The first digital assistant, visual and integrated, to quarry marble with simplicity

By Orlando Pandolfi

The digitisation of stone quarries: an information and technology babel. The world has reached a point of singularity today. Nothing will ever be the same again. Digitisation is pervasive and ubiquitous. The maxi European financing plan Next Generation - Recovery Fund indicates it as essential and strategic.

Digitization applied to stone quarries is a tough deal: most companies have not understood the urgency but are proceeding in a confused way. In Carrara, for example, all of the quarries use digital tools for the design and traceability of materials. Many companies use 4.0 machines or very advanced 3D rock instrumental monitoring systems.

The quarry is now commonly represented topographically in 3D and computer platforms are only dedicated to the management of monitoring in the Cloud, with Wi-Fi systems or other IoT communication systems.

Many quarries are also ISO 45001 and ISO 14001 certified.Everything looks futuristic and innovative. But is it really true? Does all this serve to truly solve the problems of quarrymen or is it only for capable technicians who manage information in “sealed compartments”?

There are still few stone quarries that think in a global and integrated way!

Is it so difficult to try and read data in an organic context, strictly dependent on the changing shape of the quarried rock mass?

The limited and fragmented approach in a thousand of contexts and disciplines does not help concession holders and is the cause of many failures of 4.0 digitization in the quarry.

In almost all 4.0 approaches, in fact, there is no analysis of the context and of the operational processes of the stone quarry.

An impassable wall of knowledge divides the quarrymen from the designers of computer codes: excellent management tools but not specific for the sector; extraordinary projects and models of rock mechanics, valid 3D monitoring systems, yet decontextualized, not interoperable, characterized by closed languages and different semantics, intended only for technicians but unclear for concession holders and their managers.

In short, the exact opposite of what a 4.0 factory should be! To date, a real failure.

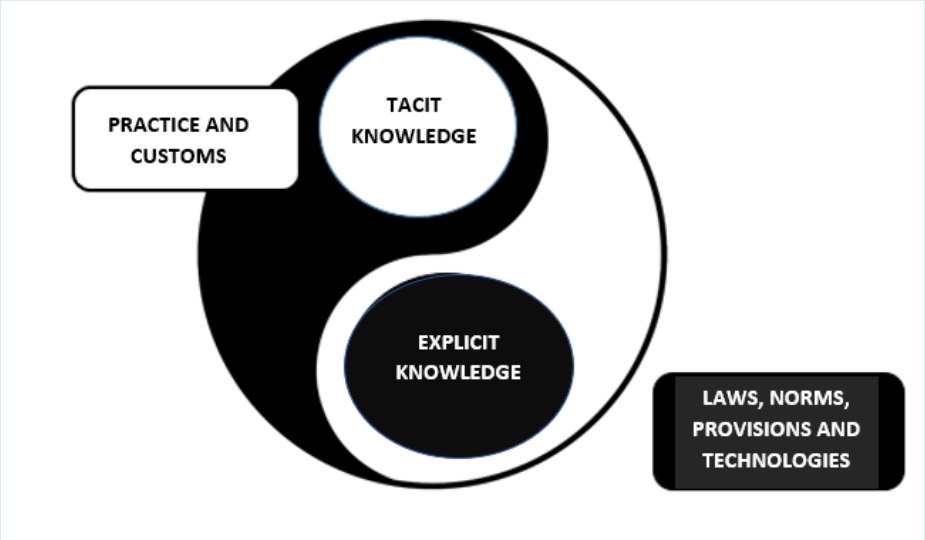
What to do then? What path to follow? How not to waste the opportunities of the PNRR 2021-2026 Next Generation - Recovery Fund? How to be a leader in the future?

One solution is to understand operational processes, see where they take place and integrate them, measuring them. To do this, experienced quarrymen and quarry technicians need to design what they need themselves. So: we need a digital twin marble quarry.

First of all: what does it mean to "nurture" a stone quarry?

“Nurturing” a marble quarry, that is: sailing in the open sea with the right compass and tools.

The whole senses are involved in the stone work: the scent of the polished and cut material, the dazzling colors and textures with which the surfaces respond to the three-dimensional shapes of the sculpture or design, the ever-changing sound with which each stone responds to blows of the chisel and the changing sensation in touching polished, honed or bush-hammered elements are the solid



"Marketing responds to production with a quarry system inserted in a context of constraints shared with the territory"

properties that have made stone materials the eternal protagonists of the highest aesthetic representation of power, art, appearance and architecture and design over the millennia.

