EFEE

NEWSLETTER

September 2021

In this edition:

The demolition of several structures on the site of the formal phosphorus plant Thermphos

Towards the full digitalisation of the blasting process in open pit mining

Pan-European Competence Certificate for Shot- firers / Blast designers.

....and more!

September 2021 edition

We in EFEE hope you will enjoy the present EFEE-Newsletter. The next edition will be published in November 2021. Please feel free to contact the EFEE secretariat or write to newsletter@efee.eu in case:

- You have a story you want to bring in the Newsletter
- You have a future event for the next EFEE Newsletter upcoming events list
- You want to advertise in an upcoming Newsletter edition

or any other matter.

Viive Tuuna, Chairman of the Newsletter Committee and the Vice President of EFEE and

Teele Tuuna, Editor of EFEE Newsletter - newsletter@efee.eu

Dear friends,

the President's voice

SO… it has been a year since we entered the new age. A year post-Covid.

One year that we thought the pandemic will last for… one year. One year that continues for one more year.

What have we done in one year?

We stopped. Physically. Only our minds ran fast and far away.

What have we learned this year? How are we after this year?

Personally, I do not feel that my life has changed. It hardly has... for the rest, I have lived pretty much like I used to. Yes, I did wear a mask. Yes, I did follow rules, but I have always been like this, I believed that civilization and love for your kind mean to abide by what is good for the others and, implicitly, for you too…

Generally, I cannot make a judgment on all of mankind, but I've seen some "waters" splitting up, and some people, some styles splitting up.

I've seen how some people came together with others, and others with other ones, all those with a common taste and a close value.

Empathy used to work a lot at the beginning of this past year, but it seems to me that it has run out...

Egoism has reached a worrying scale, and so has disillusion, and mistrust too.

Mankind has learned that its members are vulnerable, fragile, they die easily, but they are also easily fooled.

Doctors have been either loved or hated, then loved again, and hated again, and so on depending on… who knows on what? That has shown us one more time that *sic transit gloria mundi*…

The vaccine was wanted, expected, denied, demanded, sworn, taken, sworn again, taken again…

I'm not an optimist and I cannot see what else we would need, what else should happen to us to change something about/in us?

This year, we have seen hate coming up like oil in a glass of water, but we've also seen, indeed, helping hands and open hearts.

But I have my doubts, we've got potential, I know that because we are humans, i.e. the most terrible creatures on Earth, the ones that conquer everything, unless they decide to destroy everything. Hell! I slipped again…

But I have my doubts, we've got potential, I know that because we are humans, i.e. the most terrible creatures on Earth, the ones that conquer everything, unless they decide to destroy everything. Hell! I slipped again…

It has been a year, and guess what – there is another one ahead, and one more. I mean this virus won't disappear on a due date, it won't die away. It will stay around, with us, for a long time from now on.

But how long? Don't we want to know precisely the time limit of our suffering, to be told, oh, yes, for how long do we still have to wait?

This year, we have mingled conflicting feelings which came up in seconds, we have found out that people are largely equally dazed everywhere on this planet, that they do no longer know where and who to look at and who to listen to.

We have seen crashed vanities and brands trampled on, we have seen new names and beautiful people, and also aggressive characters, we have seen that, actually, nobody has a clue about what happens, nobody has neither the truth nor the conclusion and that we are actually on our own.

And?

What's left? What are we going to do? Each for himself and the devil take the hindmost? The lucky ones will live? How will we live from now on?

Well, there are too many of us around to risk other solution than love. Love for our kind, for the other, for another one.

Doru Anghelache,
President of EFEE

REGISTER TODAY

EFEE

Webinar on Explosives and Blasting Techniques
Tuesday 28th September 2021 | 2pm until 4pm - CET

EFEE is delighted to introduce an Autumn educational webinar on explosive and blasting techniques. The session will run from 2pm until 4pm CET on Tuesday 28th September and will focus on two specialist areas;

Webinar 1 - Case Study | Fly Rock Estimation Using O-Pitdev Deviation Measurement System

Looks at the technical calibration model for predicting flyrock by assessing borehole deviation using the latest technology.

Authors / Presenters include: V. Miranda, F. Leite, A. Oliveira & T. Kouvonen, H. Parra, O-Pitblast Lda., Porto, Portugal , FORCIT International Ltd

Webinar 2 - Blasting a Huge Overhanging Rock Formation in an Emergency Situation

Looks at blasting an overhanging rock formation in an emergency situation.

Authors / Presenters include: Jerry Wallace and William Gates, PhD, P.E. - Wallace Technical Blasting, Inc

Thank you to those of you who have already completed your registration. The webinar is free of charge to EFEE members. If you aren't a current member, don't worry, EFEE membership is just €75 which not only includes access to this unique webinar but also discounted attendance at our next live event - 11th EFEE World Conference from 15th - 17th May at the MECC in Maastricht. Registration will close on Friday 17th September please follow the button below to complete the registration process

Cost

Non-EFEE Members

The cost to register is €75 which includes EFEE membership for 12 months and discounted attendance at the 11th EFEE World Conference from 15th – 17th May at the MECC.

EFEE Individual Members

Attendance is free for existing EFEE members.

EFEE Corporate and National Members

Complimentary places are offered to corporate and national association members. Please contact marketing@efee.eu for further details.

Click here to Register

www.efee.eu

The demolition of several structures on the site of the formal phosphorus plant Thermphos based in Vlissingen, in the south-west part of the Netherlands.

By Jacob Uittenboogaard, a young Dutch blaster gearing up his demolition work with explosives

The demolition was performed by Dutch Explosives Engineer Jacob Uittenboogaard and his team of Uittenboogaard Explosive Demolition, commissioned by head contractor of the entire decommissioning project: van Citters Beheer B.V. In our 22 years of preforming explosive demolitions this project was the biggest project so far.

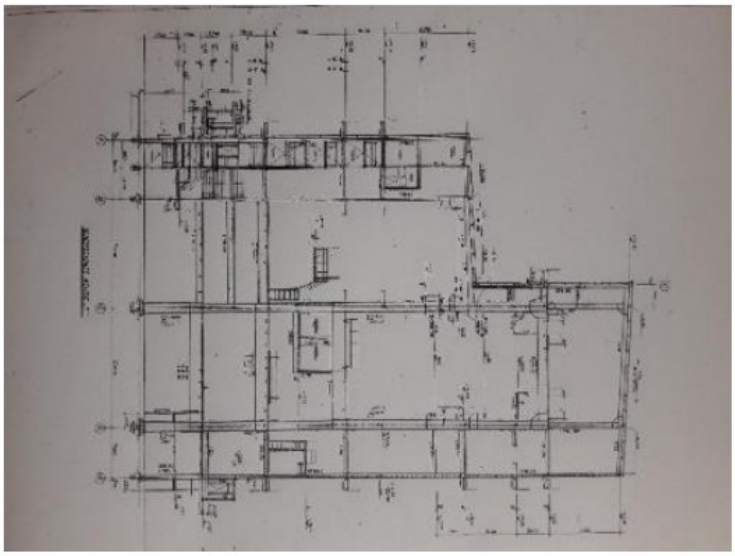
After the removal of all hazardous materials, explosive demolition was successfully preformed between August 2019 and September 2020 on the sinter factory, the furnace building, the acid factory, the cokes silo, a raw materials distribution tower and several concrete foundations of the mentioned structures.

The reason these structures were taken down using explosives was easy: safety! Our client was very clear in this. Taking down these structures by crane was to risky, would take too long and therefore people were longer at risk to accidents that may happen. And an additional reason was the cost efficiency.

