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ROADMAG

ALL-TERRAIN TRANSPORT PLANNING

CEMENT, RMC, AGGREGATES, ASPHALT

INFORM

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"Straight roads are for fast cars,

turns are for fast drivers". This is my favorite quote from motorsport legend and former World Rally Championship winner Colin McRae. The world's fastest man on gravel was fearless in the driving seat and best-known for his "all or nothing driving" style.

Like rallying, transport planning in the cement, ready-mix, asphalt, or aggregates industry is a race against the clock. On the road to the customer site, sudden and unpredictable surprises like ad-hoc orders or cancellations constantly force dispatchers to do handbrake turns and power slides.

When Colin McRae won his first title in 1995, Microsoft Excel had been the reigning champion in supply chain planning. Today, latest algorithms provide unrivalled digital torque which allows dispatchers and planners to do incredibly complex, time-critical calculations with ease – moving more payloads with fewer trucks for you each day.

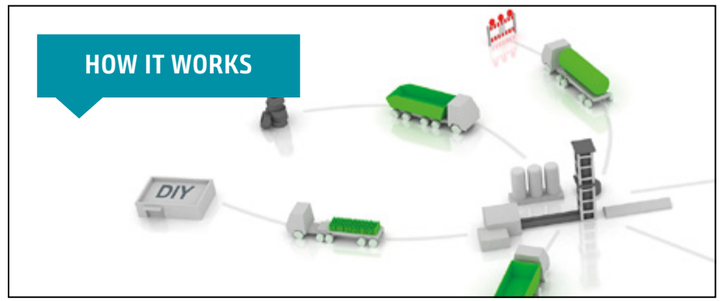
Need more insights into how our algorithms work? Then take your time and browse through this second issue of our ROADMAG. It's a must-read compilation of our best articles that were published in industry-leading journals recently. Written to stimulate and challenge your thinking on how technology impacts logistics in the modern age, they deliver a blend of big picture thinking with practical ideas you can apply today – plus more inspiring quotes from people like Mario Andretti, Henry Ford, or Bob Geldof.

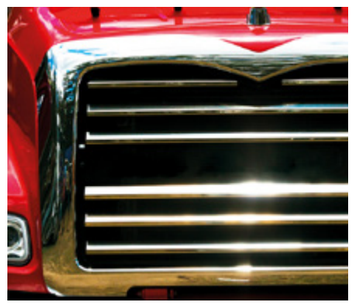
Enjoy the read!

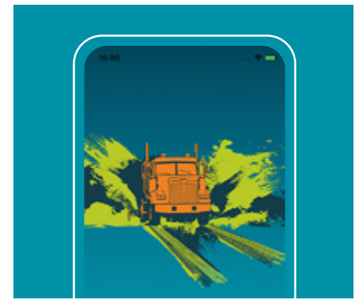
Thomas Bergmans
Senior Vice President
Logistics Division

PS: Have you met Charlie our Chief Challenge Officer (CCO) yet? He's the new face of our **#ChallengeYourPayload** campaign, see page 15.

Content







First published in "International Cement Review – June 2019"

BETTER GRIP: OPTIMIZED AGGREGATES SOURCING

Algorithms have become a major efficiency driver for outbound transport optimization in the ready-mix concrete industry. But many RMC producers still lose traction when it comes to find the optimal sourcing/transportation cost balance for their inbound aggregates supplies. This article will explore how the latest software developments help RMC producers with a larger network of batching plants and quarries to further improve their bottom-line.

"Straight roads are for fast cars. Turns are for fast drivers." This quote is from motorsport legend and former World Rally Championship (WRC) winner Colin McRae. The world's fastest man on gravel was fearless in the driving seat and best-known for his "all or nothing driving" style.

No doubt, driving a rally car is different to driving a ready-mix truck. But both, rally organizers and the RMC industry, rely on aggregates as the base material for their business. While the gravel stages make rallying one of the most spectacular motorsports on earth, aggregates are an indispensable ingredient in any concrete mix. Accounting for up to 75% of its volume, they not only influence the quality of a ready-mix, but also the RMC producer's profit. And this applies to both vertically integrated as well as non-vertically integrated pro-duction networks.

Being able to take fast turns in transport planning and aggregates sourcing can mean the difference between winning or losing the daily race against the clock. Due to the perishable nature of ready-mix concrete, only on-time and in-full deliveries will be rewarded with applause by construction site managers. The same pressure is on the aggregates supply side, however, without the applause part if they get it right.

Dispatcher's Pacenotes

In rallying, pacenotes are used to describe the route to be driven in extreme detail. The aim is to provide drivers with a minimal, but sufficient, set of information that allow them to drive through every corner at maximum possible speed even without knowing the road. Details include braking points, hazards, surface conditions, the degree and severity of bends, potholes, jumps, etc. For an experienced driver, pacenotes provide a way to visualize the road ahead.

A dispatcher's equivalent to pacenotes is Microsoft's Excel spreadsheet. Released in the late 1980s, the tool quickly became – and some might say still is – the reigning champion of supply chain management. Easy to configure, it helped planners and dispatchers to manage their daily activities, analyze data, or run macros to automate calculations.

The RMC transport planning phase is generally split into three stages: strategic planning, tactical scheduling, and real-time optimization (see fig. 2). More than any other job, being a dispatcher brings a tremendous amount of pressure and stress. Each day is a challenge, and particularly stage two and three of the planning phase can take their toll. The decisions they have to make are incredibly complex and time-critical: assigning trucks and hauliers, juggling with Adhoc orders, tracking and tracing all trucks and orders in real-time, tackling driver shortage and driver hours of service, balancing costs and service levels, maintaining a high OTIF performance, dealing with customer complaints, etc. In short – when it comes to creating complex delivery schedules and fleet configurations for the following shift(s), spreadsheet tools are not enough to support the decision-making process.

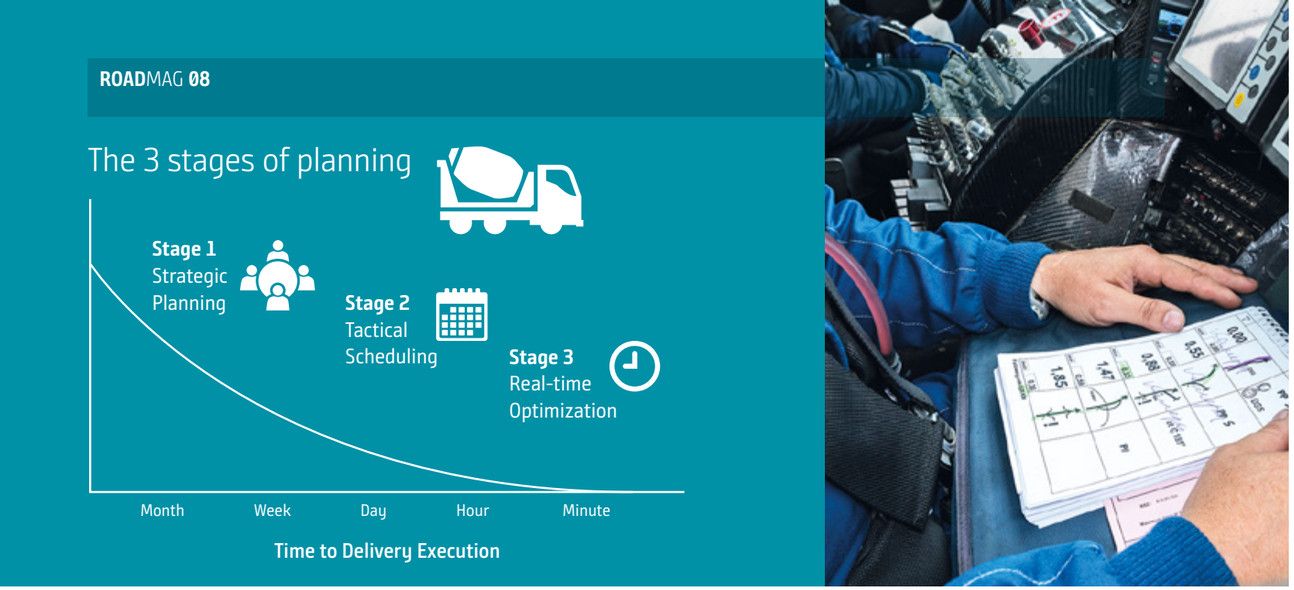


Fig. 2: RMC supply chain planning is a three-stage process.