Similarly, Homo Faber responds to these profound needs by searching, in the extraordinary nature of the mountain, for veins and deposits capable of satisfying the market, or suggesting new fashions and new expressions. From the megalithic temples of the Near East, from the stele statues of Lunigiana to the Moai of the Polynesian islands, from the Greek and Roman classicism and gradually from the Italian Renaissance to Canova and the days of new contemporary hybridizations: for each of these creations of knowledge, quarrymen responded by applying their Mining Art.

A discipline that combines **tacit and explicit knowledge**, in a continuous technological and cultural evolution taking place in a landscape: a natural and social context that changes from place to place.The finished product always has the peculiar characteristics of the history of extraction itself, which architects must apply in the most appropriate way.

The stone material must, therefore, respond to the wishes of the market, also evoking new aesthetic paradigms, with an accurate preventive fit-to-market analysis and a continuous strategic action of lean marketing leading to improvement.

The basic elements are well defined: the rock mass, the technologies, the skills of the “quarry artist” and the procedural rules of safety and environmental management.

Extracting marble out of a quarry is therefore a complex activity, pervaded by entrepreneurial risks, inserted in a fashion market, a niche, changing and subject to sudden changes, especially in current times.

The quarryman is, therefore, the person who faces navigation in an open and always changing sea, which well defines the nurturing of stone quarries.

Navigating without a correct compass and without the right tools can transform the quarryman's experience into a deep and inexorable effort, steeper than quarry ramps, until it leads to unusual storms.

The needs, pains and joys of the quarryman

The metaphor of navigation plastically renders the paradigm of stone nurturing, in a changing market influenced by ephemeral fashions, with a deposit that need to be respected and made productive.

In this sea, adverse currents and cross winds are the order of the day.

In more correct terms, from the management point of view, the quarry can be summarized as a complex system that allows the nurturing of a rocky mass of lithic material through the use of specific production factors:

machines, plants, technologies and specialized human resources. A system in which the quarrier lives every day with multiple geotechnical, deposit, technological and market uncertainties that are grafted on to the issues of safety, environmental and social impact connected to the quarrying of the deposit.

The Twin Marble Quarry ™ paradigm

To simplify the complexity of this system we have patented the Twin Marble Quarry ™: the digital twin quarry, constantly evolving just like the real quarry.

Twin Marble Quarry ™ can be read with the digital assistant ∃! PETRA | Performance Tracker ™: a visual and holistic platform, usable on PCs, tablets and smartphones, designed exclusively for stone quarries to virtualise the rock mass subjected to quarrying.

Through ∃! PETRA | Performance Tracker ™, the digital twin quarry receives and processes the collected data by a family of IOT sensors installed on the equipment and in the quarry, representing them in an intuitive and synthetic way in order to support the strategic choices of the entrepreneur: a new paradigm to nurture stone quarries that allows you to orient yourself inside the marble deposit to measure production indicators and improve good company practices with simplicity.

Check list, authorizations, deadlines, 4.0 machines, working hours, maintenance, topography, consumption and geotechnical monitoring, staff training: all operational information coming from the quarry site in real time - every day, at any time, in a single platform and at distance - are constantly shared by the owner, by the construction manager and all specialized operators.

WHAT ∃!PETRA IS:

- The revolutionary twin marble quarry facilitates your mining, displaying data and events.
- A powerful integrated visual platform connected in the Cloud to the mountains and 4.0 machines
- ·A digital assistant that helps you make important decisions with new awareness of the production process.

WHAT ∃!PETRA IS NOT:

- A general application created for a world other than quarries
- A non-integrable software exclusively dedicated to a single topic (geotechnics, machines 4.0, management, etc.)
- ·A non-customizable and binding tool.

The ∃! PETRA | platform Performance Tracker ™ is patent pending; it is open, interoperable and, thanks to its modular system, totally tailored to the customer's needs.

It is divided into 4 basic modules (Maps, Compass, Actions, Archive), fundamental for the control of the entire system, and 7 specialized modules (Machina 4.0, Use and Maintenance, Systema, Sectio, Sensorium, Lapides, Natura), which can be integrated with the basic ones.

A simple yet advanced solution that some of the most important international companies in the sector are adopting.

