

Model builders



The development of the South Flank iron ore mine was a great example of modular construction methods, where Mammoet used its transport expertise to deliver over 1,000 oversized items to site safely and on time (credit: Mammoet)

Mining project delivery is being measured by more than just schedule and cost, with successful specialised EPC/EPCM firms making important contributions that go way beyond design and construction. Dan Gleeson finds out how several providers are proving themselves in this complex environment

The three or four letters usually associated with the specialised companies involved in mine design and building do not sum up the lengths these firms go to on behalf of their mining company clients.

By playing in the engineering, procurement, construction and management services game today, contractors have to engage with a mining project throughout the lifecycle.

Drafted in as early as the prefeasibility study stage, these specialists are often used as a sounding board when looking over, for instance, Whittle-optimised pit shells, exploration data and transport infrastructure plans. At the same time, the designs they recommend are expected to continue to bear fruit for the miner and its stakeholders beyond the life of mine, whether that is community projects, the development of local supply chains or open-pit rehabilitation programs.

As projects get more complex and skilled personnel able to advise on coping with such complexity fall in number, the remit of EPC/EPCM firms and the industry's reliance on these specialists are only going to grow.

Early engagement

One of the ways to navigate the increasing number of conditions and requirements placed on modern mining companies developing projects is

to engage with these firms as early as possible.

Leonardo Kaid, Vice President, Head of Global Business Development & Strategy, **Fluor Corporation**, said early engagement is an increasingly critical factor, not only given the growing complexity in terms of ore characteristics and the orebody itself, but also with the introduction of new power strategies and technologies – both mining-specific and disruptive – that need to be factored into development.

“Opportunities derived from all these factors are unique to each project, interrelated and therefore dynamic,” he told **IM**. “During study stage, leaving no stone unturned in the entire mining and process chain allows for solid assessment and selection of process technology and equipment, plant layout and design, power sourcing and a fully integrated digital platform.”

Other examples Kaid mentioned of where contractor involvement at an early stage pays off include leveraging the same tools used for underground resource evaluation to help locate facilities and plot site layouts; providing input on access road design to accommodate not only the movement of workers, supplies and concentrate, but larger construction modules; and carrying out project optimisation ahead of regulatory submissions to alleviate issues with amending licences down the line.

The latter is a point picked up by David Meadows, Global Manager of Metallurgy at **Bechtel**, who says the need to engage with contractors early in the process reflects the timelines required for permitting mines today.

“There was a period where we would get a project at the detailed engineered stage, execute the project and that would be it,” he told **IM**. “But we now want to go back in earlier in the process, stay with the customer, work with them on solutions and develop these quality projects, while adding value at every stage by providing experience, design knowledge, project execution, benchmarking and innovative approaches.”

The key to this success hinges on getting the “construction viewpoint” established in the study phase, according to Meadows.

“Other EPCM companies can do great designs, but there is not always the construction aspect integrated into it,” he said. “That is what we, at **Bechtel**, pride ourselves on.”

Hatch has promoted the value of “front end loading” a mining project since its early days in civil tunnelling to improve delivery outcomes, according to Rick Collins, Director of Mine Execution Projects.

“In this way, we can influence decisions around methodology, selection of equipment, technology and contract styles as well as the key human resources aspects, all of which are integral to successful project outcomes,” he told **IM**.

This is where engaging project experience and expertise – including suppliers and contractors, as well as mining EPC/EPCM firms – during the feasibility phase helps.

“As well as design definition and basic engineering, this is the stage where the

execution plan is defined and fixed,” Collins said. This, in turn, informs the procurement strategy as well as the capital cost estimate and project schedule.

And this is even more important in today’s market environment.

“During heated market cycles, procurement lead times lengthen and there is often a value case to be made for early works commitment to project planning, equipment selections and engineering during the feasibility phase,” Collins said. “Clearly this necessitates a risk/reward analysis and decision process by the project owner.”

