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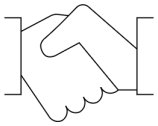
Mining capital trends and the value of more rigorous Feasibility Studies

Matthieu Dussud | June 21, 2022

Welcome and introductions



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3 critical factors are reshaping mining capital programs

High demand

High demand and several years of underinvestment combined are driving the heavy capex investment cycle

Supply deficits

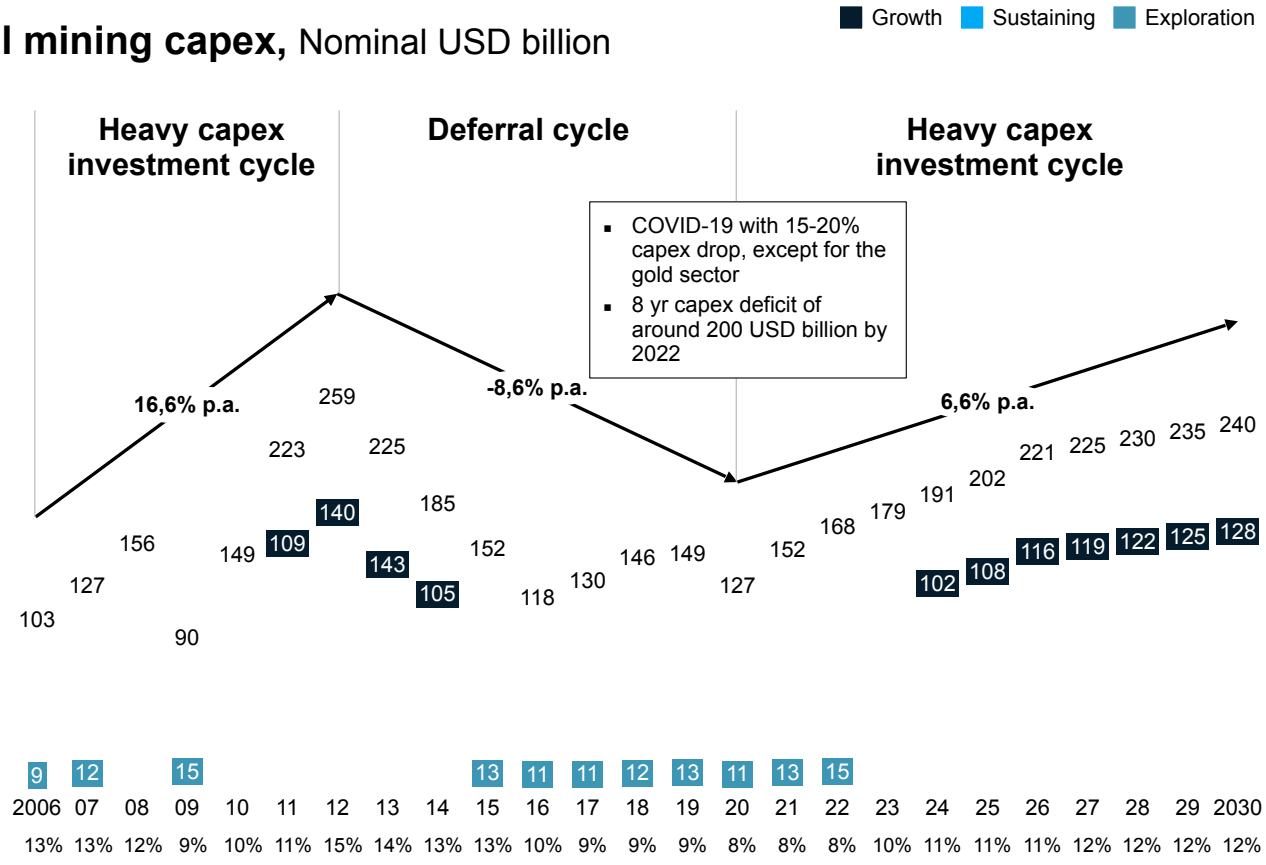
Supply deficits forecasts for copper, gold and nickel to a lesser extent will require capacity build-up across mining facilities

