

# The road to autonomous operation

by Steve Franklin



# Overview

There has been an increasing interest in the use of autonomous haul trucks in quarries, particularly in the US, Great Britain and the EU where trials are already underway.

Initial indications would suggest that there are big benefits to be had, but what does that mean in practice?

While the technology will take some time to mature and be field ready, those seeking to implement it need to recognise the changes to be put in place to make this technology a reality and start planning for them now.

*There are currently some 1,600 autonomous haul trucks in the global mining industry (predominantly in Australia) with the majority of new operations selecting autonomous capability from day one and existing operations adopting it at fleet replacement time.*

# Overview

"Reports that say that something hasn't happened are always interesting to me, because as we know, there are:

- Known knowns
- There are things we know we know
- We also know there are known unknowns; that is to say we know there are some things we do not know.
- But there are also unknown unknowns - the ones we don't know we don't know."

*Quote by then United States  
Secretary of Defence, Donald  
Rumsfeld during the Gulf war – 12  
Feb 2002*

# Overview

From skills development to telecommunications, power infrastructure, drone in a box, quarry design, scheduling and cybersecurity issues, there is much to consider beyond just choosing a manufacturer and expecting it all to work.

This presentation is a broad overview of quarry digital transformation, a summary of key players in the autonomous haulage field and a discussion of implementation considerations.

The purpose, is to give you an overview of the potential benefits and things to consider in deciding if autonomous operation is right for your business and how to proceed forward if you consider it is.

*While there are few (if any) truly field ready solutions for the quarry industry currently, now is the time to start planning for their introduction.*

# What is Digital Transformation?



# Beginnings...

Eltirus was founded in the latter part of 2016 with the express purpose of enabling autonomous haulage in quarries.

At the time, my belief was that the rise in autonomous trucks in mining would eventually transfer to large quarrying operations.

Given that quarries generally don't have an on-site Technical Services Department, I realised that there would be a need for this service – either to provide it directly or to assist clients in creating their own.

With this in mind, I set about creating a team of surveyors, geologists, geotechnical, mining and software engineers to work with progressive clients who saw a different future for the industry and wanted to apply technology and professional skills in new ways.

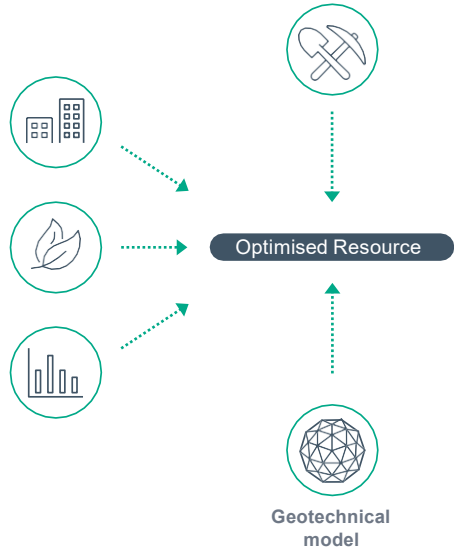
*The name Eltirus, is from the Esperanto language and means “to extract”*

# Quarry Digital Transformation Roadmap

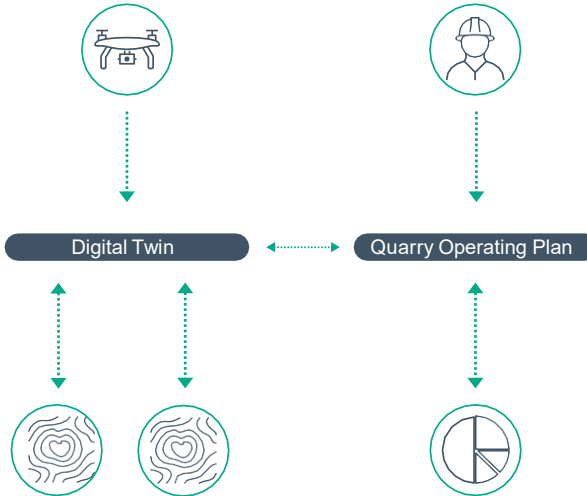


# Quarry Digital Transformation – Size of the Prize

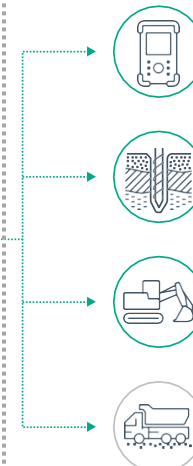
**Resource Optimisation**  
10-40% NPV increase over the life of the resource