But like the introduction of four-wheel drive in rally sports, the progress in computer hardware and algorithms over the past two decades have revolutionized the performance of logistics planning tools in the building materials industry. Today, algorithms outperform legacy systems and human planners. Compared to the 1990s, solving a logistics planning model using the latest hardware and algorithms has come down from decades to less than a second. For a detailed analysis please see ROADMAG 2018/19, page 34 ("Benchmarking ready-mix logistics performance").

Aggregates on Autopilot

While real-time optimization constantly forces dispatchers to do handbrake turns and power slides, strategic planning is a less thrilling exercise. Planning cycles here revolve around a quarterly or semi-annual review, and include items like fleet sizing, fleet (re-)distribution, fleet mix, haulier contracts, depot planning, plant/product mix, amongst others. It is an important discipline and prepares a distribution network for the season ahead. When implemented correctly, it gives dispatchers a set of routine procedures they can follow easily during their daily race for competitiveness. We are creatures of routine and when we establish routines, we can carry out tasks a lot faster since we don't have to think about the task or prepare for it. Routines allow us to go on autopilot and still accomplish most of our objectives.

Inbound raw material supplies are usually run on "autopilot". RMC producers either operate their own quarries, rely on third-party quarries for their aggregates supplies, or have a mix of both in place. The same applies to the actual deliveries. Many RMC producers operate a mixed fleet of their own tipper trucks and hired hauliers or have subcontracted all deliveries to third parties.

> Real-time optimization forces dispatchers to do handbrake turns and power slides

With long-term contracts in place, both between RMC producer and quarry operators as well as RMC producer and hired hauliers/third-party contractors, aggregates sourcing seems like a straight-forward exercise. However, managing freight rates and haulier payment schemes is a continually changing matrix with many variables, see ICR, October 2018 ("Haulier assignment: Making the right moves"). Hauliers and their trucks have different capabilities, strengths, and weaknesses. Likewise, aggregates come in different qualities and sizes. And if you add further constraints into the equation, e.g., reliability of the quarry operator, responsiveness to urgent jobs, security of supply, capacity restrictions at depots and plants, etc., optimized aggregates sourcing becomes a real brain-teaser too. Finding the optimal sourcing/transportation cost balance to replenish RMC plants and/or depots without compromising service levels can be challenging.

Simulation Challenge

A WRC rally usually opens with two days of reconnaissance in ordinary cars to help drivers and co-drivers find their marks and get familiar with the track. This is followed by a "shakedown", a final test session on closed roads. A similar approach was used for the following simulation study that the authors' company carried out for a RMC producer recently. As a first step, raw data from the producer's plant/quarry network was collected, analyzed, and then modelled into the simulation software. This included geo data from all plant/depot/quarry locations, detailed annual shipment streams from each quarry to the various plants/depots, product and transportation cost breakdown, contract profitability, preferred haulier lists, etc. In addition, several constraints were examined like opening hours of loading/unloading points, and onsite equipment availability.

Figure 3 summarizes the basic set-up: 42 batching plants, 25 quarries (own and third party), and four aggregates (gravel in two different sizes and sand in two different sizes) with a total annual transport volume of 2.8 million tons. The annual pre-simulation sourcing costs were at €55.5 million which translated into an average costs per ton of €19.81.

Based on this data, first test rounds were carried out with the simulation software. "What-If"-scenarios helped to analyze the impact of configuration changes onto the cost/service outcome. After a couple of repeating rounds and feedback loops with the RMC producer, a set-up was chosen that delivered the following post-simulation results: annual sourcing costs were down at €52.6 million, the average costs per ton dropped to €18.79. Or in other words: by using algorithms to optimize the aggregates sourcing, the RMC producer was able to achieve an annual cost savings of €2.9 million.

Some of these savings could not be realized immediately due to existing long-term contracts with quarries and hauliers. But when repeated in regular intervals, the simulation will allow the RMC producer to progressively reduce their sourcing costs by nearly 5%. And the example just focused on a specific region of the producer's operational area. On a country or continent-wide scale, potential savings can easily pile up to a lower double-digit Euro figure.

All-Terrain Planning

Besides gravel, WRC rally stages are also driven on asphalt, snow, and ice. Different surfaces require setup tweaks in order to achieve maximum speeds and best results. Likewise, there are different algorithms and optimization setups available for other sectors of the building materials industry, e.g., cement and asphalt logistics. Producers with a vertically integrated production network can combine them to drive synergies and unlock value across all corners of their business.

On a final note, producers who are content with their status quo and hesitate to invest into latest digital planning tools, can find further advice from former racing driver Mario Andretti: "If everything seems under control, you are not going fast enough."

Fig. 3: Pre- and post-simulation results of optimized aggregates sourcing.

First published in
"Global Cement – October 2018"

DYNAMIC PRICING: AN OPTION FOR CEMENT LOGISTICS?

Dynamic pricing is a strategy in which businesses set flexible prices for products and services based on current market demand. While common practice in many industries, cement producers still heavily rely on static pricing models with long-term contracts between vendors and buyers. This article will look at the technology behind digital pricing and the possible benefits for the cement industry.

"I don't like Mondays" is a tune and feeling that many people would subscribe to. But according to research, it is actually the best day for penny-pinching car owners to buy cheap petrol. Monday morning usually marks the start of the weekly roller coaster ride of rising and falling fuel prices. They're down one moment, up the next, and they're different depending on where you live. To the average person there is little rhyme or reason to how these prices are determined, but it has always been common practice in this industry.

Other industries like airlines, hotels, and concert organizers jumped onto the bandwagon and abandoned their fixed pricing strategies. And with the growth of online shopping, the arrival of the "Uber" economy, and wide-spread use of algorithms, the concept of dynamic pricing has reached new levels. On a flight we may accept that our seat neighbor did not pay the same price for his ticket as we did. And that our neighbor filled up his car with petrol for less money isn't a big problem for us too. But are we willing to accept this practice when buying cement? Will it be okay for construction companies that a Tuesday afternoon delivery of grey cement is cheaper than a Friday morning delivery, since this helps cement producers to increase traffic on days of weak frequency? Should cement producers revisit their current static pricing models and prepare for a transition to more dynamic models to overcome bottlenecks at plants and to attract customers that are more flexible with their demand?

Cover Versions

Dynamic pricing, real-time pricing, smart pricing, demand pricing, surge pricing, personal pricing, time-based pricing, flexible pricing, or yield management; there are many slightly different tunes that cash in on a pricing strategy in which businesses set flexible prices for products and service based on current market demand. Price changes may take into account supply and demand, competitor prices, and other external factors in the market. Each industry takes a slightly different approach based on its needs and the demand for a product. One goal is often to increase profit generated from a specific customer. Optimizing the utilization of logistical assets and capacities, however, is a goal that is more relevant to our industry. Or in simple terms: increase prices when demand is higher than loading capacity (e.g. long truck queues in front of the gate) and/or use incentives to increase demand when loading capacity utilization is low (i.e. idling loading stations). In essence, it is about breaking the old trade-off between upgrading plants to cope with peak demands and facing customer complaints for poor service.

With long-term contracts between vendors and buyers in place, business models of many cement producers are currently not designed for digital pricing. What's more, some still do not have the right digital instruments at hand to orchestrate their supply chain and logistics processes or are at an early stage of doing so. An easy way to learn the scales of dynamic pricing can be the introduction of a time slot management system.

From Dispatcher to Ticket Master

Time slot management, truck appointment system, pre-booking or ticketing system – these are different terms to describe the same concept: software that is used to allocate time slots to inbound trucks. It helps avoiding hauliers arriving randomly at the plant – adding

speed and consistency to onsite handling processes. Figure 2 shows a time slot management system embedded into a central transport planning tool.

This set-up helps dispatchers to initiate a three-step process:

a) The central planning tool calculates a transport plan for the following shift (delivery schedule for each truck).
b) This transport plan is used to create a time slot plan (loading schedule for each truck).
c) Free time slots are made available on an online platform for ex-works customers.

It allows to integrate the cement producer's own truck fleet, contract hauliers, spot market hauliers, as well as ex-works deliveries (pick-ups by the buyer or the buyer's designated haulier). While a) and b) already lead to greater on-site efficiencies and streamlined processes at the gate, weighbridges, and loading stations, step c) provides an excellent mechanism to introduce elements of dynamic pricing and to further balance the peaks and troughs of logistical asset utilization. For time slots that fall into peak traffic zones, a surge charge can be imposed to either cement price or transport price, or a "congestion charge" can be leveraged, similar to the traffic fee in central London. And for time slots falling into low traffic zones, an incentive can be given to increase the attractiveness of these slots (lower cement prices, lower transport prices, or a voucher/discount for follow-up orders) aiming at keeping the overall revenue in balance.