Inflation, manpower shortages & supply chain bottlenecks

Driven by global tensions and competition with “once in a lifetime global Capital Investments” of $130 trillion by 2027 to decarbonize and renew critical infrastructure

Heavy Capex investments to continue globally over next 5-7 years

Global mining capex, Nominal USD billion



Source: McKinsey BMI; includes captive thermal coal for power stations and captive smelters

1. Total annual spend in Canada expected by 2029: $18-25b (vs. $12b in 2022)

Canada's outlook

Mining capex: **10-15% increase per year**[1] resulting in ~$10-15B additional annual spend in next 7 yrs

Overall Capex (cross sectors): **C$1T of additional spend** in next 7 yrs

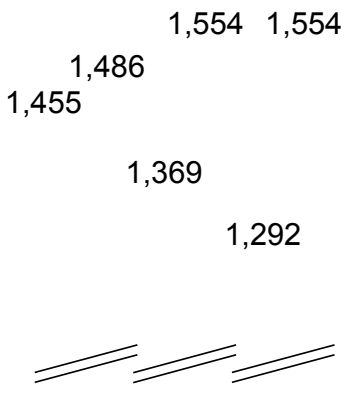
1-2 million additional construction workers required in next 7 years at current productivity levels (field productivity dropped by 1.6% btw 2019-20)

Material supply is mostly forecast to increase across materials to meet rising demand, with the exception of iron ore and gold

2030 forecast demand and supply, MTPA

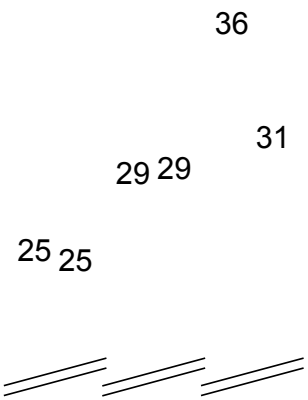
Demand Supply

Iron ore



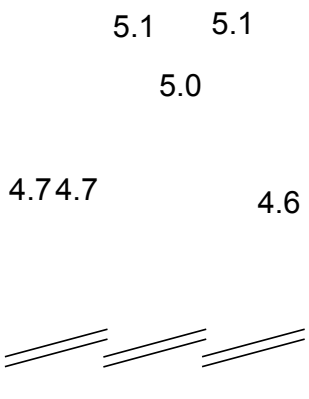
Seaborne market to be potentially oversupplied in the coming years; however, supply deficit in the high-grade iron ore market could occur

Copper



~6 Mt supply deficit forecast by 2030, however potential to close gap based on announced project capacity

Gold



To balance the market from 2025 onwards new supply is needed, either from scrap, early stage, or currently undiscovered projects

Nickel (class 1)