**Quarry Operating Plan**  
\$0.50-2.00/t op costs saving  
Multi-million dollar stock swings and value destroying quarry operations averted



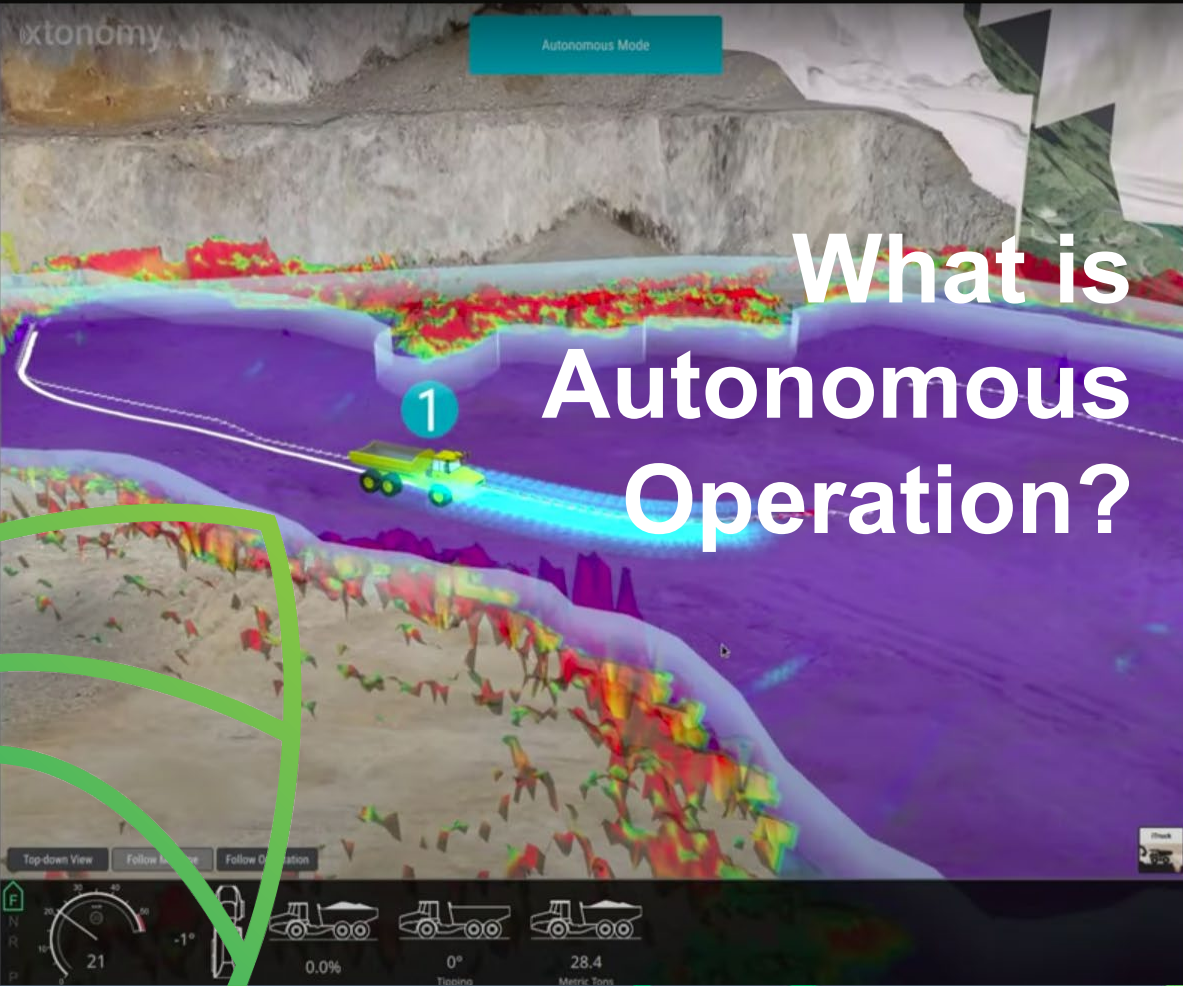
**Survey control**  
Cost savings of \$150k per year in a 1mtpa quarry through tight floor control