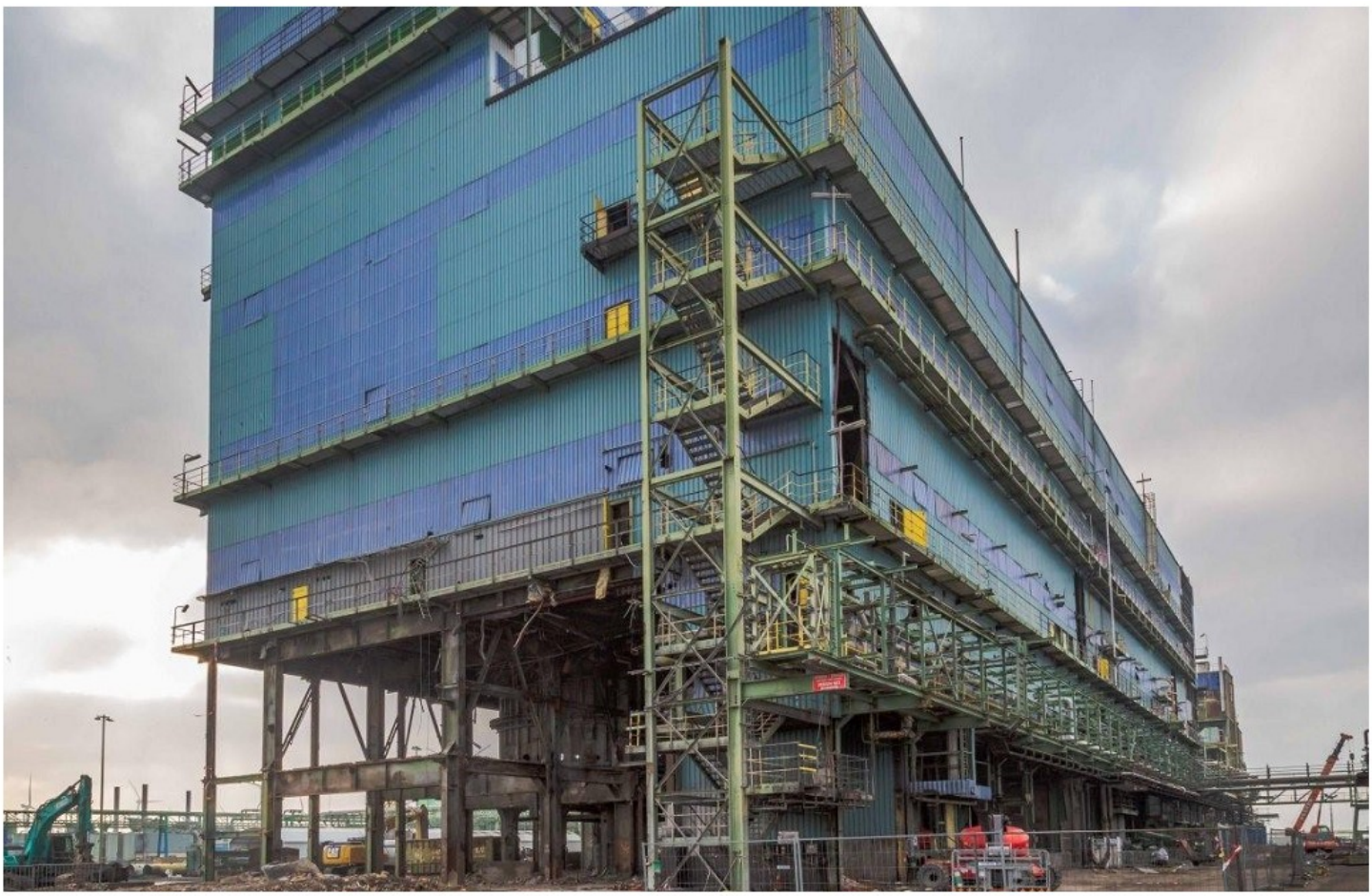
This article is about the biggest object of the project: the furnace building.

The furnace building

In the furnace house, 3 electric furnaces were situated. It was 55 meters high, 35 meters wide and well over 100 meters long. The main construction was a steel structure, 18 rows of 5 columns with 8 reinforced concrete floors and a roof.



The gap that was necessary to make sure that when the building was going to fall over, the centre of gravity needed to be outside of the footprint of the building. The gap should be 6 meters. Therefore the entire non-structural parts were removed and the structural columns and beams were prepared for the placing of 96 Linear Shaped Charges (LSC) of 851 gr/m with a maximum penetration of 50,8 mm, 36 LSC's of 425 gr/ m with a maximum penetration of 38,1 mm and 18 LSC's of 255 gr/m with a maximum penetration of 25,4 mm, all placed under a 45 degree angle. The LSC's were initiated with Non-electrical instant detonators.



Preparing for demolition

September 2021

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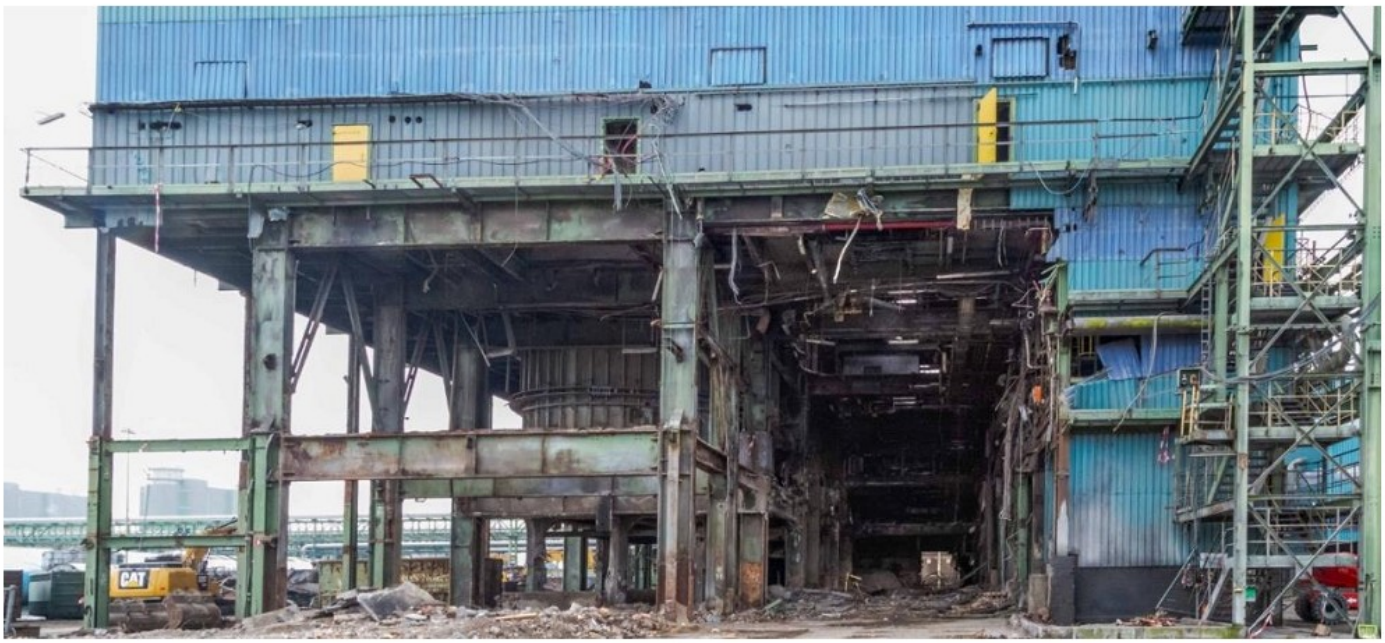


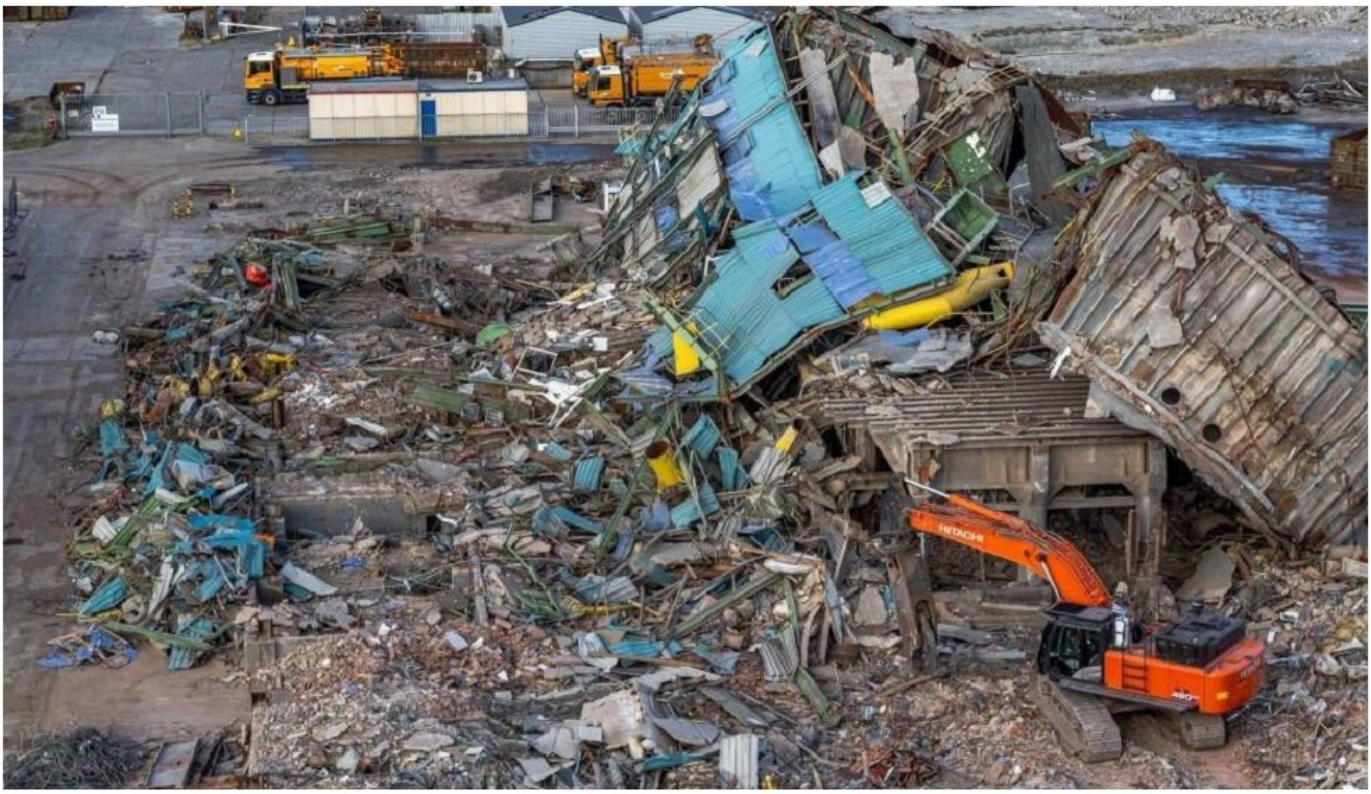
Two months were necessary to prepare the building for demolition. After making the plans, the structural and technical calculations for pre-weakening and preparing the columns for placing of the shaped charges, in association with the decommissioning team of van Citters Beheer B.V. the work began.

