WORKPLACE TECHNICAL OVERVIEW

6.1. Key Features

Any Data

The Object Server technology that underpins the data integration capabilities of Visual Workplace is designed to work with a wide range of data types, whether real-time streams from automation systems, multimedia (CCTV video, thermal imaging), point clouds, meshes, or anything relevant to your operation.

Any Device

The real-time rendering engine we use by default (Unity3D) supports deployment of native applications to PCs and Macs, as well as browser-based and mobile versions for Android and Apple phones and tablets.

Designed for Operations

Demonstrating a solution is one thing, but once you put something into production we know that your business will evolve, the equipment will change, and the platform needs to keep up to date with all of this. Visual Workplace has been designed with this in mind, by providing a comprehensive management interface that allows the system to be maintained and extended by operations staff through a Web interface, rather than a team of software developers.
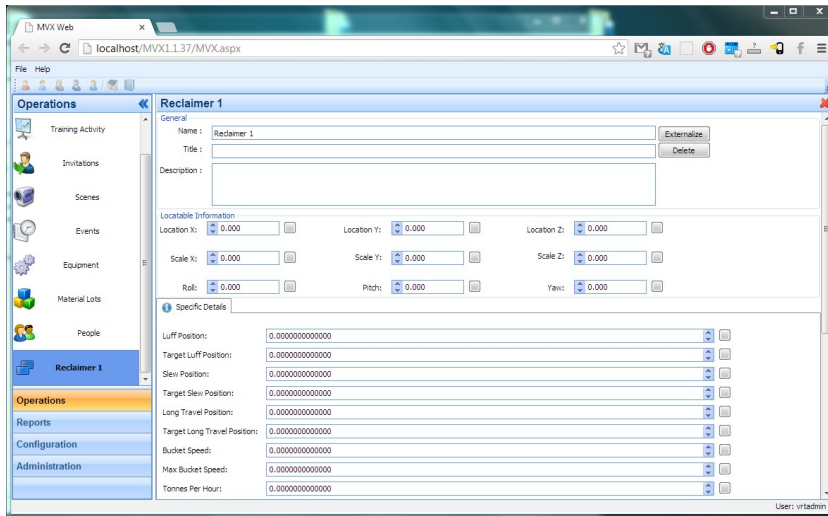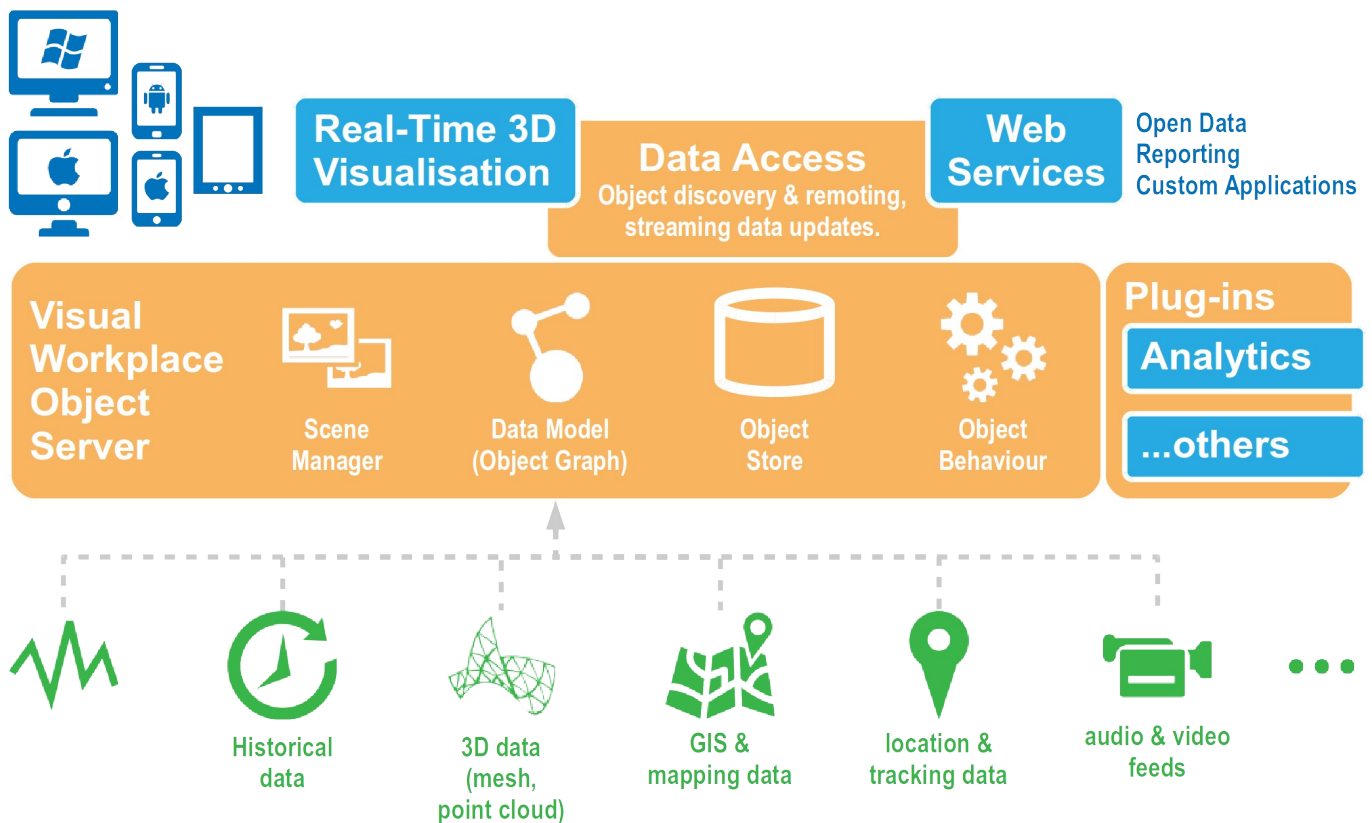
Illustration 4: Visual Workplace's Object Server technology allows for industry-specific object types to be defined (stockpile reclaimer shown here), and for these objects to be related in complex ways, with the object's data attributes bound to any number of real-time, simulated or historical data sources.

6.2. Reference Architecture

- **Real-time 3D Visualisation** -
> Scale all the way from mobile devices, Web, native PC and Mac apps, through to multi-channel immersive display systems (including 360° domes).
> Two runtime engines to choose from – "Unity3D" (Games Engine) or "Space Engine" (High-end Commercial-grade vis. Engine)
> Can blend CCTV with models (augmented reality) or integrate existing application UI to drill-down to source systems within the virtual environment (Web apps, VNC, Citrix, RDP etc.)

- **Data Layer**
> To data platforms to choose from - "Object Server" (Windows server, real-time only, OPC client, predefined objects) or "WideSky" (hosted solution, large scale historian, open APIs, flexible semantic modelling).
> Object Server: Off-the-shelf product, industrial controls focused (ISA95 model), Source:Scene mapping/switching. Object graph (metadata) persistence via an object database, "live" data not kept.
> WideSky: SaaS solution (with site hosted option for Enterprise), flexible semantic models (Project Haystack by default, IS95 capable), real-time, command+control, time-series data store. Open Web Service APIs

- **Web Services** -
> APIs for accessing data
> Web Management interface for configuring connectors, objects, applications and their deployments.
> User access portal for connecting to visualisation application deployments

- **Data Source Integration** -
> Connectors for a wide range of data sources & types.
> Supports multiple source for the same data point (e.g. real-time, historical, simulated – multiple scenarios).