**Autonomous haulage savings**  
-40% operator, -70% energy



Track 1	
Track 2	
Excavator	
Crusher	
Articulation Rate	0.1
Autonomous Status	0
Bin Control	0
Bin Cylinder Pos	100
Cabin Buzzer	●
Cargo Weight	28424
Comm Status	0
Engine RPM	1479.5
Engine Status	1
Gear	4
Ignition	●
ITP	0
Lights	●
Main Horn	●
Operator Status	
Parking	●
Reverse Backup	●
Steering Cylinder	0
Velocity	5.0



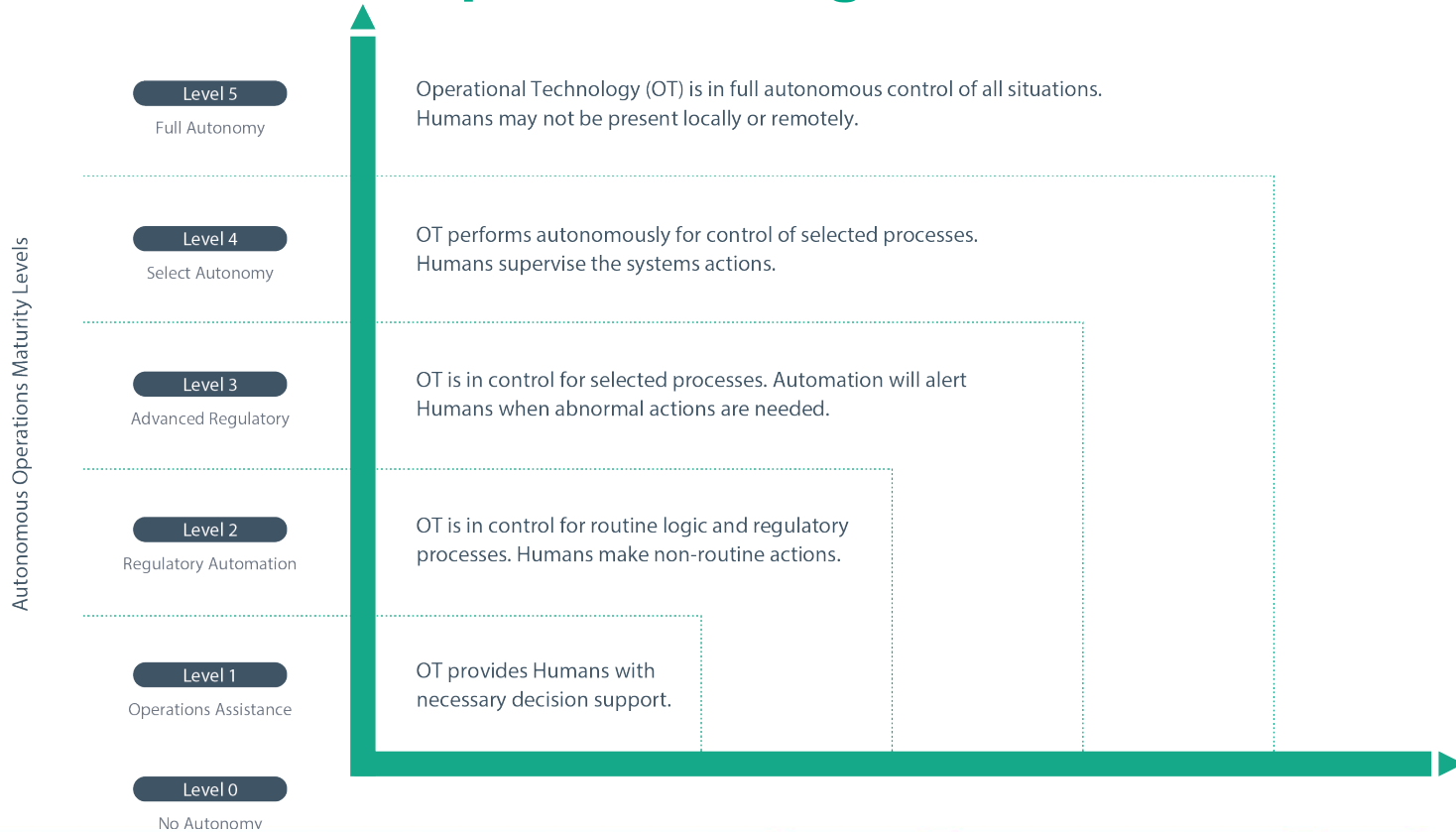
# What is Autonomous Operation?