Backbone of this set-up is the transport plan generated by the central transport planning tool. Standard tools are either spreadsheet based or use predefined business rules to drive the calculations. But since decision-making at this stage has a crucial impact on the quality of the transport plan, state-of-the-art planning tools use algorithms and Artificial Intelligence to analyse a virtually endless number of scheduling decisions and identify those that are ideal for minimizing costs and maximizing service quality – based on the business criteria defined. And the same algorithms can be used to add further dynamics to the time slot management system.

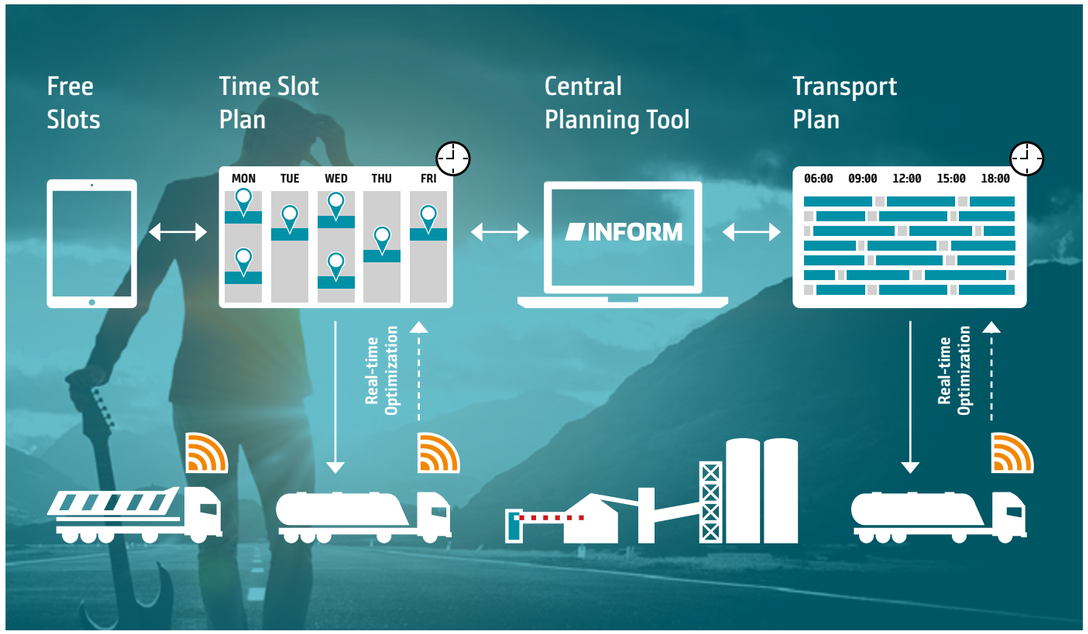


Fig. 2: Digital instruments for dynamic pricing.

VIP Ticket

In any business, all customers should be treated fairly, but that doesn't mean they must be treated equally. Why should a class A customer wait behind a one-off buyer picking up a small order, even though class A customer arrived one hour late and missed his pre-booked time slot? Business practice often requires that some clients receive preferred service or "VIP" status. Premium customers, one's own truck fleet, contract hauliers, or ex-works deliveries – the list of possible beneficiaries is long, as is the list of reasons why they should be allowed to jump the queue or benefit from incentives or specific product promotions derived from a dynamic pricing scheme.

Business Rules for Time Slot Management

- **Customer / contract profitability**
- **Preferred haulier list**
- **Premium service to specific customer**
- **Timeline of orders**
- **Minimizing product changes at loading points**
- **Maximizing loading capacity utilization**
- **Targets for product volumes or utilization**

Fig. 3: Incentives can help to introduce dynamic pricing.

To roll out the digital red carpet for your customers, algorithms can process a larger range of variables from incentives or specific product promotions derived from a dynamic pricing scheme.

To roll out the digital red carpet for your customers, algorithms can process a larger range of variables to create a loading schedule and time slot plan that includes all applicable business rules and site constraints. Business rules may include customer/contract profitability, preferred haulier list, premium service to specific customers, targets for product volumes or specific regions, and many more (see figure 3). Site constraints that may apply are product availability at a specific loading point, loading capacity of the loading point per product group, loading point availability, interdependencies between loading points, maximum number of trucks allowed on-premise for safety reasons, equipment compatibility between truck and loading point.

And a "red-carpet" time slot management system with real-time capabilities will also include GPS data from the trucks and live information from the gates, weighbridges, and loading stations to allow the software to review and adjust all planning decisions constantly – right up to the moment before execution. It checks which order(s) can be moved forward and updates the entire schedule accordingly.

It Takes Two to Tango

When introducing a dynamic pricing scheme, it may be very tempting to listen to the Uber economy and immediate play or plagiarize the complete repertoire of influencing factors. But a step-by-step approach is more advisable. Cement producers should start with a simple price differentiation approach for different weekdays and times of a day, e.g. by means of a time slot management system as described above. Customer trust is a key element in any business. The driving factors behind dynamic pricing should therefore always be explainable and transparent. Once customers are used to differentiation and fluctuating prices, cement producers can slowly expand their dynamic pricing strategy, e.g. by using predictive algorithms or Machine Learning tools.

As outlined in "Born digital: A new workforce in cement logistics" (see ROADMAG 2018/19, page 30), millennials will continue to replace the generation of "pen and paper" dispatchers. And they will also be the one who drive demand on the customers side. Instead of clinging to aging strategies, adaptation is needed for cement producers to survive in a digital world.

"Great songs of indifference" was another hit by Bob Geldof. The "I don't mind at all" attitude he sings about in this song could prove to be very costly for any cement producer ignoring digital change. It is not a question of "if", but "when" to learn the scales.

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MEET CHARLIE,

OUR CHIEF CHALLENGE OFFICER (CCO)

Charlie is the new face of our #ChallengeYourPayload campaign. He's a solid guy, sharp as a tack, with a big curiosity for logistics. In his official capacity, Charlie is travelling the world, popping up at cement, ready-mix, aggregates, and asphalt events as well as business meetings around the world.

We'll be featuring updates on LinkedIn so be sure to follow the hashtag #CharlietheCCO and #ChallengeYourPayload.

First published in
"Global Cement – April 2019"

HEY ALEXA WHERE'S MY CONCRETE?

The construction industry is facing a major overhaul. Traditional tools and processes are being enhanced or replaced by Artificial Intelligence (AI). From self-driving ready-mix trucks, to automated decision-making and even wallboard-mounting robots, algorithms are pushing and challenging long-established mindsets. This article takes a look at the technology behind these tools.

Most of us know, all too well, the pain of starting a home improvement project. You've just returned from the DIY store with a car full of building materials, only to realise you have to stop and drive back; not just once, but multiple times. Whether you're an amateur or seasoned pro, at some point we all buy the wrong part, forget something, or simply don't purchase enough in the first place.

What used to be a time-consuming exercise and a potential risk to your project's timeline, can now be done by a simple voice command. "Alexa, order four 25kg bags of CEM I 42.5N and three bags of 20mm gravel." Now with a same-day delivery service to your doorstep, there is no excuse to not finish the project on time.

The Digital Jack of all Trades

AI enhanced assistants like Siri, Alexa, and Cortana have become an ordinary, if not integral part of our lives. And now they are about to enter the workforce in our industry. The term "Artificial Intelligence" has always been a source of confusion and controversy. The most prominent type of AI, which is catching attention and drumming up doomsday scenarios, is so-called General Artificial Intelligence. Its goal is to create a robot or android that looks, speaks, and even reacts like human beings. AI enhanced assistants like Siri, Alexa, or Cortana are an early example of this approach.

But a digital jack of all trades who can outperform or replace human builders is not yet available, and the truth is, it still has a very long way to go. Instead, most AI programs today are "narrow minded" specialists that can beat humans at chess or can master discrete tasks to solve specific business problems. This practical type of AI uses Machine Learning techniques and is delivering value to our industry now.

The AI Toolbox

In contrast with General AI's goal of mimicking human intelligence, Machine Learning tools (ML) use algorithms to iteratively learn from and adapt to data, enabling computers to find hidden insights without being instructed where to look. A beginner's example for this can be found in your email inbox: spam filters. Simple rule-based filters are not very effective against spam, since spammers can quickly update their messages to work around them. Instead, ML enhanced spam filters continuously learn from a variety of signals and tailor themselves to the email needs of the individual user.