For more information:

FOCUS LAUNCH WEBINAR

May 20, 2021 - By Carolina Meanti

∃! PETRA | Performance Tracker ™ was born in Carrara, for Carrara, from the work of high technological innovation of Orlando Pandolfi, Innovation & Quarry Strategist for two generations at the service of mining, that from the marble basins where the finest 'white gold' in the world is kept, looks to the challenges of stone to trace a route from the past to the future, respecting the mountain and those who wisely work it.

It was right in Carrara where the launch webinar of ∃! Petra has been held, with the participation of Confindustria Livorno Massa Carrara and Confindustria Marmomacchine, the academic contribution of the University of Pisa, of ANIM (National Association of Mining Engineers), an expert in 4.0 transition, and the case histories representing, respectively,the points of view of marble entrepreneurship and quarrying machinery manufacturers.

The meeting - held on May 20, 2021 - was opened by the President of the Massa Carrara delegation of C**onfindustria Livorno Massa Carrara**, **Matteo Venturi**, who declared: "Today, the stone sector is also facing the challenge of a digital turnaround, to which the turning point of circularity in the sector will be connected. Both of them challenges based on systemic, that allow to check in detail the complex system represented by the stone quarry, simplifying it into measurable processes. To do this, we have been collaborating with Orlando Pandolfi for years in order to guarantee companies a virtuous path on ISO 45001 and ISO 14001 certifications: a path that has given important results, carried out together with RINA,

and which on the basis of this consolidated experience led to the development of a roadmap to respond increasingly to the needs of 4.0 companies, with a view to digitization and circularity. The measurability of all the phenomena that occur in the quarry is fundamental for our associative policy issues in consideration of which we like to disclose in the most reliable possible way all the activities carried out by our companies. Thanks to the digital platform ∃! PETRA it will be possible to identify the training needs of companies to provide advanced training that brings man ever closer to intelligent machines: a priority for our Association which considers training as an indispensable element, being man, with his skills, the centre of the entire path of industrial growth". Along the same lines is **Marco De Angelis**, **President of Confindustria Marmomacchine**, for whom ∃! Petra represents "the correct way to take at a national level to finally allow the marble industry to rationalise the quarrying of stone quarries and truly enter the new millennium. After a year of pandemic, the two reference markets, USA and China, are showing clear signs of recovery, and finally Italy is rising up: the digital twin quarry and the integrated platform that represents it, will pave the way for advanced training cycles for companies, of which the sector is in great need, allowing the involvement of the entire production team and generating a consequent reduction of costs".

Professor **Mario Cimino**, from the Department of Information Engineering at the **University of Pisa**, gives us an academic vision of the 4.0 future in the manufacturing industry by deepening the theme of information transfer and data coordination with a view to optimising process management and production. "In the manufacturing industry, the reference model is that of cyber-physical systems: Internet of things, simulation and integration of systems and big data represent an integration still in progress in many companies and, on the state of current art, not yet fully achieved due to the fact that, often, the transferred data are not fully exploited to maximise the result that we find in the company's processes. In fact, we speak of true interoperability among machines when we can make them cooperate to fully support business processes. This requires a higher level of awareness on the side of factories, which means sharing a vision and a process model where the processes themselves are well codified and well identified: a "shop floor management system" that allows you to have a constant vision on production, quality, cycle times, the status of machines and the various indicators that make it possible to make processes more efficient. A system that also allows you to review the process model in real time if, for example, problems not foreseen before in the design phase are identified. Models such as that of the digital twin, such as the one for stone quarries on which ∃! PETRA platform is based, can also be a source of data for simulations and projections capable of guiding the entrepreneur in the choices to be made".

With **Davide Gentili,** an expert in innovation engineering and investments in capital and material goods, the focus of attention shifts to an equally crucial aspect in the 4.0 transition process, namely: the tax benefits for factories deriving from the purchase of technological goods with a high innovative content and able to fully satisfy certain requirements. "There are many companies that currently want to move in this direction" - explains Gentili – “the State machine wants to lead the industry in this direction, which for some companies will be an opportunity of improvement, for others a need to keep up with times and increase its competitiveness