Top down View Follow Machine Follow Operator

0.0% 0° 28.4 Metric Tons

# Autonomous Operation Stages





1:00PM

The Fushan Quarry operates 16 hours per day

A high-angle photograph of a mining site. In the center, a yellow excavator is loading a yellow Deere 460E dump truck with dark brown earth. The background shows a vast, terraced mining pit with multiple levels of excavation. In the foreground, the rear of another Deere 460E dump truck is visible, its bed empty. The ground is a mix of reddish-brown soil and greyish-white mineral deposits. On the left side, there are three overlapping green curved lines that appear to be part of a graphic design.

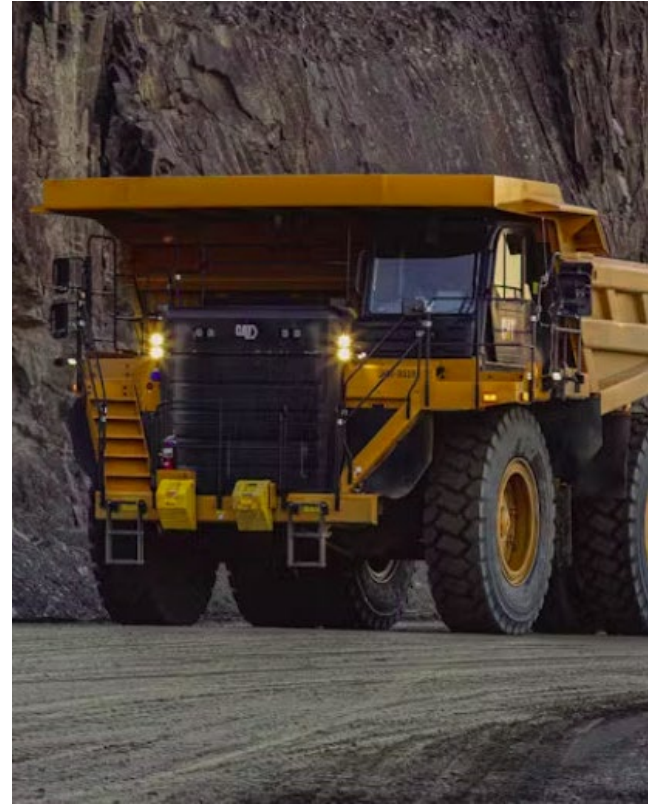
# Who are the Key Players?

# Caterpillar

From 1994-1995, Caterpillar ran two prototype Cat 777C autonomous trucks at a Texas limestone quarry, successfully hauling more than 5,000 production loads over a 4.2 km course.