A hidden champion of AI is Operations Research (OR). It uses analytical methods (mathematical optimization, heuristic methods, etc.) to analyze vast amounts of data to optimize the planning and real-time control of business processes. Much of this technology has its roots in supply chain optimization; and in the mid-1990s, sparked by massive improvements in low-cost computer power, it also entered our industry. Redlands in France (now LafargeHolcim) was the first company in the aggregates and ready-mix industry to use an OR planning tool to optimize their truck fleet operations. Six years later, Hanson Australia (part of the HeidelbergCement Group), followed.

From a classical research perspective, OR and AI are two separate disciplines that have independently developed intelligence-based computing techniques. However, if you take the broad definition of AI – building systems that demonstrate intelligent behavior – OR can be classified as a part of AI.

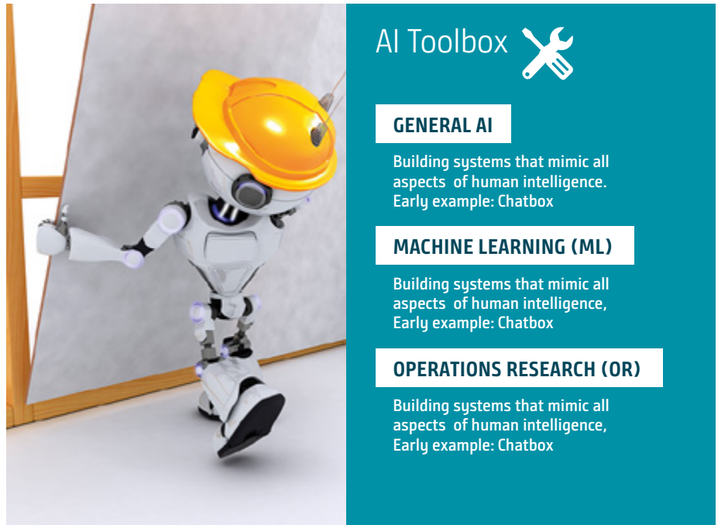

Fig. 2: AI toolbox

The ABCs of Machine Learning

Besides data, ML generates a lot of buzzwords: Deep Learning, Data Mining, Predictive Analytics, Data Engineering, Data Science, Statistical Learning, the list goes on. What they all have in common is that they use algorithms to analyze data, learn from it, and then make a decision or prediction based on that learning. Like at school, there are different teaching methods. Some prefer to teach theory, others encourage students to practice. Let's take a look at three of them: reinforcement, unsupervised learning, and supervised learning.

Reinforcement is basically the "school of life" or learning by trial and error. Infants, for example, learn to walk through repetition, e.g. trying and falling, and then trying again and again before eventually getting it right. And the same principle can be used to teach a robot to walk. Instead of time-consuming programming and simulations, reinforcement algorithms invoke the trial-and-error process and speed up the learning curve considerably.

Similar to the Montessori method of education, where students are relatively unsupervised and learn from working with materials rather than by direct instruction, unsupervised learning is a branch of Machine Learning that learns from test data that has not been labeled, classified, or categorized. Both Google founders are Montessori alumni and, ironically, it was their Go-playing software, AlphaGo Zero, that made a giant leap forward in unsupervised Machine Learning. While computers had beaten human Go champions earlier, Zero had only been programmed with the basic rules of Go. Everything else it learned from scratch. It started with random moves on the board, but every time it won, Zero updated its own system, and played itself again. And again. Millions of times over.

In contrast, supervised learning can be compared to a lecture type of school format where you have a teacher standing in front of the class. The data engineer acts as a guide to show the algorithm what conclusions it should come up with. Supervised learning requires that the possible outcomes are known and that the data used to train the algorithm is labeled with correct answers, for example to tell the difference between a screw and a bolt, just by looking at photos of them.

From Jenga Bricks to House Bricks

Earlier this year, engineers at MIT developed a robot that can play Jenga, a game that involves removing blocks from a tower while trying to avoid the collapse of the tower in the process. While playing Jenga may not seem like a mission-critical skill for robots, the underlying technology of combining sight, sensitive touch, and know-how is very much needed in the construction industry, e.g. when laying bricks. In case you're skeptical that a robot will ever be capable of doing such a job, just google "HRP-5P" for a robot that can install gypsum wallboard panels.

But AI is more than just robotics. There is a myriad of applications where algorithms provide brain muscles to other areas in our industry, ranging from supply chain and resource planning to a contract-reviewing algorithm at the legal department. Likewise, R&D scientists at a concrete producer as well as design engineers at a construction company can benefit from it. Machine Learning allows them to explore all possible permutations of a solution, quickly generating design alternatives, testing and learning from each iteration what works and what doesn't. It helps them to cut down the amount of time they spend on repetitive, monotonous tasks, thus unleashing their problem-solving skills and creativity. Or in other words, for companies finding it hard to attract new skilled professionals, ML provides the means to upskill their existing workforce and overcome labor shortages. As the following example from the logistics industry shows, hiring algorithms can be far more productive than hiring robots or new drivers.

No Hands on the Wheel

There is a massive shortage of truck drivers in many countries around the world and, this is no secret, it hurts every corner of the transportation industry. Some say, self-driving trucks powered by AI are the solution to driver shortage. Everyone agrees that autonomous trucks are coming, yet there is not much consensus as to when they will hit our roads. And they won't be driverless, at least not initially. It will take many years before trucks are truly free of drivers. And we shouldn't forget, truck driving is a lot more than holding a wheel. This particularly holds true in the ready-mix industry. While truck driver's may soon see their status as "king of the road" challenged by AI, dispatchers in transport planning have successfully been co-working with algorithms for decades. When equipped with the latest algorithms, digital decision-making tools allow for a reduction in truck fleet size of up to 14 percent, see figure 3. Or in other words, a fleet with 100 trucks can be downsized to 86; that's 14 driver seats less to fill, be it with humans or robots.

Alexa, Build me a House

From stones to AI, tools have had a huge impact on human evolution. So far, AI has been nothing more than a tool – like a hammer. A hammer designed to work with data as its nails. But we are now entering a phase where AI will transition from being a hammer and become the carpenter – pushing and challenging our creative boundaries and traditional mindsets. It may sound far-fetched today, but „Hey Alexa, build me a house" could soon become reality.

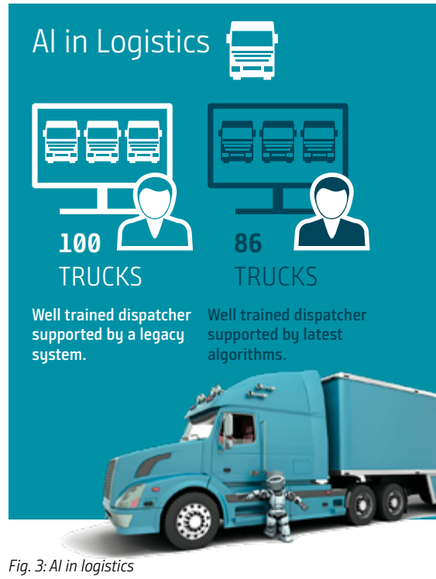

Fig. 3: AI in logistics

WHAT'S NEW?

Our journey to deliver best-in-class algorithms and transport optimization products continues. A truckload of new features and benefits awaits you.

#1 Revamped LTL Planning

Our full truckload (FTL) algorithms are best-in-class. But our revamped less-than-truckload (LTL) algorithms caught up and can't be stopped. To learn more what they can do for your LTL business, stop by **www.inform-software.com/ltl**

#2 Optimization as a Service (Oaas)

Our industry leading AI algorithms are now available as Optimization as a Service (OaaS). This new concept allows dispatchers in the ready-mix business to interact with their existing dispatch software environment while benefiting from our industry leading AI algorithms. **www.inform-software.com/oaas**

#3 Overhauled User Interface

The new design enhances user experience for transport planners, making the software more intuitive and visually engaging. Our UI experts followed a strict '3C' approach – color, contrast, clarity – thus reducing visual fatigue and digital eye strain.

#4 Finetuned Decision-Making Engine

The latest release comes with an improved set of optimizers tailored for the specific needs of different industries – providing more digital torque for all three stages of the transport planning challenge.

#5 All-New Track & Trace App

The all-new, long-awaited telematics app makes in-house drivers and subcontractors an integral part of your logistics workflow. The smartphone app ensures quick and efficient communication between customer service center and drivers.

#6 ML Powered Add-ons

Our Machine Learning add-ons generate useful insights into your business. Connected to the optimization process, they iteratively learn from and adapt to data, further enhancing the decision-making quality of the system.