Janne Tikka, Head of Mining & Metals at **AFRY Process Industries**, said the company’s clear phased approach to investment project development, plus its experience leveraging new technology in other industries within the Nordic region, mitigates the apparent risks of bringing innovation to mining projects.

This, he said, involves “careful decision steps, design and pilot testing the flowsheet already in the prefeasibility study”.

Similarly, Steve Rusk, Mining Vice President at **Stantec**, says emphasising safety and constructability considerations in the project design phase, along with early engagement of construction companies, provides tangible positive outcomes for the mine’s development.

“Engineering for risk mitigation” is a common practice he has seen when working on projects, for example, carrying out some work traditionally associated with front end engineering and design stages earlier in the process to ensure the designs are sound before agreeing on budgets and timelines.

“The key is to apply the right level of engineering to have confidence in the outcome while managing the time available,” he told **IM**.

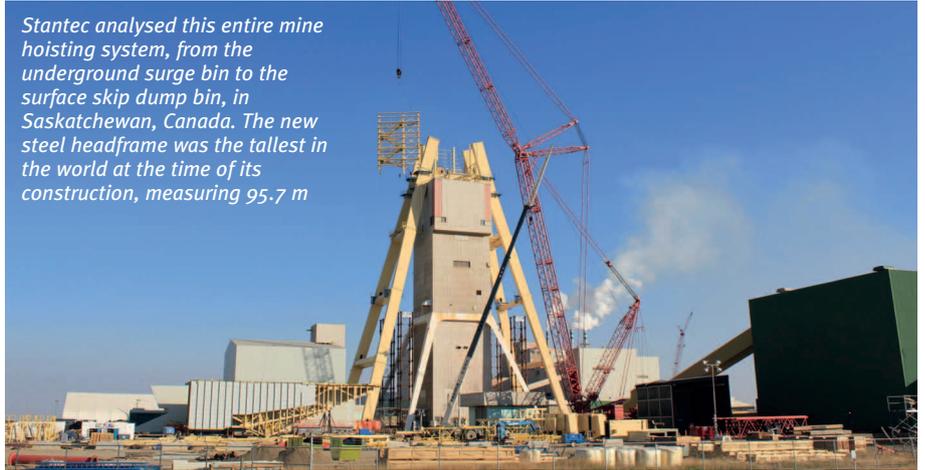
“The earlier we get involved, the more impact we can have without needing to spend extra budget on design changes later in the process. The right knowledge at the right time minimises the risk around assumptions.”

Wood has built out a mining consulting group comprised of technical experts to specifically work with mining clients at the earliest stages of project development, according to Michael Woloschuk, Vice President, Global Business Development & Consulting, noting: “In mining projects, there is a lot of value to be gained or lost at conceptual levels.”

He illustrated this with an example of the work Wood has carried out with IAMGOLD at the Côté Gold project, in Ontario, Canada, an asset that will leverage high levels of automation and is due to produce 493,000 oz/y (100% basis) of gold over the first five years of operations when it starts up – expected in the second half of 2023.

“Beginning with work on the initial scoping

Stantec analysed this entire mine hoisting system, from the underground surge bin to the surface skip dump bin, in Saskatchewan, Canada. The new steel headframe was the tallest in the world at the time of its construction, measuring 95.7 m



study in 2011, we have worked closely with IAMGOLD all the way into execution, helping to identify more than \$450 million of improvements in net present value,” he said.

Risky business

Long-term partnerships such as the one referenced by Wood’s Woloschuk are rarer than many would think; reflecting the way the market has evolved in recent years.

In the decade since Wood commenced work with IAMGOLD on the gold project in question, the miner-EPC/EPCM contractor dynamic has changed.