In late 2022, Caterpillar announced a collaboration with Luck Stone, the largest family-owned and operated producer of crushed stone, sand, and gravel in the US, to deploy their autonomous solution at the Bull Run quarry in Chantilly, Virginia.

This will be Caterpillar's first autonomous deployment in the aggregates industry and will allow them to gain greater insights into quarry operations in order to tailor the next generation of autonomous solutions to quarry and aggregate applications



# Caterpillar



*Bull Run is a multi-million tonne per annum, operating quarry and should be an excellent proving ground for the technology – building on the proven MineStar system to produce a quarry specific version based on the well-known and reliable Cat 777G haul truck.*

*Note that Caterpillar are also working on battery electric large haul trucks and we can expect this technology to trickle down over time.*

# Eacon

Eacon is focusing on autonomous haulage solutions using advanced AI technology which deeply integrates self-driving technology with on-site operational requirements.

They already have a number of large-scale implementations in play (some 400 trucks) of which the most relevant is Fushan Quarry located in Zoucheng, Shandong Province in China with a capacity of 18mt/year and producing limestone for cement making.

The full-battery autonomous fleet consists of 20 BEVs (70t payload), operating 16 hours per day.

By April 2024, the fleet had travelled over 320,000km and achieved a CO2 reduction of 2,501 tons.

*Eacon began commissioning its autonomous equipment at Fushan in February 2023 and achieved 'multi-fleet' self-driving haulage without safety drivers on board in just two months.*

# Eacon



*The Eacon electric, autonomous haul truck and associated systems appears to be the most viable (and widely implemented) quarry system in the world at this time.*

*Eacon can either provide a full truck fleet and support systems or retrofit other machines.*

*Either way, it seems a working, well thought out and comprehensive solution that also considers support equipment and associated activities.*



# Komatsu

Komatsu has been at the forefront of autonomous mine haulage for more than a decade. They have some 600 Komatsu autonomous trucks operating at 19 sites in four countries, with some 400 of these trucks operating in Australia.

Interestingly, given how active Komatsu Australia is in the technology space, there do not appear to be any public announcements of an autonomous quarry truck.

Komatsu have recently announced an autonomous HD785 water truck. This may be a step towards the quarry industry (Caterpillar had already introduced an autonomous 777G water truck before the trial with Luck Stone was announced), but there is nothing definitive at this time.

*Komatsu were early to this technology with trials of HD985 autonomous trucks in Western Australia in the late 1990's.*

# Pronto



Pronto delivers off-road autonomous haulage systems that use camera and GNSS to offer the most affordable system on the market.

Working closely with Bell Engineering (though it can also be fitted to other machines) for the past two years to engineer and refine their hardware and software, they are operating on several sites on the US west coast.

# SafeAI

SafeAI specialises in retrofitting machines with autonomous technology and can upgrade existing equipment, regardless of the manufacturer or vehicle type.

SafeAI has partnered with MACA (now part of Thiess) to create their first autonomous vehicle in Australia – a 180t Hitachi haul truck.

They also recently announced a partnership with CRH in the US and that they are talking to “seven or eight of the biggest producers in aggregates and they are all very interested in this technology.”

We see SafeAI as a player to watch in this space.

*SafeAI believe that implementation of autonomous haul truck technology results in a 20% increase in productivity.*

# Volvo Autonomous Solutions (VAS)

The Volvo TA15 is a fully automated electric dumper developed by Volvo Autonomous Solutions with a payload of 15t.

It's part of a complete autonomous haulage system called TARA, which includes all necessary site infrastructure, from charging stations and safety systems to the operator interface.

Ideal for replacing larger, diesel-powered vehicles, helping to cut emissions, increase efficiency, and optimise machine utilisation by operating as a “swarm” of smaller trucks, it runs on a battery-electric drivetrain and uses GNSS, Lidar, radar, and multiple sensors for positioning and navigation.