ALL-TERRAIN TRANSPORT PLANNING

Our smartest-working algorithms are known for their all-terrain capabilities, be it cement, ready-mix, asphalt, or aggregates. And they know how to combine them – driving synergies and unlocking value across all corners of your business. Overcome the limitations of disconnected planning and learn how to **#CHALLENGE YOUR PAYLOAD.**

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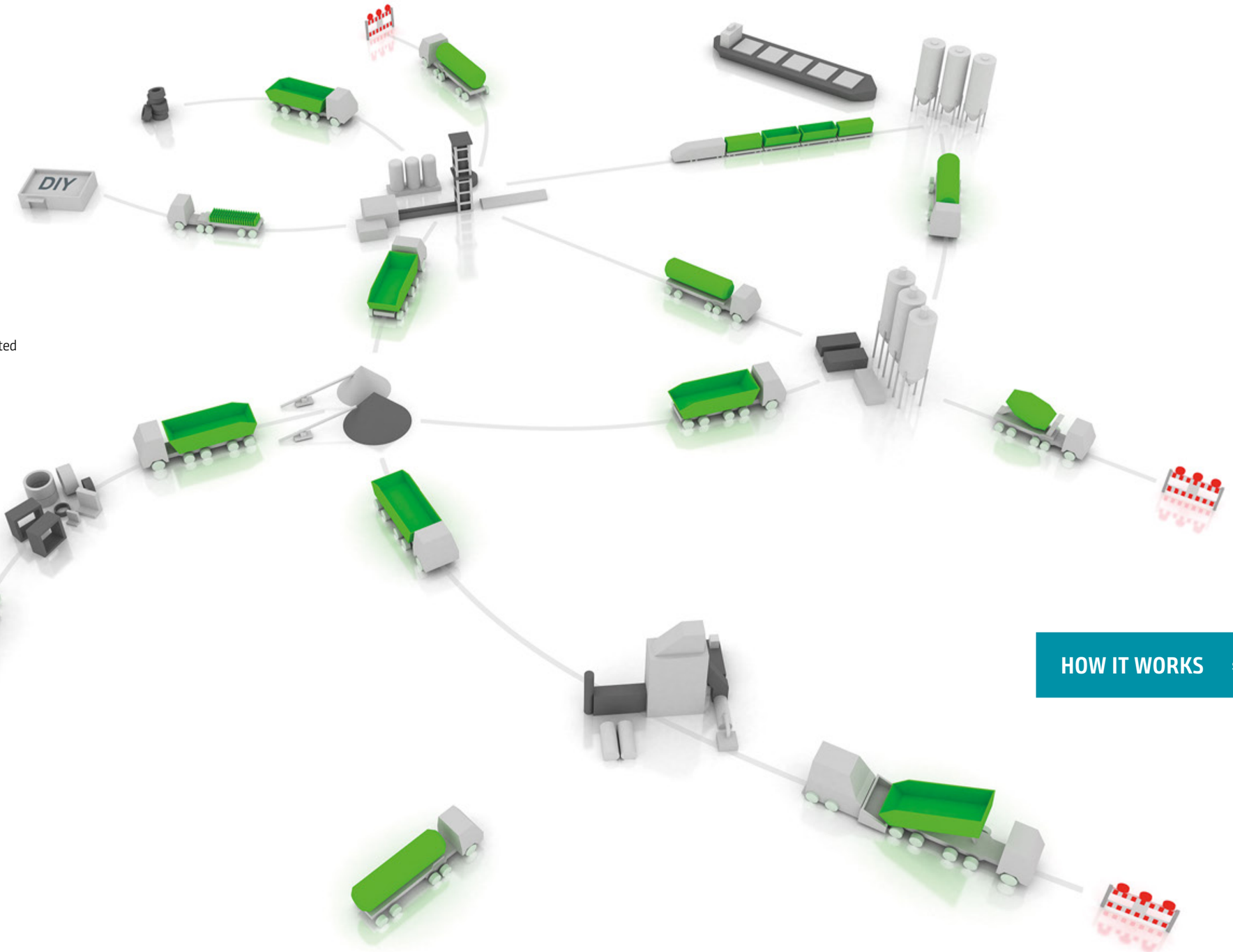
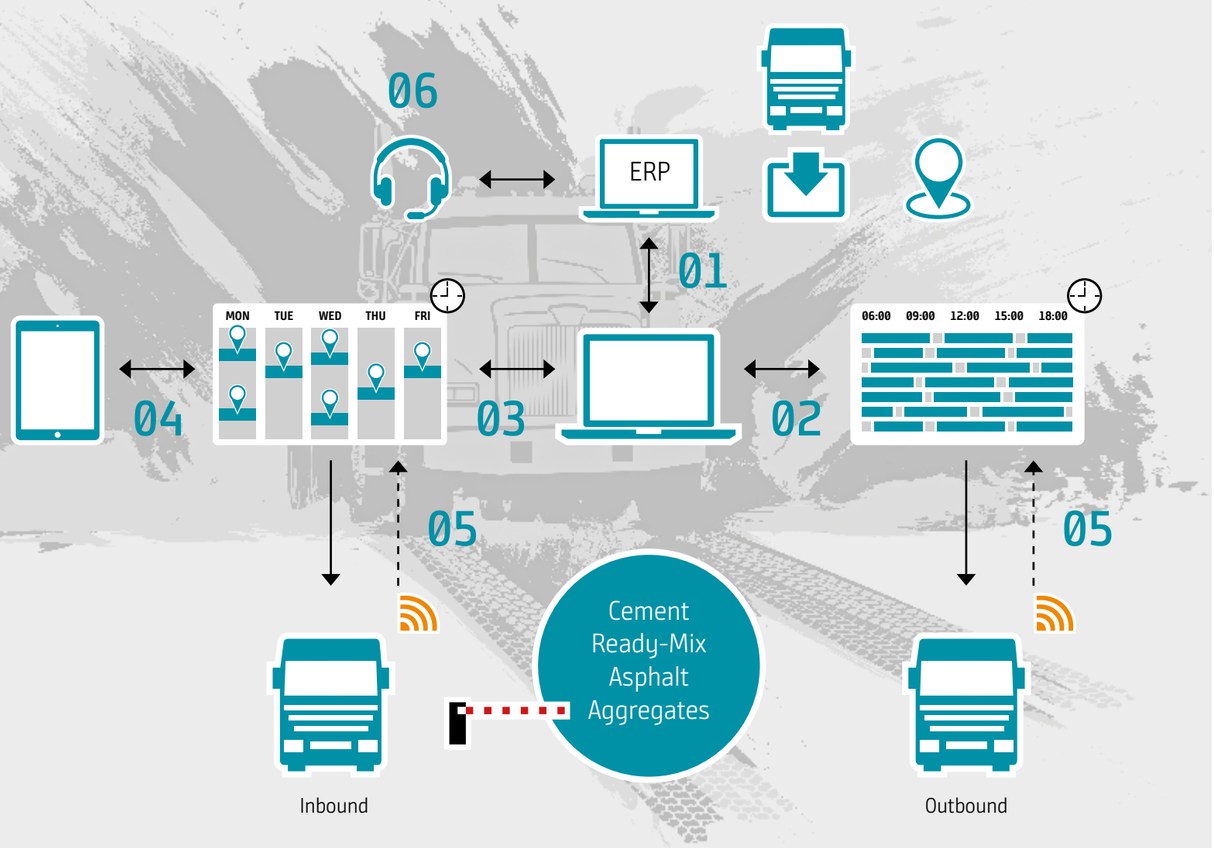


HOW IT WORKS see next pages

HOW IT WORKS

INFORM's software is equipped with algorithms that analyze a virtually endless number of scheduling decisions in real time and identify those that are ideal for minimizing costs and maximizing service quality – based on the business criteria defined.



01 Data Import

The current order book is taken from the ERP system. Geo data is used to calculate travel distances and trip durations. Fleet data provides information on each available truck and its characteristics and capacities.

02 Tactical Scheduling

The software calculates an optimized delivery schedule and fleet configuration for the following shift(s) or day(s) – incorporating the service levels selected by the dispatcher. Dispatchers can also compare several scenarios for the same data set by changing the scaling factors.

03 Time Slot Management

The software allocates time slots to hauliers (franco & ex-works) – adding speed and consistency to your loading stations.

04 Hauliers Access

Hauliers, suppliers and ex-works customers will receive an e-mail or text notification on available time slots and haulage orders. A web portal grants access for all transactions.

05 Real-time Updates

Industry dynamics like ad-hoc orders, cancellations, delays, truck or machine breakdowns, etc. disrupt the schedule. The software automatically updates your transport plan every 30 to 120 seconds.