Looking at the cross section of the main structure it consists out of a higher and a lower part. The high part was planned to fall first by blasting the columns on row E and D and letting it tip over on de columns on row C. Columns, floor beams and floors on rows A and B to C were to be pre-weakened by torch cutting and excavators with steel and concrete shears.

On the 21st of February 2020 at 16:00u the moment of truth was there, will or our hard work pay off? 3, 2, 1….. fire

The result was as planned an maybe even better. 6000 tons of steel and concrete reduced into a in small pile of debris. The structure fell as predicted and was cleared afterwards using several excavators from 30 up to 50 tons, equipped with shears and sorting-grabs, all this in a matter of weeks.

Linear Shaped Charges



Towards the full digitalization of the blasting process in open pit mining

Hector Parra
Market and Product Manager
Initiation Systems and
Digital Products
Forcit Explosives

Tomi Kouvonen
CEO
Forcit International

CONTEXT

Nowadays, Digitalization is arguably the biggest driver of change in the industrial sector, including the mining industry. Digitalization is not only changing the way processes work but also how mining companies, operators and suppliers interact. In the future, Digitalization is expected to significantly modify the traditional value chain of mining operations, and with this, the business models used in the industry.

In recent years, Digitalization started to be aggressively adopted by the industry as a means to achieve a leap of improvement in the productivity and sustainability performance of mines. By now, digitalization has reached, to different extents, most of the processes involved in the extraction of a ton or ounce of ore. That said, the industry is still going through the early stages of the process of digital transformation towards the so- called Mine 4.0. At this stage, companies are facing challenges to both quantify the impact of the initial efforts in the operations and to estimate the final total gains expected when the digital transformation is complete.

Nonetheless, an indisputable conclusion that has been withdrawn from the ongoing digitalization process is that some of the key aspects controlling the implementation of sustainable, integrated digital systems, lie beyond its practical aspects such as technology and processes. In this sense, experience has demonstrated that cultural, organizational, contractual and strategic factors have a significant influence on the performance of the digital transformation processes at a business scale.

Despite the complexity of the topic and the current uncertainty surrounding the implementation of digital transformation, some attempts have been made to estimate the potential economic impact of digitalization at an industry level. For instance, the World Economic Forum [1] has estimated a potential benefit of around USD 190 billion to be realized in the mining sector between 2016 and 2025 using digital systems. Also, the McKinsey Global Institute [2] has estimated that digitalization could create potential gains of over USD 320 billion per year by 2025. Even though these figures are considerably different, their order of magnitude alone can give all the actors in the mining industry enough encouragement to follow the digitalization path.

As the digital transformation progresses, the World Economic Forum [1] have forecasted that the three most relevant digitally-driven applications in the metal and mining industry by 2025 – in terms of benefits realization – will be a connected workforce, remote operations centres, and autonomous operations.

DIGITALIZATION IN MINING

The main premises behind the pursue of digitalization in mining is that the combination of digital technologies and tools can enable the integration of sub-processes that are part of a unitary operation (e.g., blasting) as well as the seamless interaction between different unitary operations included in the business' value chain (e.g., drilling-blasting- loading-hauling).

Experience has shown that achieving this desired state requires both a previous alignment of the entire mine operation at a tactical level and the inclusion of the digital efforts into the corporate strategy.

From a tactical perspective, proper management of operations is indispensable to align both people and processes. For instance, shared key performance indicators and a purposeful organizational structure have demonstrated to be pre- requisites for digitalization's success. Complementarily, the extent of the digitalization depends on the adopted strategy whereas the sequence in which the digital tools and systems are implemented depends on the strategic deployment plan.

Since a mine's strategy responds to the site-specific technical conditions (e.g. mining method, geology, mineralization, etc), the commercial agreements in force, the current technological state, the specific value chain of the operation and the availability of resources, it is not possible to define a one-size-fits-all approach to digitalization.

This hinders the ability to develop a unified method to calculate and compare the tangible and intangible value created by digital processes across the industry.

Despite disparities in the breadth and depth of the digitalization processes in the mining industry, there are still clear commonalities in the type of technologies that have been adopted and the range of benefits derived from their implementation. Table 1 summarizes some of the most common technologies used in the industry and the direct improvements observed in the operations [1] [2] [3] [4] [5] [6] [7] [8].

In the last decade, these technologies have significantly spread across some unitary processes such as drilling, loading and hauling, positioning them well ahead in the path to digitalization. In contrast, other disciplines such as blasting have proved to have the laggards within the mining value chain, with some of their tasks still conducted fully manually. These discrepancies in the degree of digitalization make it difficult, at this point, to reliably estimate the full extent of the operational and business impact that the entire digital transformation of the mining industry can have.

Technology	Improvement
Advanced Sensor and Monitoring Networks	Extended and immediate situational awareness
Advanced Communication and Connectivity	Integration of processes / Real-time information visualization / Agile decision-making
Advanced Data Analytics and Modelling	Unlocking insight into the functioning of single processes and the interaction between processes
Automatic Equipment and Robotics	Safer and more precise operations
Autonomous Equipment	Safer, more precise and consistent operations / Improved decision-making
Augmented and Virtual Reality	Facilitation of personnel training and task execution.

Table 1. Common technologies implemented in the mining industry and their associated improvements.

DIGITALIZATION IN BLASTING

From a digitalization standpoint, the development of electronic initiation systems has been the focus of explosive suppliers in the last two decades, with the incorporation of remote operation and wireless communication as the latest achievements.

Some incremental improvement has also been made in mobile explosive manufacturing units, with the addition of automatic features that have improved the speed and accuracy of the loading process. That said, the digitalization of blasting – as we understand it now – may have only started around ten years ago, with a few first- generation digital tools and systems only available in the last five years.

In the case of blasting, all the sub-processes can be allocated to one of the following six categories of activities: Management, Planning, Design, Implementation, Output Analysis and Outcome Evaluation. Table 2 shows the typical activities involved in each one of these categories.

Category	Blasting-related Activities
Management	> Definition of key performance indicators > Definition of evaluation criteria > Analysis of key performance indicators > Definition of best practices and guidelines
Planning	> Definition of polygon's size and shape > Outlining of geological zones inside the polygon > Outlining of ore zones
Design	> Definition of drilling pattern > Definition of explosive configurations > Definition of sequence and delays > Selection of accessories (e.g. air bags, plugs, etc.)
Implementation	> Review of the state of the boreholes > Mapping of the free face profile > Placement of initiation systems in boreholes > Loading of explosive > Placement of accessories > Initiation of blast
Output Analysis (not limited to this list)	> Measuring and analysing fragmentation results (i.e. fragment size distribution, muckpile movement and fragment conditioning) > Measuring and analysing environmental results (e.g. flyrock, airblast, ground vibration, fumes, dust)
Outcome Evaluation (not limited to this list)	> Assessment of geotechnical conciliation > Assessment of shovel dig rate > Assessment of crushing and grinding throughput > Assessment of crushing and grinding energy consumption > Assessment of efficiency of ore recovery processes > Assessment of safety indicators > Assessment of community complaints/sentiment

Table 2. Typical blasting activities by category

In a practical sense, most of the industry's interest in blasting digitalization has been directed and still revolves around achieving a reasonable well-defined pool of activities that can be grouped according to the six categories previously presented.