After a spate of projects commissioned during the most recent boom suffered cost and schedule blowouts, many ‘burnt’ miners looked to offload the execution risk that comes with mine development onto contractors, selecting a model resembling a fixed-price, turnkey EPC project. This saw the onus placed squarely on the contractor to bring the project in on time; being rewarded with a ‘carrot’ for timely delivery that was in line with the budget and hit with a ‘stick’ for delays and capital expenditure overruns.

This shift in market sentiment moved many in the contracting game towards such a model, with

competitively priced bids that reflected lower commodity prices and a sparse project pipeline.

This may have delivered projects on time and budget, but it was not a sustainable choice for all market participants.

In the throes of another supposed commodity boom and guided by market pressures tied to sustainability, this dynamic has further evolved.

Kaid explained: “Over the recent years, we have seen competitors back away from high-risk contract models, which demonstrates that a project is most successful when all involved parties jointly work towards established value-driven objectives, rather than offering the lowest price with unacceptable project schedule and cost risk.”

For Fluor, the “partnership model” will always provide the highest value to the full lifecycle of an operation, he added.

“The most cost-effective approach to project execution is for the risk to reside with the partner that has the expertise and ability to manage such risk, and the associated financial impact,” he explained.

Collins has witnessed the same evolutionary process in the major projects Hatch is involved in.



Wood’s Michael Woloschuk says the company’s work with IAMGOLD at the Côté Gold project, in Ontario, Canada, starting in 2011, has helped identify more than \$450 million of improvements in net present value (credit: IAMGOLD)



Teck Resources' QB2 project comprises a 143,000 t/d copper concentrator, a high-capacity desalination plant and a 165 km water supply pipeline (credit: Teck Resources)

"In the mining space on major projects we are trending towards integrated project teams where the owner supplies expertise in areas where it has the best local knowledge and experience – ore reserves, geomechanics, indigenous agreements, government relations, etc – and Hatch supplies project delivery disciplines such as engineering, project controls, procurement, construction management, quality assurance, commissioning, etc."

Stantec's Rusk said the market has taken some time to find its feet with this type of model, struggling to comprehend what it meant for running their businesses and serving clients.

"We were on a learning curve on how to operate in a partnership," he said.

The business model has since been embedded within the offering of major providers, with the underlying delivery mechanisms established.

"We've been delivering on more partnership projects, to the point where we can now approach clients and offer our services including partnership elements," he said. "Stantec continues to work with our clients to learn and improve on more cooperative and integrated project delivery."

Like most major providers in the space, Wood leverages a variety of contracting models to provide commercial flexibility, but Woloschuk said its most successful projects are those where execution strategy has a "balanced risk/reward between contractor and owner".

Like Hatch, Wood often works with "a true integrated project team" where all stakeholders are incentivised to deliver projects safely, on time and on budget, he added.

While AFRY's Tikka argues the EPCM model remains the most cost efficient and technologically robust method for mining projects today, Bechtel, in response to demand in its core mining and metals markets, is highlighting the benefits of a direct hire, integrated EPC execution model whereby the prime contractor has all the controls and tools

necessary to influence the final outcome.

Ailie MacAdam, President of Bechtel's Mining & Metals division, explained the rationale for this move at the *CRU World Copper Virtual Conference 2021* in April.

"Our shareholders are seeking ways to guarantee project outcomes and avoid costly surprises and our communities are expecting to be consulted and included in the success," she said. "For these reasons, we're extending our strategy beyond innovation, capital efficiency and execution to delivery models that ensure that our company can control the outcomes of our projects and meet the high expectations that our customers have for our work."

The direct hire, integrated EPC execution model has been deployed around the world and has delivered "tremendous results in key sectors including those that are already part of the energy transition such as liquefied natural gas", MacAdam said.

Bechtel's Meadows said the model – or parts of it – have proven successful on major projects such as Antofagasta's Los Pelambres Marginal project and Teck Resources' Quebrada Blanca Phase 2 (QB2) copper project, both in Chile.