06 Race Control

The software gives dispatchers full control over their OTIF (On-Time In-Full) performance.

DIGITAL TWIN TECHNOLOGY

A digital twin is a virtual model of a physical asset, process, or system. Pioneered by NASA in the early years of space exploration, it allows many industries today to understand and manage the operations of their remote machines and assets. This article will review use cases and benefits for digital twin technology in bulk material logistics.

In April 1970, NASA sent astronauts Jim Lovell, Jack Swigert, and Fred Haise on America's third landing mission to the moon. Two days into the flight, and more than 200,000 miles from earth, disaster struck Apollo 13: an explosion rocked the spaceship, and soon its oxygen and power began draining away. „Houston, we have problem," were the famous words that the crew radioed to mission control immediately after they heard the loud bang. NASA's engineers solved the problem by constructing a twin of the component they were trying to fix, using only physical parts that the astronauts in the capsule had available to them. While there was nothing digital about the process, mirrored systems became the precursor of digital twins. And nearly 50 years later, this technology allows many industries to understand and manage the operations of their remote machines and assets.

Down to Earth

A digital twin is a virtual model of a physical asset, process, or system. As conditions change, the digital twin reports those changes in real-time, whether it is a bearing in a roller mill, a chain in a bucket elevator, or a cement truck stuck in traffic. Combining the virtual and physical world allows cement producers to avoid problems before they occur, prevent downtime, and even plan the next steps using simulations. The ultimate goal is to have a digital twin running for every real-world asset in the field, with the digital replica updating its status as it receives operational data.

Apollo-era data acquisition technologies got mankind to the moon, and back, nine times. But sensors have advanced dramatically since then and with the rise of the Internet of Things (IoT) they have become connected too. Computing has emerged as a cheap and abundant resource that can be deployed against any problem, making large-scale digital twin modelling cost-effective for a wide range of applications.

A Giant Leap for Dispatchers

The daily mission of a dispatcher in a cement company is to determine the delivery schedule and fleet configuration for the following shift(s); decision-making at this stage is complex and intricate. Each decision has multiple flow-on decisions that, in turn, impacts future decisions. Coming up with an optimized plan is a real brain teaser. However, it offers the potential for great savings if done right.

State-of-the-art planning tools use algorithms and Artificial Intelligence to analyse a virtually endless number of scheduling decisions in real-time and identify those that are ideal for minimizing costs and maximizing service quality – based on the business criteria defined. The software allows dispatchers to make incredibly complex, time-critical decisions with ease. What's more, it offers great visibility into all logistics assets. With a digital copy of each truck it allows dispatchers to drill down to the deepest level of detail to analyse each transaction and move. At the push of a button, dispatchers can run different "what-if-scenarios" and model the outcome of even minor changes to the truck/order set-up.

The decisions made also take into account a larger range of variables than the human mind can, resulting in better overall decision quality. And like the men on the ground in Houston, it enables dispatchers to come up with actionable plans and steps that get the job done. Cement producers who use intelligent optimization software powered by algorithms typically achieve:

- A reduction in truck fleet size by 10 to 30 per cent.
- A reduction in empty mileage by almost 9 percent.
- An increase in loads/truck/day by up to 30 per cent.

Failure is Not an Option

NASA flight director Gene Kranz was the man behind the team that got the Apollo 13 crew home safely. Portrayed in the blockbuster movie "Apollo 13" and best known for his flattop haircut and white vest, he was also author of the book "Failure is not an option" in which he recounts the details of this mission. One of the most critical decisions he had to make was to choose between firing the spacecraft's rockets and returning it home immediately as it drifted away from earth, or using the moon to slingshot the Apollo 13 capsule back to earth. Despite the longer route, he picked the latter option which proved to be the key to success.

Cement plants are often found in remote locations and cement truck drivers face long hauls to reach their final

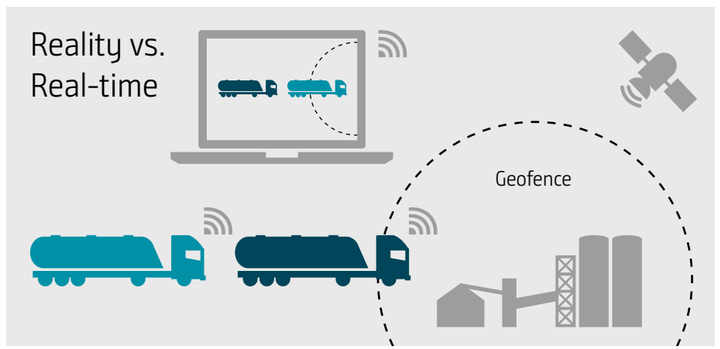


Fig. 2: Digital twins and real-time capabilities of telematics systems.

customer destinations. Telematics systems form the communication backbone between the trucks and the supporting customer service center where new orders are taken and transport plans are updated automatically by the planning software. Telematics allow dispatchers to track every mile on the road and every heartbeat of the engine is captured. The real-time data is vital to keep a digital twin system of the entire fleet running.

For many, the term "real-time" means immediate response. However, uptime of the system, accuracy of the status messages and sampling rates as well as accuracy of GPS readings due to external factors may vary between telematics providers. So depending on the type of telematics services used, the term "near real-time" might be more appropriate. Figure 2 shows what effect this might have for the planning process. The dark green truck is crossing the geofence around the cement plant ahead of the green truck. But due to different GPS signal sampling-times, the light green truck's digital twin appears to be ahead of the dark green truck's twin in the "real-time" view of the planning software. If the light green truck is running late for his next shipment, the software assumes that loading will start shortly and time can be made up. In reality, the dark green truck will enter the loading bay first – adding further delay to the light green truck.

The telematics market is very competitive and crowded. It is easy to get dazzled by fancy features. So buyers should make sure they get the best out of their investment. Telematics products that are tailored to the needs of the construction material industry make it easier to access relevant and actionable data for the transport planning software.

Houston, We Have a Program

NASA's mission control center is based in Houston, Texas and was built to coordinate the US manned spaceflight program. It centrally manages space flights from point of launch until landing. Flight controllers and other support personnel monitor all aspects of the mission using telemetry and send commands to the spacecraft.

Fig. 3: Centralized planning is a key element of digital twin technology.

A key element of digital twin technology in logistics is the centralization of all planning and dispatching units. Instead of planning independently at a local level, centralization unlocks synergies across the entire network of cement plants, terminals, depots, and, of course, planning teams. A centralized customer service office can be located close to any urban hotspot with a high density of top talents. Instead of dust, heat, and noise, centralized offices offer a call center atmosphere, which in turn attracts more female staff. Like in many traditional industries, female workers are hugely underrepresented in the cement industry. This hurts even more, since research has shown that gender-balanced teams outperform homogenous teams by means of productivity and financial performance.

The Dusty Road to Digital Twins

The Lunar Roving Vehicle (LRV), or simply called the "moon buggy", was a battery-powered four-wheel vehicle used in the last three missions of the Apollo program. LRVs allowed the astronauts to explore beyond their landing site, although the non-rechargeable battery limited their range. It marked the beginning of a new technology to overcome many challenging problems for which there was no precedent in vehicle design and operations.

Logistics and IT have come a long way since then. And when it comes to planning and optimization, digital twin technology goes far beyond traditional tools. Moving forward, there is more to explore and discover for the bulk materials industry. Artificial Intelligence and Machine Learning are about to further enhance the decision-making quality of the planning software. Semi-autonomous vehicles and trucks equipped with platooning technology will hit the logistics industry soon and on-site charging terminals or battery swapping stations for electric trucks may become a common sight at many cement plants. And undoubtedly, connected vehicles will transform mobility soon. The next generation of telematic systems will feature vehicle-to-vehicle and vehicle-to-infrastructure communications, allowing trucks to exchange data between nearby vehicles as well as roadway infrastructure. This has the potential to move telematics for digital twin technology from data capture and reporting to on-board actions based upon real-time conditions.

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SHIFTING THE DYNAMICS OF WORKFORCE MANAGEMENT

Algorithms are a major efficiency driver for logistics assets in the cement industry. But many producers still lose traction when it comes to create optimal shift schedules for their human assets. This article will explore latest developments and technology in workforce management and discuss how they can be applied in our industry.