CURRENT BLASTING DIGITAL TECHNOLOGIES

In the attempt to digitalize the blasting process, several products have been developed, mainly by suppliers either at customer request or as potential sources of differentiation and competitive advantage.

Category	Blasting-related Activities
Management	▯ Integrated data back-analysis ▯ Continuous monitoring of overall key performance indicators to define major trends
Planning	▯ Agile project and production short term planning using field data collected in real-time
Design	▯ Seamless integration with upstream processes to include a wider range of valuable inputs (e.g. accurate ore zones and measurement-while-drilling data) ▯ Robust and updated modelling for result forecasting ▯ Re-design using data collected in real-time from the field
Implementation	▯ Online communication of field data ▯ Detailed and systematic data collection of operational parameters ▯ Real-time execution and visualization of quality assurance and quality control activities ▯ Nimble adaptation of loading operation to respond to field conditions ▯ Reduction of human exposure to conditions of risk. ▯ Real-time tracking of the progress of the implementation activities to allow timely decision-making
Output Analysis (not limited to this list)	▯ On-line and real-time measurement systems of technical and environmental aspects
Outcome Evaluation (not limited to this list)	▯ Agile and accessible measurement systems to assess the efficiency of the blast and communicate findings

Table 3. Desired blasting activities

Currently, the products and systems that are starting to successfully be implemented and are expanding their reach within the industry are described below.

- **Track and Trace Systems.**

  These systems digitally follow the manufacturing process of a piece of product and allow retrospectively checking their paths from the production plant to the customer facilities. These features not only help ensure the quality and delivery of the product but also help identify the raw materials involved and the batches produced. The latter is extremely valuable when processes or products malfunction and further enquiries are required to decide what containment measures to deploy.

- **Online Ordering Systems**.

  These systems act as a digital interface between the customer and the production planning area of explosive companies. These systems simplify the ordering process and enable online tracking of the deliveries. These systems tend to reduce the lead time and, when used to their full extent, can enable the implementation of leaner procurement strategies. For instance, Forcit has designed Forcit GO, an app that facilitates the customer's product ordering by connecting the site with the manufacturing plant and logistics team in real-time.

- **Next-Generation Design Software**.

  Software to design blast projects have been around for well more than 2 decades, however, in the last 5 years, the development of design software started to include more sophisticated analysis and predictive tools as well as features to effectively interact with up and downstream processes. By now, it is possible to easily import data such as topography, geology and ore zones to inform the design process. On top of that, some software allows to directly transfer the design information to drill rigs, explosive charging units and other management systems. This next-gen software become top-end solutions when paired with three other technologies in the list, which are the semi-automatic charging units, the data collection systems of the charging units and the cloud-based platforms. Figure 1 shows the main user interface of the O-Pitblast software where a 3D topography model of part of an open pit has been imported.

- **Semi-Automatic Charging Units**.

  These pieces of equipment allow the automatic execution of the emulsion loading process based on manually pre-defined configurations. These configurations are defined by different combinations of operational parameters such as the explosive formulation, the maximum amount of explosive per hole and the desired stemming length. Ultimately, this feature allows choosing the most adequate configuration to match the field conditions and provides more flexibility to the blast design process.

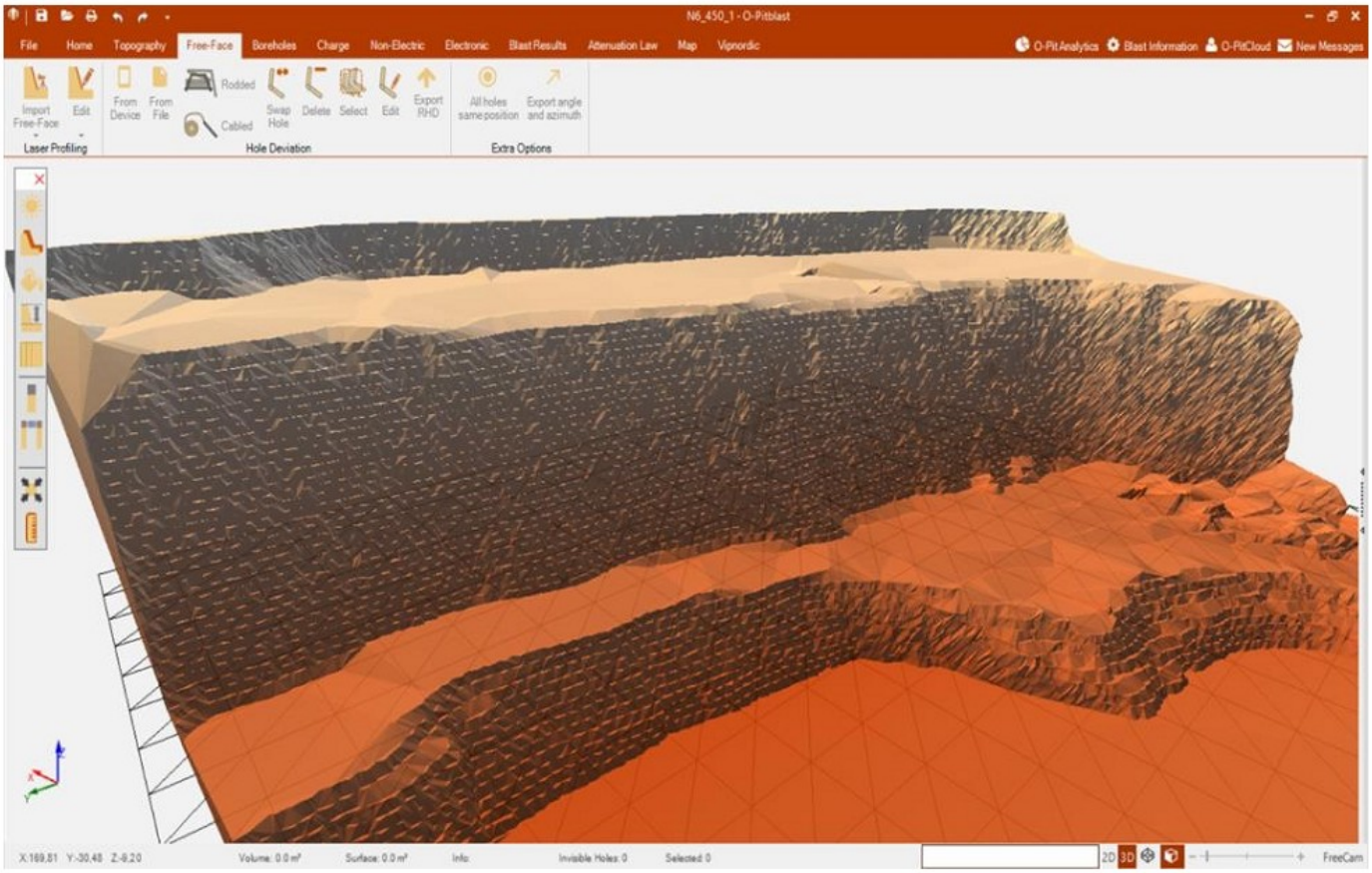


Figure 1. O-Pitblast's main user interface showing a 3D topography model.

- **Data Collection Systems on Charging Units.**

  Most of the bulk explosives' charging units continuously record the operational parameters of the loading process. The number of parameters measured varies and loading process based on manually pre-defined configurations. These configurations are defined by different combinations of operational parameters such as the explosive formulation, the maximum amount of explosive per hole and the desired stemming length. Ultimately, this feature allows choosing the most adequate configuration to match the field conditions and provides more flexibility to the blast design process.

- **Online Implementation Tracking Systems.**

  These systems work together with the data collection systems and provide the status of the loading process in real- time. Provided that the mine site counts with a compatible communication network such as WIFI, the data from the loading process can be visualized with minimum or no latency in a laptop, phone or tablet (depending on the supplier's capabilities). This allows, for instance, knowing how many holes are left to be loaded and estimate when the mine clearance protocol should start. It can also allow knowing the existence of boreholes with quality issues and redesign the sequence and timing of the blast to compensate for the abnormalities. Figure 2 presents the use of the tablet paired with the ForAware real- time tracking system that is integrated with Forcit's digital charging units.

The tablet enables the input of field data on the spot as well as the visualization of the operation progress. The data gathered in the field is transferred to the O- Pit Cloud via WIFI where it is stored and can then be accessed through the O-Pitblast software.

- **Remote and Centralised Blasting Initiation Systems (using Electronic Detonators)**.

  These systems allow firing multiple blasts simultaneously from a single safe point and assign a specific sequence between the different blasts. Several thousand detonators can be initiated with these systems, using a variety of communication networks systems such as Wi-Fi, leaky feeder, fibre optic, and phone lines.