will be an opportunity of improvement, for others a need to keep up with times and increase its competitiveness.The production system evolves and it is important to have tools, such as the one designed by Orlando Pandolfi, that allow us to be competitive. The goods that are normally used for the quarry environment can fall under the assets for which tax benefits are needed, but it is also necessary to clear out what requirements these assets must have in order for companies to take advantage of the tax benefits deriving from their purchase. In fact, if it is true that the assets must have a high technological content, they must also have specific requirements imposed by the State, that is: innovation 4.0 requirements that must be interconnected and integrated with the company's activities. And this is exactly the most difficult challenge to face. The concession is interesting because from November 16, 2020 until December 31, 2021, for goods purchased in this period and which will be delivered by June 30, 2022, the State gives a tax benefit equal to 50% of the value tax credit of the asset, up to 2.5 million euros (the benefit decreases for investments of a higher amount). For goods purchased until the year 2022 and delivered until June 30, 2023, the benefit is reduced to 40%. In order for us to have this import credit, we must also demonstrate that the purchased good is interconnected and integrated. All this began with the 2017 Budget Law, which dictates the technical principles on which we are still based today. The law provided for an over-amortization of 250% for those who purchased innovative goods, a percentage raised to 270% by the 2018 Law - which remained unchanged in 2019 - in 2020 we switched to tax credit, up to 2021. The interesting fact is that, if the company purchased an asset in 2018 or 2019 but also in 2017, if it interconnects it today, it can have the benefit connected to the Budget Law of the year in which it purchased the asset. To this information it must be added that the State requests that a third party draw up a certified assessment in which it is demonstrated that the investment that has been made in integration and interconnection is an investment compatible with the obligations required. The survey is issued by an engineer, or alternatively by an industrial expert or an accredited certification body; it is mandatory for amounts exceeding 300 thousand euros but at the same time it is strongly recommended also for lower amounts (in this case, as an alternative to the survey, a declaration by the legal representative of the company is required regarding the fulfillment of the 4.0 requirements). The Company must, therefore, demonstrate the integration of the asset with its factory logistics, with the processes and the production chain, and the asset must lead to an evident benefit compared to a non-4.0 asset: improvements regarding control, management, quality, production, etc. The asset must also be kept interconnected and integrated throughout the depreciation period.

Having said all this, the system designed by Orlando Pandolfi represents the ideal method for making the machines communicate jointly with each other by integrating the information that each machine is able to provide and receive, each one contributing individually to productivity and innovation. The ∃! PETRA platform is the ideal place where all processes are conveyed integrated in order to be reported, monitored, managed and give real results to the company that uses them".

It was then the turn of Successori Adolfo Corsi, historical family in the stone business of Carrara since the XIX century, which through its General Manager Giulio Corsi, flanked by the systems engineer Andrea Potenza of the Pandolfi team, illustrated the benefits found from the application of ∃!PETRA to the management of his quarries: "The use of ∃! PETRA allow us to deal with a multitude of aspects relating safety, environment, design and production of the quarry: it is a simple and innovative management method that is helping very much our company making it possible to monitor the quarrying activities at 360 degrees through various tools, from the historical archive of the company to the mining plans, but above all for the possibility of interconnecting the machines and conveying all the data referring to the production cycle in an integrated platform in line with the state requirements for industry 4.0 This has allowed us not only a leaner and more effective business management, but also to make important technological investments with significant tax breaks. Given our positive experience, I can only recommend ∃! PETRA because it is helping us on many fronts ".

On the side of machinery manufactures, **Benetti Macchine** – in the words of its Sourcing Manager **Tito Franzini** – makes its position clear: "Our machines are set up and designed to be 4.0, starting from the concept that the quarry itself is a production environment, full of problems but also of innovation, which welcomes and integrates the machine. As manufacturers we constantly interact with our customers to try and improve our product: the concept of industry 4.0 has certainly been a positive stimulus for everyone and we are confident that the integration of machines, whether logistic or training, can lead us to a further qualitative leap where the real value of all this consists in being able to exploit data in real time, transforming it into optimisation. .
We believe, therefore, that the results we are obtaining can turn into advantages of productivity, telemetry, assistance, greater safety in the quarry and scheduled maintenance developed in terms of reliability. Aspects that particularly over the last year, made so difficult by the pandemic, have allowed us to make many machines work with customers where we could not physically go".

Domenico Savoca, President of **ANIM | National Association of Mining Engineers**, has concluded: "∃! PETRA is projecting us towards the future. As President of ANIM, I am dealing with future mining at a national and global level, so what the mining activity must do to compete on production, environmental and safety issues. The main point on which the current world discussion in the sector is focused is the need for digitization, which leads to the innovation and competitiveness of the system: all primary topics contained in the Recovery Plan, as well as priority objectives to be achieved and supported by the State. The ideas that emerged in this context are part of the baggage we should carry for the future. The interconnection of machines has an extremely important impact on safety and the environment from the point of view of circular economy".