In the old days, shifting gears was hard work. Back then, commercial trucks came with unsynchronized manual transmissions and drivers had to use a method called "double-clutching" to prevent damage to the vehicle's gearbox during shifting. It took some timing and practice, and it came at the expense of extra work for your left leg. Today, auto-shift gearboxes are commonplace in heavy trucks, and changing gears requires virtually no effort at all from drivers. However, when it comes to manage shift work, many manufacturing companies still use old technology that is neither suited to synchronize the competing interest of employee needs and operational objectives, nor provide the planning comfort or intuitive logic of the latest workforce management tools. This often results in expensive overtime, non-productive idle times, lower employee morale, poor customer service, and, worst case, loss of production. Failing to adequately schedule your workforce can become extremely costly in the long-run. Before we'll review some potential application areas and benefits within the cement industry, let's take a look under the hood to explore the basic technology that powers the latest workforce management tools.

Fig. 1: Shifting the dynamics of workforce management.

DI Technology

Not all gearboxes are built the same and that is why there's a myriad of different and sometimes confusing brand names out there. The same applies to workforce management: Rostering, staff scheduling, employee logistics, shift planning, resource planning – almost every organization has a different term and approach to this. Employee logistics, however, is quite a fitting term since the latest workforce management tools are based on the same technology that has been deployed in the building materials industry for over two and a half decades to optimize the use of logistics assets: Operations Research (OR) and algorithms. In the mid-1990s, Redlands in France (now LafargeHolcim) was an early adopter in the aggregates and ready-mix business. Six years later, Hanson Australia (part of the Heidelberg-Cement Group), followed. Both have been using algorithms, real-time information, and automated decision-making to run their fleet of trucks ever since.

But even if there is a large number of petrolheads among your workforce, human specs are quite different compared to trucks and other logistics assets. While the logistical processes of a cement producer are usually programmed into the transport optimization software, workforce management tools need to be more flexible to accommodate the requirements of human assets. With so-called Deductive Intelligence (DI), the representable logic and structure remain flexible. This allows experts to easily formulate requirements without touching the programming level.

Human specs are quite different compared to trucks and other logistics assets

Deduction is an important area of Artificial Intelligence and many AI systems rely on deduction to solve problems. With this top-down logic, conclusions are reached by applying general rules to observations. Or as the Greek philosopher Aristotle, considered by many to be the father of deductive reasoning, would say: "All cars with manual transmission have a gear stick. My car has a gear stick. Therefore, my car has a manual transmission." Workforce management tools equipped with DI technology enable planners to easily weigh factors according to their priorities, e.g. by costs, service level, shift ergonomics, or employee satisfaction.

With this unique technology in mind, let's review some potential application areas and benefits within the cement industry.

Central Shifts

A transmission control unit is a device that controls modern electronic automatic transmissions. It centrally collects vehicle data and by evaluating information

Fig 2: DI technology for workforce management.

about speed, acceleration, road grade and torque demand, it applies extreme precision to every shift. In contrast, shift scheduling in the cement industry is often managed by local teams and within their specific departments, e.g. logistics, manufacturing, maintenance, R&D, etc. Some are lucky enough to have an ERP system to support them, but many still rely on MS Excel or, let's face it, pen and paper. This silo approach has its limitation, including the fact that shift leaders are experts in their field of expertise, but usually lack the time and skill set to create optimized shift schedules. A centralized tool equipped with DI technology can analyze a larger range of variables than the human mind is able to, resulting in better overall decision quality. What's more, it finds the best possible balance for all legal, operational, and individual requirements.

But centralized scheduling does not stop at the gate. It can span over several cement plants, quarries, depots, terminals, and integrate other verticals like concrete batching plants. Again, transport planning in our industry can serve as an example: centralized planning has been an integral part of the truck fleet optimization cases mentioned above – driving synergies and unlocking value across all corners of the business.

Flexible Shifts

Fully-loaded trucks are slower to accelerate than cars, take up more space for maneuvering, and need more time to come to a stop. The same rules apply in the corporate world: The larger the business, the slower the movement. Traditionally, many cement producers use rigid shifts and simple rotating patterns, e.g. week one early shift, week two mid-day shift, week three night shift. Rotating shifts are popular among shift managers since they can be managed easily by spreadsheet tools. However, they do not cater for the shifting needs of a younger workforce generation [see ROADMAG 2018/19, page 30, "Born digital"]. By 2025, millennials will make up 75% of the global workforce and our industry needs to find ways to be attractive for this digital-savvy generation. One thing they take for granted are flexible schedules that help them to achieve a healthy work-life balance.

Flexible shifts are a nightmare for any shift planner, but with software tools based on OR and algorithms, more granular start, break, and finish times can be assigned to each individual worker, while keeping the overall staffing at an optimized level and in-sync with targeted production goals.

Seasonal Shifts

In cold weather, the effort it takes to shift gears can increase due to the higher viscosity of the transmission fluid. This may result in higher wear and tear of the components. When tem-

peratures drop, cement producers are faced with the prospect of lost time due to employees who call in sick. But warm weather also places its challenges onto the workforce planning process. A summer vacation schedule that everyone can live with is hard to find. The legal position on this is clear. In most countries, cement producers are legally entitled to restrict annual leave for their staff, e.g. at high-peak periods. And they can also tell their employees to take leave at certain times, e.g. at a planned kiln or plant shutdown. But beyond these legal guidelines, key priority for any employer should be to ensure that they find a fair and consistent solution for everyone involved, that also meets the staffing requirements and shift demands.

The dilemma starts with finding a consensus on which criteria vacation requests will be approved or denied. 'Seniority', where long-term employees get a first pick of the most wanted days/weeks, is a classic example. Or employees with school-aged children might have a higher priority during official summer holidays. You cannot please everyone, but software tools powered by algorithms allow you to add more constraints to the calculation, e.g. social factors, and provide a higher level of transparency at the same time.

Evaluating Shifts

An electronic logging device, also called E-log, is a piece of hardware that is installed on an engine to record a truck driver's hours of service (HoS). An E-log cannot be tampered with and it provides full transparency between drivers, hauliers, and shippers. In manufacturing environments, time and attendance systems are used to track when employees start/stop their work or take a break. Some systems also allow to record the type of work they carried out. Time recording data needs to be managed and evaluated to process the payroll. Shift work with its many different allowances and premiums, however, is prone to inaccuracies. Add overtime or paid time-off compensation to it and there's enough reason for workers to throw a spanner into the payroll works.

Payroll errors can be very costly and time-consuming to rectify. What's more, a single mistake can erode trust. Integrating workforce management tool and payroll software helps to reduce the amount of work required for the time evaluation process. This approach allows to automatically assess and correct deviations that fall within a specified tolerance range. Only cases outside this tolerance range need to be evaluated by the payroll accountant, while the system takes care of the routine work.

Fig 3: How to avoid throwing a spanner into the workforce planning process.

Technology Shifts

More than thirty years after its debut, Excel is still an important cog in the wheel of many cement producers. And it is no secret that workforce planners and accounting professionals are among the most loyal users of the iconic spreadsheet program, mostly because it is easy to configure. But technology has evolved dramatically over the years and when it comes to create complex shift schedules, even the best macro cannot compete with an optimization engine powered by algorithms.

Instead of clinging to ageing processes and tools, transformation is needed for cement producers to survive in a world of IoT and Industry 4.0. Producers who are content with their status quo and hesitate to invest into latest digital planning tools, can find further advice from Henry Ford, who shifted America's Industrial Revolution into overdrive: "If you need a machine and don't buy it, then you will ultimately find that you have paid for it and don't have it."

First published in "International Cement Review – December 2019"

DIGITALIZATION IN LOGISTICS – SHINY CHROME OR SOLID BASE?

Fig. 1: Cement distribution – digital or dazzling?

A paintjob is only as good as its foundation. The same applies to any digitalization project. Spraying bright and shiny technology over a company's existing IT infrastructure and business processes will lead to poor quality and costly rework. This article looks at the different layers of digitalization in logistics and discusses how they can be applied in our industry.

When it comes to painting a car, any automotive expert will tell you the same thing: it's all in the preparation. Whether you're repairing a chip or spraying the whole car, prepping can make or break a paintjob. Selecting and applying the right primer ensures better adhesion of paint to the surface, increases durability, and provides additional protection for the body of the car.

When it comes to digital transformation, all too often companies are using the latest technology to try to give their traditional products and services a facelift. However, not understanding the different layers of digital transformation can lead to "delaminated" processes that do not adhere properly or may give the entire project a dull and unwanted finish.

Digitalization in its simplest form refers to taking analog information and encoding it into zeroes and ones so that computers can store and process such information, e.g. scanning a paper proof of delivery (POD). Digitalization in a wider form is making processes digital, e.g. using mobile apps to create an electronic proof of delivery (E-POD). Digital transformation, in contrast, is quite distinct from digitalization. It is, for example, about using E-POD data in real-time and feeding it into an intelligent transport planning tool that automatically updates the entire truck delivery schedule; or providing it to customers in real-time for their downstream optimization processes.