All this optimizes the clearance process by increasing safety and production time. The wireless communication mode also provides the opportunity to reduce the consumables cost (e.g., cable and connectors), the preparation and repairing time of the firing lines, and the sources of potential communications issues. Figure 3 shows a set of the Daveytronic UG electronic initiation system that is fully equipped to perform remote and centralised blasting initiation.

Figure 2. Use of ForAware's tablet during the explosive loading process.

Figure 3. Full set of Daveytronic UG electronic initiation system for remote and centralised blasting.

- **Advanced Measuring Tools.**

  There is a wide range of these tools in the market, some more advanced and widely adopted than others. It is possible to find borehole deviation probes, online vibration monitoring systems, high-speed cameras, fragmentation image analysis software, drones for blast recording and 3D mapping, ore tracking devices, etc. Almost all these devices use apps as the main interface to operate and visualize the data, and some of them are also integrated with cloud-based platforms for data storage and reporting. Some of the algorithms behind or supporting these tools are incorporating AI and Machine Learning features to significantly improve the accuracy of the measurements, that is the case of online fragmentation cameras and 3D mapping scanners, for instance. As an example of these measuring tools, Figure 4 (left) shows the deployment of the O- Pit Dev probe. The probe instantly transfers the data of the borehole position to a purpose-built app via Bluetooth 4.2 for visualization as shown in Figure 4.

- **Cloud-based Platforms**.

  These platforms centralize the storage of blasting-related data -that is sometimes automatically uploaded from next-gen design software, digital charging units, electronic initiation systems and other integrated systems- and enable the collation, analysis, and reporting of said data. All this process allows easily identify overall trends, unlock valuable insight, and make more informed tactical and strategic decisions. For instance, it is possible to closely track the real powder factor across blasts as a proxy of explosive consumption and operational expenditure and compare these values with the planned and budgeted amounts. Figure 5 presents two examples of graphs produced in O-Pit Analytics to track the evolution of drill and blast parameters such as spacing-burden ratio and stemming- burden ratio (left) as well as powder factor (right).

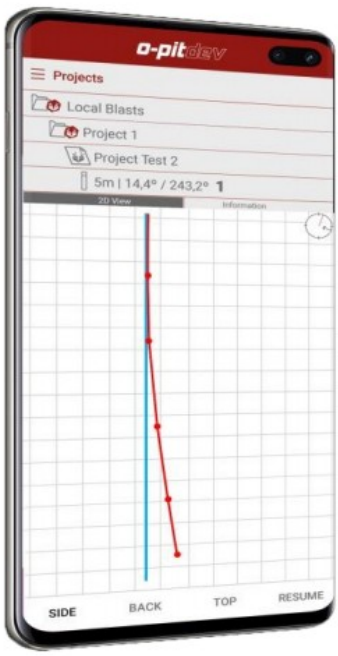


Figure 4. (left) Deployment of O-Pit DEV probe, (right) Visualization of borehole deviation on the app.

Figure 5. Examples of data analysis visualization using O-Pit Analytics.

FUTURE BLASTING DIGITAL TECHNOLOGIES

It is evident that some of the digital technologies available in the mining industry have yet not reached the blasting process and therefore there are still many opportunities to explore in this regard. This gap in digital applications is expected to be partially addressed in the medium term by technologies that are currently in the research and development pipeline of many explosive suppliers and are described below.

- **Fully Wireless Electronic Initiation Systems.**

  The cordless primer (booster + detonator) will be available in the coming years.

  Some successful trials have been conducted in a few mines around the world. However, most of the suppliers still need to catch up with the development for a massive application of the technology to occur. This technology will certainly result in a simpler and safer loading operation, which will facilitate the inclusion of new automatic and autonomous features.

- **Fully Automatic Charging Units.**

  The missing piece of the jigsaw here is the ability to instruct the charging unit based on data transferred from a design software or input on a tablet on-site. The most recognised explosive companies are well advanced in the development and implementation of this type of charging units. Therefore, this technology is expected to be in operation on a wide scale in the next couple of years.

- **Semi-autonomous Charging Units with the assistance of robotic applications and artificial intelligence.**

  The unit will be able to take the wireless primer, locate the corresponding borehole and loading it inside, and then deliver the corresponding amount of explosive. A few driverless charging units are currently under development, with an unclear release date (unlikely in the next couple of years), however, full autonomous charging units still appear far on the horizon.

- **Advanced Training and Remote-Assistance Devices using augmented and virtual reality.**

  Some of these devices are being used in mines and tunnels, however, the number of users is still very limited. That said, since the technology is readily available, a quick increase in their adoption can be expected, especially considering the limitation imposed by the coronavirus.

- **Advanced data analytic tools.**

  As mentioned in the previous section, there already exist cloud- based platforms that store, manage and provide basic blasting reports that can be accessed through apps, however, stronger analysis techniques need to be applied to convert the available data into more meaningful information. Techniques such as Data Mining, Clustering and Machine Learning are already starting to be used to develop some of the future digital products.

- **Integrated management software**.

  This will be the pivotal element that connects all the different blasting sub-processes in terms of data transfer and allow the interaction between the several digital tools implemented.

EXPECTED BENEFITS

Both the theoretical analysis of the digitalization of mining and the evidence gathered from the deployment of digitalization strategies by some companies in recent years have allowed the industry to laid out a reasonably accurate list of general common benefits that can be expected at an operational level. These benefits can be expected in the case of blasting as well, as described below.

- **Improved Reporting and Communication**.

  Digital platforms enable a tailored, paperless and immediate flow of data and information. This improvement not only reduces the time spent on these mechanic tasks but also represents the foundations for the next point on the list. Could- based platforms can allow the centralization of all the data corresponding to a given blast and easily produce tailored reports to inform the management of the planning, material loading, crushing and leaching processes in the short and long term.

- **Improved Decision-Making.**

  The implementation of digital systems opens the door to acquiring a range of data considerably wider than the one provided by conventional systems. With all this data, a significantly more accurate representation of reality can be realised, allowing - with the assistance of advanced data analysis – the extraction of valuable insight regarding the fundamentals governing each blasting sub-process and the interaction between blasting and the rest of the processes within the value chain. On top of that, the ability of digital tools to process complex datasets in a very quick manner significantly improves the response time to unexpected field conditions. For instance, the relation between measurement-while-drilling data could be properly studied, using this information as an input for blasting design and modelling. Similarly, the relation between the effect of the operational loading parameters (e.g. matrix temperature, pumping speeds, mixing arrays, etc.) could be studied in depth to create knowledge and control systems that ensure the consistent manufacturing of quality products.

- **Improved Productivity.**

  The fact of having smart charging units is reducing the blasting time which, in turn, boosts the productivity of the entire operation. Also, these charging units enable a more efficient on- site manufacturing and loading of bulk explosives, minimizing the delays associated with sub- standard practices.

  In the same line, the use of centralized and remote blasting centres contributes to reducing the time spent in the clearance process and the extent of the exclusion zone which consequently maximizes the operating time of all assets.

- **Increased Safety**.

  Digital systems tend to reduce the number of people required to operate the charging units and execute the entire blasting process. Broadly speaking, the entire process can now be done by one or two people in a comparable timeframe. The use of next-gen charging units and associated digital tools typically lead to reduced loading and blasting cycles which reduces the exposure of the personnel to risky conditions in the production and development fronts. In addition, the use of electronic initiation systems significantly improves the safety and security conditions of the entire blasting since these systems possess a series of preventive features such as encoded data, insulation for high currents, RFID cards to initiate the blasts, etc.

- **Higher Degree of Compliance.**

  Smart, automatic charging units can execute a significantly more accurate explosive loading, resulting in an implementation that both represents the blast designs and can adapt to the field conditions. This enables the accomplishment of the expenditure budget and helps achieve the expected blasting results and consequently the desired performance of downstream processes.

CHALLENGES IN BLASTING DIGITALIZATION

The digital transformation of blasting, although in its early stages, have encountered several obstacles in the implementation of technologies and the setup of an integrated system. Most of these challenges can be typically observed in the digitalization of other mining processes and even outside the industry. The most recurrent and relevant challenges faced by both mining companies and explosive suppliers are described below.

- **Resistance to Change.**

  The adoption of technologies in the mining and construction industries is rather slow due to cultural factors, and this is particularly true in the case of blasting. For example, electronic detonators were created in the '90s and only in the last decade, the technology started to enter the market massively, even though the associated benefits have been talked about since its inception.

- **Lack of integration between technologies.**

  The co-existence of proprietary equipment, devices and platforms from multiple suppliers is adding to the complexity of communication and data transfer between technologies covering different sub processes associated with blasting.

- **Transfer of a silo perspective between unitary operations to the digitalization process.**

  This is because most of the digital tools and technologies are designed and developed by specialised suppliers that have limited or no presence in the upstream and downstream processes. It is fair to say that the flexibility and integration in the application of the technologies reach as far as the sphere of influence of the supplier that creates said technological advancements.