*Despite being announced as “market ready” in late 2020, the only quarry that I am aware of that is trialing this technology is the Holcim Gabenchopf quarry at Siggenthal in Switzerland which announced its trial in late 2021.*

*Volvo also have a fleet of seven FH autonomous road trucks hauling limestone in the Brønnøy Kalk mine in Velfjord, Norway, which recently reached a major milestone with the removal of the safety driver from the system after some years.*

# Xtonomy



Xtonomy are a European based provider who have recently announced trials with Sibelco in the UK.

Based on a Bell B40E articulated haul truck, the truck uses Xtonomy's AI technology and is equipped with radar sensors, GPS, multi-channel communication systems and on-board processing software.



# Implementation considerations

# Things to consider

## Safety

Who is responsible if something goes wrong and a serious injury or fatality occurs?

- Manufacturer
- Dealer
- Quarry manager
- Company management

## Cybersecurity

How will you be sure that the code base and command and communication systems are secure?

- Should it be an on-premise solution?
- Will you rely on the manufacturer and dealer?

*Autonomous operations are already a big part of our lives.*

*A good example is the ability of passenger airliners to auto-land with the crew operating primarily in a supervisory function.*

*This technology has been in commercial use since 1968.*

# Things to consider

## Quarry Planning

Accurate quarry survey, planning and scheduling will be vital. Who will conduct this?

- Company surveyors and mining engineers
- External partners
- The dealer

## Dealers

How will dealers support such broad ranging technology and requirements?

- The machine itself
- New drive technology (if electric)
- Software and control systems, Lidar, GNSS etc.

*Westrac, the Caterpillar dealer responsible for Western Australia and New South Wales set up their own autonomous training facility south of Perth to train internal and customer personnel on how to implement, operate and maintain autonomous machines.*



# Things to consider

## Manufacturers

Where does the manufacturer's responsibility start and end?

- Delivery and implementation
- Ongoing support
- Support for site (or in the case of retrofit, other manufacturer) modifications (that could compromise the system)

## Quarry operations

- Where will you get advice from?
- Do you go for an integrated solution or retrofit?
- What are the potential IT requirements e.g. bandwidth?
- What are the potential power requirements?
- What are the staffing requirements?

*We are moving into an age where more quarry resource professionals are needed – e.g. surveyors, geologists and mining engineers.*

*In Australia, mining engineering graduation rates have fallen 74% in the period 2015-2022.*

*The industry will require 1,500 new engineers in 2025 vs. 50 expected to graduate in 2022.*

*Where will the skilled technical professionals come from?*

*How will we attract them to our industry and how will we afford them?*

# Closing



# Key take aways

- Autonomous haulage will be part of the quarry of the future in much the same way as prior autonomy advances, such as PLC control of fixed plant did in the past.
- Learn from the mining industry – they know what works and what doesn't – membership of the Global Mining Group (GMG) and studying their Guidelines are a good place to start.
- Start planning for change now. There are a wide range of foundational actions that need to occur before the technology is fully viable – haul road re-design, power and telecommunications upgrades, upskilling of people etc.
- Re-position our community image with a focus on innovation and being a “cool place to work and build a career”, rather than just “turning big rocks into little rocks”.
- Start attracting new talent and new types of talent to our industry and if need be, provide scholarships and cadetships to fill the dearth of current graduates.

*Autonomous haulage and autonomous electric haulage in particular, has the potential to make a substantial difference to both the bottom line and CO2 reduction in your operations.*

*Whether you consider yourselves first movers, fast followers or are prepared to wait it out - this is a seismic shift in technology that will affect your business.*

*Please contact me if you would like a list of resources and references.*

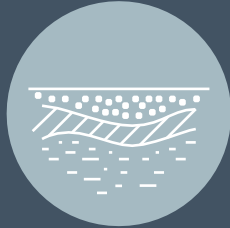
*steve.franklin@eltirus.com*

# About Us



## People

We hire the best, continue their professional development and look after them



## Knowledge

We continually research, looking for better, more efficient ways to do things



## Transparency

We are open, honest and transparent in our dealings with others



## Partners

We work with partners who add value to your business and ours



## Clients

We work with people who share our values and desire for success