Digital transformation typically includes several digitalization projects, but cement producers who believe they can neglect the preparation work are making a profound strategic mistake. To help you prep like a pro, the following paragraphs will give you some insights into the basic techniques, show you how to avoid common mistakes and offers insider tips that give your cement logistics a truly digital finish.

Prep Work

Sanding a vehicle's body is a time-consuming, and let's face it, boring process. But it is one of the most important parts of paint preparation, thus time well spent. It takes several stages of sanding to get the surface straight, smooth and ready for paint to be applied.

The equivalent of sanding in digital transformation is data management. Sounds simple, but many digital transformation projects fail due to lack of data quality. The daily grind of data entry is a tedious and error-prone activity across all big organizations and many lack the necessary processes and integrations that contribute to robust data consolidation. Some departments store or even hoard information, leaving it inaccessible to the rest of the company. But even when information is shared, people see things from their perspective, and they are likely to make decisions that protect their interest.

Wet sanding can produce amazing results. The same is true for KPIs. They help to identify negative trends in performance, and subsequently costs, and allow companies to take corrective action at an early stage. There is no absolute, or objective, right or wrong KPI. Good KPIs, however, have one thing in common: they fit the purpose and tie in with your company's goals and objectives. And all departments across the company should have the same understanding of a particular goal or objective. Latest software tools make it easy to share information and get everyone on the same page. But don't be fooled into thinking software will cover up small scratches or marks - it won't. Before you apply any "digital layer" you need

a perfectly smooth data surface. What's more, touching up and polishing your data and KPI management is a never-ending process.

Priming Layer

Primers are sometimes referred to as undercoats, sealers, surfacers, or adhesion promoters. Compared to paint, a primer is not intended to be used as the outermost durable finish. Instead, it can be engineered to have improved binding properties with the material underneath.

Digitalization affects many aspects along the supply chain. And depending on what needs to be achieved, different "digital primers" are available that are either tailored to suit a specific problem or cover a wider range of goals, e.g. route planning, telematic systems, track & trace, E-POD, mobile apps, self-check-in gates, online ordering, yard management, dispatch automation (see figure 2).

As a first step all these measures are great and needed. But with all first steps there are limitations on what can be achieved. Much of the focus is on digital and not so much on transformation. Equipping the vehicle fleet with telematics systems in order to allow customers to track and trace the whereabouts of their cement or ready-mix delivery has become a standard in our industry and is an excellent service offering. But while tracking a single delivery provides temporary information for a customer and transport planner, it offers no deeper insights on what any delay might have on the customer's follow-up orders, let alone what impact a single delay can have onto the orders of other customers or the delivery schedule of the entire truck fleet. Worse, order tracking without deeper insights might induce time-consuming calls from anxious customers when they see that their delivery got stuck in traffic.

> Touching up and polishing your data is a never-ending process

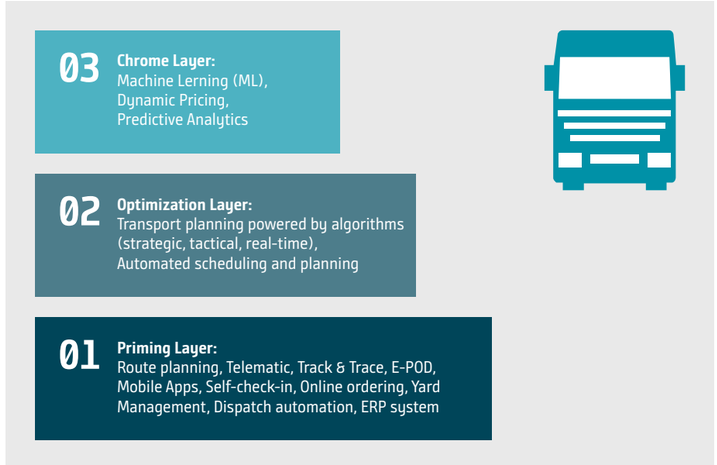

Fig. 2: The Three layers of digital transformation in cement logistics.

More than any other job, being a transport planner brings a tremendous amount of pressure and stress. And when it comes to updating an entire delivery schedule in real-time while juggling with Adhoc orders, the tools of the priming layer are not enough to support the decision-making process.

Optimization Layer

Automotive paint must withstand extreme conditions over the course of its lifetime. It needs to endure scratches, gravel, bird droppings, UV radiation, salt, hail, heat and cold. To make sure the paint holds up to this level of stress, paint manufacturers have optimized and standardized their formulations.

In cement logistics, optimization is neither a standardized process nor a constant. A look into the paint pot reveals that logistics software vendors typically use three different types of additives to enhance their performance: spreadsheet macros, pre-defined business rules, and AI algorithms.

Macros are sufficient to support the decision-making process of transport plans with low complexity and low unpredictability. As complexity rises, predefined business rules provide better results. But substantial gain in speed and quality will only come from AI powered optimization tools that are embedded into a wider digital supply chain. They allow transport planners to do incredibly complex, time-critical calculations with ease. What's more, algorithms can process a larger range of variables, e.g. customer/contract profitability, working time directive (WTD), product volume targets, or haulier contracts.

Again, using telematics to collect HOS data from a driver is digitalization; feeding this data into the optimization tool to improve the quality of the entire delivery schedule and to provide a means to comply with legal requirements is digital transformation.

Fig. 3: The formula for failure in digitalization.

Using an online platform to assign jobs to hauliers instead of phone or fax is digitalization. Connecting that platform to the optimization tool to automatically select the best haulier for a job based on a multitude of different criteria is digital transformation.

Using yard management and dispatch automation to control the flow of trucks and goods in and out of a production plant is digitalization. Using time stamps from gates, weighbridges, and loading stations to optimize the use of all logistical assets within and outside the plant is digital transformation.

Chrome Layer

Chrome trims and accessories turn every truck into an eye catcher. It is highly decorative yet extremely corrosion and wear resistant. Chrome spray paint is often used to give vehicles a faux chrome finish.

Software vendors offer a couple of other digital tools that can further enhance the quality of the logistics optimization process. But like faux chrome, some tools add little value. Others, however, can provide a truly digital finish to cement distribution.

A Machine Learning (ML) platform can be connected to the optimization process to further enhance the decision-making quality of the system. Looking at huge amounts of data from the past, ML can analyse the order behavior of each individual customer and identify patterns: when and at what time did the customer confirm or cancel the order? What was the additional volume that the customer ordered? What is the likelihood of cancellation and what is the typical lead time before cancellation? The overall goal of this exercise is to fine-tune the truck capacity planning (pre-planning) for the upcoming shifts and days: At which plants will I need more trucks? Where should I reduce the fleet capacity? This avoids idle trucks and excessive delays due to insufficient resource capacities.

Algorithms form also the backbone of any dynamic pricing scheme. Dynamic pricing is a strategy in which businesses set flexible prices for products and services based on current market demand. Price changes may take into account supply and demand, competitor prices, and other external factors in the market. Each industry takes a slightly different approach based on its needs and the demand for a product. One goal is often to increase profit generated from a specific customer. Optimizing the utilization of logistical assets and capacities, however, is a goal that is more relevant to our industry. Or in simple terms: increase prices when demand is higher than loading capacity (e.g. long truck queues in front of the gate) and/or use incentives to increase demand when loading capacity utilization is low (i.e. idling loading stations). In essence, it is about breaking the old trade-off between upgrading plants to cope with peak demands and facing customer complaints for poor service.

Automated Painting

Automated painting is a standard practice in the automotive industry. Industrial painting robots are able to flawlessly and consistently produce a high-quality paint finish. But ensuring that they are deployed effectively still requires human hands – and minds.

The same is true for cement logistics. When dispatchers are supported by algorithms or AI software, they produce higher quality results than any one of them working alone. This process is less about technology. Real digital transformation requires change at a deeper level. It is more about understanding how to use and interpret data and technology so that it shifts every layer of the business.

As stated earlier, spraying bright and shiny technology over a company's existing IT infrastructure and business processes will lead to poor quality and costly repair work. The simple formula in figure 3 sums this up.

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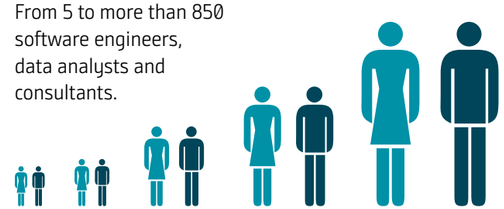

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