- **Presence of highly complex and challenging on-bench conditions.**

  Unlike other mining processes such as haulage and comminution, explosive loading activities require a superior level of precision as crews and equipment face significantly irregular conditions. Factors such as highly uneven work surfaces, restricted access to certain areas of the polygons, tight drilling patterns with the presence of unexpected inaccuracies, exposure to free faces, and complex explosive configurations have contributed to keeping some of the blasting activities as manual tasks. Each one of the factors changes from one blast to the other, which requires a highly advanced technological system that can capture those variations and act accordingly. The full integration and automation of the blasting process depend on the existence

of certain technologies that are still under development, with some of these technologies not expected to be available in the short term (< 3 years).

- **Lack of consistent evidence to support the business case for digital transformation.**

  Although the potential benefits of digitalization have been theoretically laid out by now, there is no standard valorisation method to quantify the effect of digitalization within the business - even when we look at single unitary operations such as blasting. This is mainly because the realization of the benefits significantly varies from one operation to the other as it is highly dependent on the technical and commercial conditions of the mines. For instance, there are clear inherent differences between the mining methods and the value chains of a gold mine that uses dump leaching and a copper mine that uses flotation.

FINAL REMARKS

From a technical perspective, important differences can be perceived between the development and implementation of digital technologies in the mining industry and other industries. However, from a strategic and tactical standpoint, the digital transformation of mining processes exhibits many parallels with the experiences observed in other industries in the primary and secondary sectors of the economy.

The current technological advancements seem to provide the core capabilities to address the complexity in the development of tailored tools and systems and transform blasting into a fully digital process in the future. Therefore, at this point, it seems pertinent to discuss strategic and tactical aspects that have not been the focus of the companies 'efforts and that have proved to be crucial to the establishment of integrated digital systems in other industries.

- **Digitalization efforts should trigger the review of the business model and the corporate strategy**.

  Since digitalization is changing how the unitary processes are executed and gradually modifying the entire value chain of mine operations, it is crucial to ensure that the company develops the corresponding capabilities to support the digital transformation. Topics such as the worker's skills and the degree of vertical integration required to realise the Mining 4.0 state are already being discussed by most companies. For instance, in the case of blasting, skills such as piloting drones, operating electronic initiation systems, maintaining and repairing automatic systems will be common in blasting crews in the future.

- **Digitalization requires a holistic approach that congregates technology, processes and people.**

  Because blasting is going through the earlier stages of the digital transformation, all the actors are focusing on the practical aspect of it which is producing smart technologies. However, the rest of the stages that will consolidate and enable the accomplishment of the so-called Mining 4.0 need to incorporate the whole range of aspects that shape out the performance of the business if a sustainable state is to be reached.

- **The development of a unified digital strategy is required.**

  This can ensure both the implementation of compatible technologies and the transfer of insightful and actionable information across unitary processes. For instance, the digitalization of the blasting design process must be linked to the digital transformation of the geology, geotechnical, planning, and drilling departments from the very beginning.

- **Process integration precedes the implementation of digital tools.**

  As mentioned before, most of the efforts towards digitalization has been direct to create cutting-edge technology, however, it is relevant to ensure that each sub-process serves its purpose within the value chain, and consequently contributes to the creation of value for the business. There is no point in executing a task in an extremely efficient fashion if it is not the correct task to perform within the context of the entire operation. In this sense, aligning the performance indicators of blasting with the performance indicators of downstream processes is fundamental. Some mines have already adopted a more integrative approach by creating areas where converge processes such as Blasting and Material Loading or Blasting and Crushing.

- **Changes in the contracts between mining companies and suppliers are required.**

  The new reality created by digitalization can open the door for explosive and blasting contracts to move from being product-centric to being solution-centric as this will encourage suppliers to provide what is required to produce integrated digital systems that deliver the desired results at a technical and business level. In this sense, contracts of the type "rock on ground" or "rock to specifications" seem to be viable options to reframe the commercial agreements between the interested parties. This type of contract not only link the financial gains (or losses) to the

consecution of pre-defined outcomes and therefore the achievement of the mine's overall targets, but it also gives suppliers most of the control over how the blasting operation is executed, and subsequently over the performance of their businesses. This can certainly be seen as a win-win situation as it sets the foundations to align the parties' interests.

- **Future digital technologies must consider environmental and safety aspects associated with blasting.**

  As the effort to design and operate more sustainable mines increase, it would be necessary to produce tools that measure and track the performance of the blasting process in terms of greenhouse gas emissions, fumes generation, waste management, among other relevant factors.

- **The co-development of tailored and integrated digital systems is key to maximise the realisation of value.**

  As discussed previously, it is unlikely that a one-size-fits- all approach to digital transformation, it is relevant that mining companies and suppliers work together to produce sound digital solutions that perform at their best in any given production environment. This situation required that suppliers and manufacturers exhibit a high level of flexibility in the design of their digital products and the delivery of digitally enabled services.

It also highlights the need for long-lasting and trusting relationships between customers and providers as it is possible that, in the future, the entire implementation of the digital system of a unitary process such as blasting would be commissioned to a single supplier.

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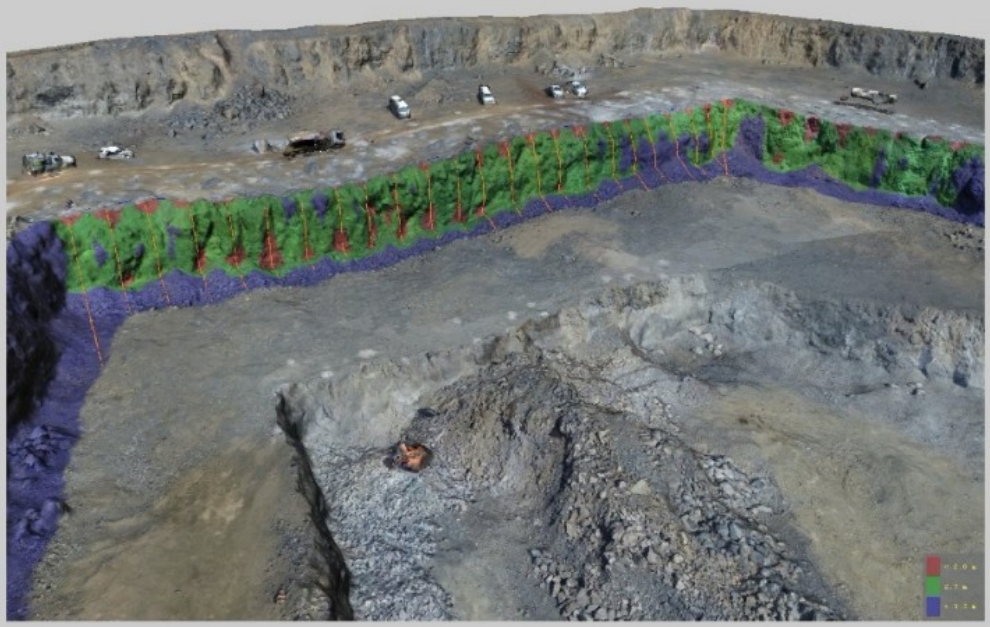
Blast Optimization

Blast Design and Blast Analysis with 3D images



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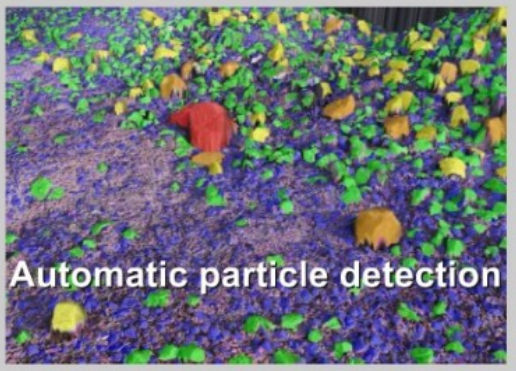

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Pan-European Competence certificate for Shot-firers / Blast designers.

By Teele Tuuna, EFEE Council Member, CEO of Spark & Stone Concept OÜ

**If you already know everything about the history of PECCS and wish to find most current information and news about PECCS situation, please move to the end of the article!*

To understand the idea behind EFEE- s activities in the field of the shot- firer education in Europe, it might be good to go through the whole history together. First, let me tell you about the Shot-firer Committee – it is a standing committee covering the aims of the Federation in area of promotion of standardization and harmonization of explosives training in Europe and in promotion of explosives technology in all fields related to the use of industrial explosives. For so many years, the Shot-firer Committee has been led by Karl Kure – Kure Fjellsprengteknik, from Norway.