The former involves a concentrator plant expansion with the addition of a grinding line with a SAG and ball mill, a flotation line and the expansion of the existing stockpile to increase throughput by 40,000 t/d; a 400 l/s desalinated water production system; and a 65 km desalinated water transport system.

Similarly, QB2 comprises a 143,000 t/d copper concentrator, a high-capacity desalination plant and a 165 km water supply pipeline.

This model – which includes a partnership element – is not the only one Bechtel will offer clients, but it is the one that best leverages the company's skillset, according to Meadows.

"We are still guided by the customer's specific preference, yet Bechtel is very well setup in terms of implementation of projects, execution and construction to deliver on this model," he said.

"Where Bechtel does differentiate itself is the ability to pull everything together with a single level of accountability. If you look at QB2, for instance, there are many different components to

handle, it has a well over \$5 billion scope; you have the port, the concentrator, pipelines, tailings dam, etc.

"A company like Bechtel has the ability to manage and pull all that together into an integrated scope, where only a few in the EPCM space have such capabilities."

Growing scope

As project complexity has increased, so too has the contract scope for these key mining service providers.

For Bechtel, this has seen the company look beyond its traditional concentrator focus to water services, power infrastructure and more.

"The difference between now and where we were 10 years ago is the scope has grown beyond simply the concentrator," Meadows said. "Back then, the concentrator reflected 40-50% of the upfront cost on projects in remote locations. It now represents – on similar projects – something closer to 20-30%, with water and the power infrastructure side of things taking up more of the budget."

In the future, should dry stacking of tailings become embedded in the mining industry process flowsheet philosophy, Meadows sees Bechtel providing dry-stacked tailings solutions, too.

"If we go to dry-stacked tailings, we could leverage our geotechnical and conveying expertise to bring this element under our control," he said.

For Hatch's Collins, the increasing number of mining company obligations related to safety, community interface, permitting and environmental sensitivities – on top of the complexity in accessing orebodies – has resulted in clients relying on a wider spectrum of its professional services.

"Hatch, as an example, has grown dedicated practices in community engagement, government affairs, indigenous relations, environmental, advisory and climate change," he said.

And these rising number of services are increasingly being leveraged past the traditional mechanical completion and handover point.

"We are now actively involved in commissioning planning, start-ups and ramp ups; roles that traditionally were owner led," he said. "Hatch has a unique practice in 'Operational Readiness' professionals who help our clients prepare to operate, including the training of staff and commissioning of operational tools and systems."

Wood has also expanded its remit in line with the growing list of project considerations, according to Woloschuk.

"At Wood, we are focused on delivering our clients green-to-green objectives across the asset lifecycle," he said. "While the industry's need to incorporate local stakeholder engagement and

build strong partnerships are not new concepts in mine project development, we are seeing greater interest in the adoption of renewable energy and innovative solutions driven by a social licence to operate that will responsibly enable this sector to provide the metals and minerals needed for a sustainable future.”

The company, for example, is currently engaged with a major diversified miner to support its energy transition goals by implementing green hydrogen technologies.

Delivering with digital

The EPC and EPCM providers have been aided in serving these new client demands with an assortment of tools including digital twins, 3D modelling, automation, machine learning and other innovations.

Many such products are available on the market for miners to use themselves, but innovative mine builders are increasing their value proposition by turning them into fit-for-purpose solutions that could potentially be used beyond project delivery.

Hatch, for instance, has developed and deployed a series of integrated tools to improve construction and development outcomes referred to as “Digital Project Delivery”.

This offering allows the company to create a 3D model of every asset and commodity in the project, which are mapped to supply contracts and installation work packages. Additionally, it is able to carry out construction simulation to shorten the overall schedule, maximise workforce activity and minimise indirect costs.

“These tools and workflows have proven to reduce the overall cost and schedule of complex mining projects,” Collins said, adding that they come on top of technologies to support underground safety, improve underground communications and use short interval control systems.