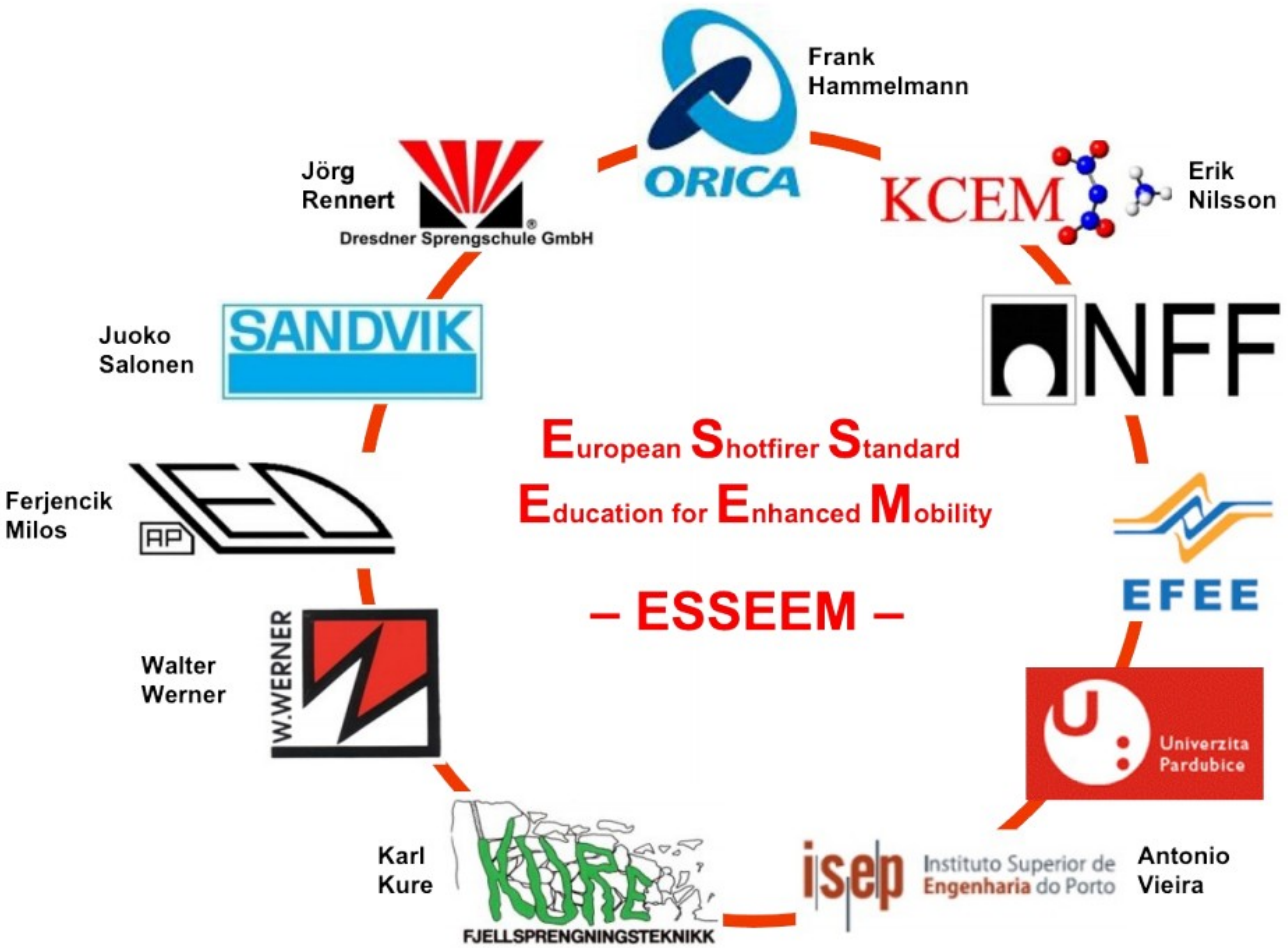
Thanks, to Karl, EFEE has been active in the field of shot-firer education, already since 1988. During that time EFEE had issued more than 300 EFEE Shotfirer Certificates to applicants holding a national shotfirer license from a country which is considered to meet the set of EFEE requirements.

With this activity, the shot-firer education in the EFEE member countries have been systematically analysed within the Shot-firer committee to understand if their national training means meet the requirements set by EFEE. Through this work, it was clear, that the levels of shot-firer education are still very different around Europe and the differences in the levels of knowledge were too big for a one universal acceptance. This also meant that the mobility of this profession was very limited and EFEE stopped issuing these certificates.

But the problem with shot-firer mobility remained. Many countries needed qualified workforce, while other countries had too many of them. There was also the issue of international companies, who couldn't move their own workforce without extra certification processes in another work site. To tackle the problem of shot-firer mobility EFEE decided to start with harmonisation of the shot-firer education. With this idea, the Shotfirer Committee started to move towards an EU directive which did not lead to a solution right away, but it gave EFEE the push towards creating a shot-firer training material, which would be usable all over Europe and give every shot-firer access to different kind of competences from Germany to Scandinavia and Romania.

In 2004 EFEE started with creating a "Training manual for Rock blasting technique" and in 2006 they also created the "Training manual for Demolition blasting"

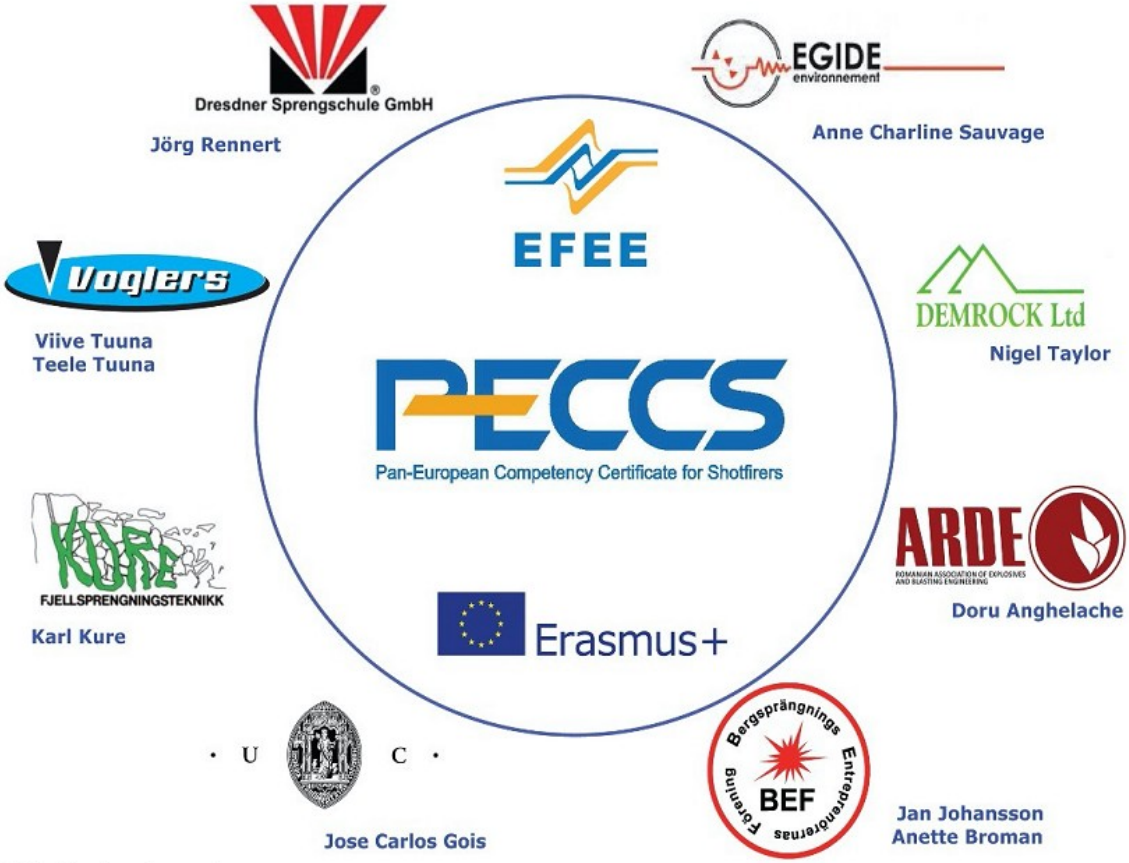
These two manuals became the base for the ESSEEM – "European Shotfirer Standard Education for Enhanced Mobility" project, which was led by Karl Kure and Aslak Ravlo from, the NFF - Norwegian Tunnelling Association in cooperation with EFEE. Thanks to active participation of different specialists, members of EFEE, the Shotfirer Committee and the funding from European Commission, the project was carried through from 2008 to 2010.



ESEEM Project partners

The ESEEM project ended with a result of 1200 slides of materials, collected from highly appreciated specialists, authors and teachers from Europe. To make this material more comprehensible, NFF organised and funded the work to reorganise the material. The results of all this work were presented in Zandwoort, Netherlands, in 2013 for the representatives from 23 countries. The idea behind a more universal training means to harmonise the levels of shot-firer knowledge and competences in Europe was greatly welcomed, but it was also acknowledged that there's still a lot of work to do.

It was decided to create a group of people who would start working towards another project to finalize the training means. Finally, in 2016, after two years of unsuccessful applications to gather another funding from the EC, the PECCS – Pan-European Competence Certificate for Shot-firers and blast designers project started. The idea of the PECCS materials in the beginning was a more modern approach. An accessible online teaching and testing application, which would mean mostly self-learning and self-testing, with a Certificate issued by EFEE after a successful exam. But through the work with the materials, it was clear that a proper training by a teacher is always better when it comes to using industrial explosives.



PECCS Project partners

The partners and EFEE decided to go with a compromise and the outcome was an online testing environment for the trainers and the shot- firers themselves to understand current level of competences and knowledge and next to the training means an online database for the training materials and documents connected to it. This means that through online communication, EFEE can give out training materials without extra heavy data being sent, only an access to the PECCS online environment is necessary to download the materials. This also means, that as the materials are updated and modernised with a workshop organised by EFEE every two years and with the help of verified specialists all over Europe, the training organisations will always have a possibility to use the most updated knowledges for training their shot- firers through existing online database.

For three years, intensive work was carried through by partners from 8 different countries to create the PECCS outcomes, and in 2019 the project ended with finished materials but still with some overall framework issues.

In 2020 a PECCS test training course was organised in Sweden. For 7 days, shot-firers, teachers and specialists used the PECCS materials, studied them from inside out and even went through exams, based on these materials. Some side marks were made, some small grammar errors got corrected and the partners reached an overall understanding of how the PECCS materials are working. Thanks to this test course, the shot-firer committee knew what else they needed to do in order to give access for the materials to all educational entities in Europe.

Some of the PECCS partners from the last project meeting in Rakvere, Estonia. From left: Doru Anghelache, Karl Kure, Nigel Taylor, Jörg Rennert, Viive Tuuna, Teele Tuuna, Jose Carlos Gois

After the PECCS project ended, EFEE decided to create a working group who would keep the materials alive and available for educational entities. The working group consists of 4 people, Jörg Rennert, EFEE Board member from Dresdner Sprengschule, Robert Lazlo, EFEE Board member from Insemex, Jose Carlos Gois, EFEE Board member from the University of Coimbra, Karl Kure our honoured mentor as EFEE Council member from Kure Fjellsprengteknik - and finally me, Teele Tuuna, EFEE Council member and the PECCS administration, from Spark and Stone Concept OÜ.

Unfortunately, due to the coronavirus situation, it was not too easy to create the framework around the PECCS materials, meetings were complicated to organise, and other issues needed solving too, all this was done online eventually.

But finally, now, in 2021, it is time to make the dream come true! Everything is ready and accessible for every educational entity who wishes to use the materials without a fee.

EFEE sees this as a form of cooperation between educational entities, authorities, private companies and EFEE itself, to harmonize the knowledge and competences of a shot-firer profession in Europe. Once the certificate itself has started to work as it is supposed to – as most National Members of EFEE have already agreed with the idea of supporting one universal certificate and that it could be the PECCS certificate - then the real EU directive is not far to achieve.

At this time, the Pan-European Competence Certificate for Shot-firers and Blast designers is created for those, who already have experience as a shot-firer and who already hold a national shot-firer certificate. According to the European Qualification Framework, the PECCS certificate is for level 4-5. And those shot firers, who have passed the PECCS course and received the Attendance certificate from their national course holder, will be able to apply for a full PECCS Certificate from EFEE.

So in order to gain access to the PECCS materials as a trainer, please write to Info@shotfirer.eu – we will have a basic Agreement for signing and after that all you need to do is create a user on www.peccs.datel.ee webpage, and the PECCS administrator will give you access for downloading the materials in PowerPoint and in PDF format. Every educational entity will get a different set of examination questions from the administration and the updated materials in every two years. Meanwhile, the Shot-firer committee, the PECCS working Group, and all active members of EFEE will do whatever is needed to move closer to the original goals.

September 2021

BACK TO TOP

The art of blasting

Pieter van den Bosch, artist

Pieter Van den Bosch is a visual artist from Belgium.
Since the start of his practice he's had a great interest in working with 'energetic materials'.
In the beginning, this mainly resulted in art projects in which the visitors interacted with light and fire. Then he started to use pyrotechnics, and his activities evolved into happenings with explosions of paint or ice.

He is fascinated by the transformation caused by energetic material and tries to visualise this in an aesthetic way.
He uses energetic material as an art medium to create sculptures, installations, performances and videos.

He received his diplomas in performance art, primary school teacher, pyrotechnics, firework master, civil safety and engineering. Van den Bosch recently realized there was still unexplored territory in the art landscape and wondered what was needed to get there.

In order to be able to deal with high-energy material knowingly and skilfully, he took a course in working safely with explosive substances. According to civil law, he operates as a blasting engineer and is allowed to blast small objects such as rocks, tree stumps, bridges or structures up to 6 meter.

Up until now, he has mainly been focused on discovering, defending and enabling the energetic material as art medium.

His interest is the yet to be discovered, unknown, underexposed and unloved creation possibilities of high-energy material.

This research, the use of high-energy materials as an art medium, is supported by the department of Arts and Culture.
Most of the works were carried out on private property in a movie recording context, and regulated accordingly.

Van den Bosch made the following works with low or minuscule amounts of high-energy materials:

Canvas

https://vimeo.com/508103222 'canvas' is an installation with a traditionally looking set-up of painting material that falls apart before the painter could start.

This installation questions the use of the canvas and cherishes the moment when it comes to an end, and tries to show this in a way typical to the material.

For this work 1 pyrotechnical electric squib was ignited with a 10 cap blasting machine.



ICE EXPERIMENTS

https://vimeo.com/511750594
'ice experiments' is a video in which naturally red coloured ice blocks in different arrangements are being pulverised.

The video shows a selection from a project in which the useless but beautiful fragmentation qualities of ice are displayed.

For this work several pyrotechnical electric squibs were ignited with a 9 volt firing system.

BLACK POWDER

https://vimeo.com/508116908
'black powder' was a live performance, that allowed 100 protected participants to experience a controlled pyrotechnical deflagration of black powder fuse. These performances safely showed the almost surreal and typical properties of energetic material, and made it possible to experience them in a positive way.

For this work 3 pyrotechnical electric matches and 3000 meter rapid fuse based on black powder were ignited with a 12 volt firing system.

In the near future Van den Bosch' research will focus specifically on the detonation process and application of high-energetic material in the arts. The use of shock tubes, detonation cord, detonators and a range of charges will be applied to regular art media like clay, stone, metal, paint and wood.

In May 2022, he will present the first results of some test cases for this niche market on the world conference on explosives and blasting in Maastricht.
His aim and dream is to carry out a more profound pilot project 'the art of blasting' later in 2022, likely in a quarry setting with local partnerships.

Van den Bosch is always open to and looking forward to world-wide partnerships to carry out 'the art of blasting', based on a positive culture. For more information, questions or discussion, please contact info@pietervandenbosch.be linkedin: linkedin.com/in/pieter-van- den-bosch-661a65b0
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Congratulations and a warm welcome for joining EFEE as a member.

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Ulster Industrial Explosives Ltd., Ireland

Individual Members

Antonio Albendea Garcia, R. Claveria, S.a., Spain

Miguel Ángel Escanciano Sánchez, Peal Group, Spain

Student Member

Tian Feng, BGRIMM Technology Group, China

Upcoming International Events

ISRM's EUROCK 2021
September 20-25, 2021
Online event.
www.eurock2021.com

ISEE 48th Annual Conference on
Explosives and Blasting
Technique January 30-February 2, 2022
Las Vegas, Nevada, USA
https://www.isee.org/conferences/2022-conference

SME Annual Conference and
Expo February 26–March 2, 2022
Salt Palace Convention Center Salt
Lake City, Utah, USA
www.smeannualconference.com

SAFEX International Congress
April 3-8, 2022
Salzburg, Austria
https://www.safex-international.org/safex/news-safex-congress-xx-in- salzburg.html?sid=1580472102

WORLD TUNNEL CONGRESS 2022
UNDERGROUND SOLUTIONS FOR A
WORLD IN CHANGE
April 22-28, 2022
Bella Congress Center Copenhagen, Denmark
https://www.wtc2022.dk/

EFEE 11th World Conference
on Explosives and Blasting
May 15-17, 2022
Maastricht, Netherlands
www.efee2022.com

HILLHEAD 2022
June, 21-23, 2022
Hillhead Quarry
Buxton. UK
https://www.hillhead.com

FRAGBLAST 13
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