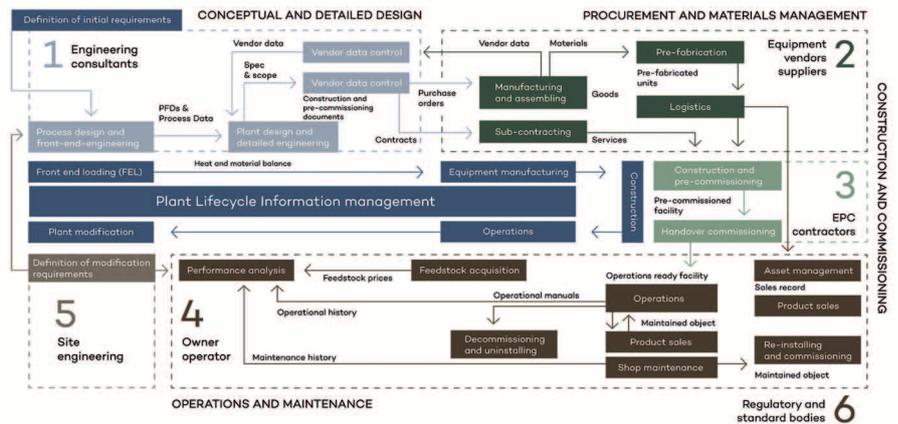
Hatch is also readily using digital twins to augment mine operators’ decision-making process.

AFRY’s Tikka said his company is creating and using digital twins/models that ingest operational and technology data, as well as factor in the project’s digitalisation strategy roadmap.

“By establishing this engineering technology digital twin model, companies are able to move towards full digital twin operational data integration supported by artificial intelligence and machine learning,” he said.

This requires a collaboration on data to alleviate any interoperability issues that might arise during project design and construction phases; a process that involves multiple parties and systems. This has seen the company build relationships with clients and fellow contractors

Plant Lifecycle



to provide a ‘true’ digital twin of the asset in question.

Fluor’s Kaid agrees that data needs to freely flow throughout a project ecosystem for a digital twin to become valuable.

The company is also using AI to continuously assess the health of a project, thereby identifying any deviations and opportunities from a project’s baseline for immediate mitigation, helping shorten overall project schedules, according to Kaid.

“Such technology has proven to be highly effective in managing disruptions to construction schedules that were driven by the pandemic over the past 18 months,” he said. “As such, we were able to re-sequence tasks, reallocate resources, adjust staffing levels and reorganise shifts with minimal impact on project cost and completion dates.”

This type of digitalisation and systems integration is becoming a ‘normal’ part of Stantec’s business, according to Rusk.

“For example, years ago, virtual reality (VR) was a cool, new technology,” he said. “Now, it’s a regular component in our work. And we’re seeing that demand from our clients. It’s an expectation that we work efficiently with technology and help them implement new technologies.”

This expectation sees the company regularly provide VR reviews of projects with clients, where Stantec engineers use VR headsets and go into the ‘virtual mine space’ alongside clients (also using VR headsets) to provide increased visibility.

“Our clients can be present in the model and ask a question about a component of the design, and our engineers can interact directly with them to see the same thing they’re looking at and answer the question,” he said.

By using digital tools, Rusk said Stantec can leverage the core functions of what the company does, providing more efficient design reviews and very powerful communication, particularly for non-technical audiences.

“If a picture is worth a thousand words, a 3D model is worth an encyclopaedia,” he said.

Wood has recently announced an alliance with

An example of complex data handover requirements across plant lifecycle stages (credit: AFRY)

AVEVA focused on accelerating the digital transformation of industries such as power, energy, chemicals and mining with the launch of a new solution called Connected Build. This solution, Woloschuk said, is a key part of the company’s digital twin offering.

“Connected Build optimises project delivery while improving collaboration on new build projects and facilitating the digital modernisation of existing plants and refurbishments,” he said. “The new solution capitalises on design efficiencies to deliver the build accurately the first time, unlocking sustainability and value benefits while ensuring worker safety.”

Modularisation

It is not only digital tools that are improving project outcomes, with the modular construction efforts at BHP’s South Flank iron ore mine in the Pilbara of Western Australia providing a great case study of where this construction trend can pay off.

This project, which was developed as autonomous ready with the ability to remotely monitor and control all aspects of daily operation from a remote operations centre in Perth, saw Mammoet use its transport expertise to deliver over 1,000 oversized items to site safely and on time. In the process, it pushed transport possibilities to new limits, delivering a 349 t module comprising the train load out bin gate and HPU module for the 80 Mt/y project. This was the heaviest load ever carried along a 340 km stretch of Western Australia’s Great Northern Highway.

Fluor was the EPCM provider on this project, with Kaid explaining that some of the company’s biggest areas of focus in improving construction outcomes, to date, include the use of pre-cast, pre-fabrication, modularisation strategies.

Hatch’s Collins said pre-assembly and

modularisation of components are providing great value for the company's clients.

"On a recent mining project, we created an innovative approach to pre-building the floors in a headframe at grade and jacking them into final position," he said. "This saved months from the schedule and millions from the budget."

The company's pre-assembly design functions extend to mining machinery and shaft bottom equipment at collar level for lowering down shaft in single units, he added, whereby modular design and 3D modelling are used in tandem.

"We simulate this work in 3D to ensure feasibility and, in so doing, the work is ultimately conducted in a more productive and safer environment," he said.

Stantec's Rusk provided another value-generating example of modularised construction.

"We delivered a concept to construction production upgrade for a large underground operation where the design needed to include a significant increase in production capability with minimal impact on current operations, all while maintaining access to in-use common infrastructure," he said. "Innovation in design, including integrated safety and modularisation, along with early contractor engagement, paved a path to success for the client's operation."

Sustainable outcomes

All these elements and more are factoring into sustainable outcomes for mining clients that

align with their internal goals, while providing benefits to stakeholders beyond the design and construction phase of a project.

Despite widespread acknowledgement of sustainability targets in investor and stakeholder presentations, AFRY's Tikka said the industry is not wholly aligned in the direction of travel.

"At one end of the spectrum, there are these responsible companies representing both established industry players as well as junior companies that have access to prime funding," he said. These firms are striving to strictly comply with all the sustainability goals as per industry standards.

"Then there are these companies at the other end of the spectrum, often funded from countries and by institutions, that have not yet defined sustainability as a high priority," he said.

Regardless of where a client sits on this sustainability spectrum, Tikka said AFRY, as a sustainability consultant, always emphasises the required industry responsibilities in all client relations.

Fluor's Kaid said the market mining companies are operating in is more complex in terms of social, environmental and stakeholder aspects than a few years ago, and it is looking to lead the change in sustainable project delivery.

"As Fluor, we are present in a mining community for the duration of a project but always take the opportunity to leave a positive, long-lasting impact we can make to a region after

we handed over a project," he said.

The identification of local and regional needs and challenges is an instrumental activity in early project stages, according to Kaid. "This encompasses environmental aspects, community infrastructure needs and maximising potential for local content and upskilling the local workforce," he said.

Examples of such engagement beyond Fluor's core engineering and construction activities are water treatment facilities for communities, craft and skilled worker training programs, and improvement of local school infrastructure.

Woloschuk said the introduction of new technology and new thinking will be required to ensure the next generation of projects deliver on the sustainability promises the industry is making.

"Currently, the mining industry is facing challenges with rising costs, declining grades, ore deposits with more overburden and less infrastructure and, more complex metallurgical challenges," he said. "Driven by a stronger licence to operate, sustainability initiatives and cost factors, adoption of new technologies into today's mines will enable miners to better manage their use of energy, water, and emissions and build stronger partnerships with local stakeholders."

The relationships between mining EPC/EPCM firms and their mining company clients will be integral to enabling such a transition. 