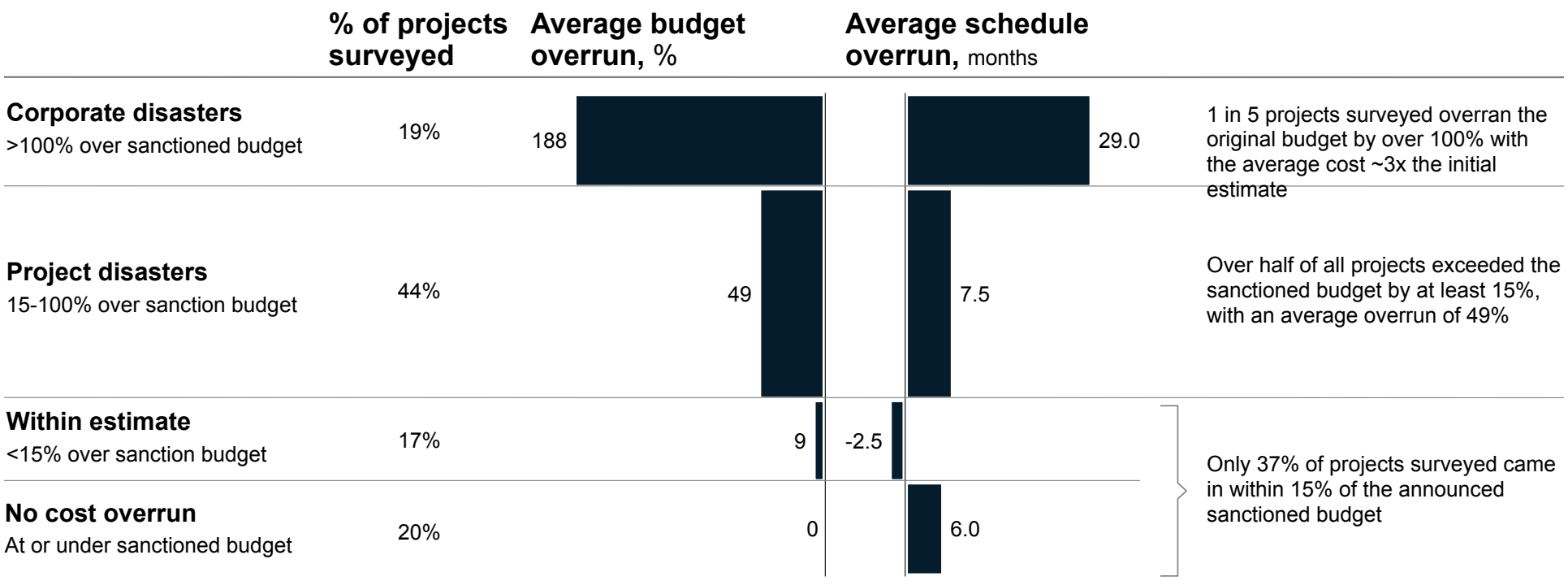
Despite decent project pipeline by 2030, there is a likelihood for shortage due to growing demand, yet limited additional development

Lithium

Developing new projects is needed in the longer-term to accelerating demand growth; unannounced projects expected to close gap

Putting recent headwinds aside, mining projects have a poor track record for on time and on budget delivery

A survey of 40+ mining projects[1] completed in the last 10 years shows an average overrun of 60% vs. metrics announced at Feasibility Study (FS)



1. 41 projects with Capex greater than $500m and completed between 2008-2018

Source: McKinsey & Company survey

A few holistic actions can help deliver a step change in project predictability, productivity and performance in tomorrow's market

☐ Focus of next section

Invest sufficient time in developing Feasibility Studies that reflect project complexities, de-risk execution and transition to operations

Build a collaborative ecosystem to drive end-to-end value and setting up projects for success across robust planning, right incentive structures and sharing of risks

Build workforce readiness and adaptability for future skills

Significantly accelerate engineering and construction productivity by reimagining delivery models and harnessing the full potential of digital and analytics

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Our research on tens of mining projects shows that studies are affected by Owner's shortcuts & structural issues with how the industry approaches FS

Key issues affecting mining feasibility studies

Blindsided management practices	FS (& PFS) are often driven by **artificial, self-imposed schedule constraints**; technical shortcuts are taken (eg. met. test work) and risks not fully assessed **Insufficient focus** placed on building a **strong, agile team** upfront	*International miner self imposed a tight deadline for an UG mine FS and left ~$500m NPV on the table; project was put on ice by investment committee*
Insufficient definition to guarantee predictable outcomes	**No widely leveraged standard criteria** for what constitutes a bankable feasibility study with sufficient maturity to ensure a narrow estimate band and predictable outcomes Studies **focus too much on technical systems** and insufficiently integrate grade & commodity price predictions, business objectives, project delivery, operations readiness.	*Major mining company delayed large project submission to its investment committee by lack of alignment between FS and marketing strategy and lost $100's million in NPV*
Misaligned mindsets & behaviors	Owners and EPCm **objectives are often misaligned**; the former look for maximum value, new solutions whereas the latter often provides "habitual" designs & equipment solutions **Transparency and problem solving are rarely observed** behaviors on FS teams	*Major mining EPCm gold plated a project design leading to suboptimal constructability and overall economics and forcing Owner to bring-in a 3rd party to improve value before sanction*

Source: McKinsey & Company mining capital projects service line

Owners can increase mining capital projects outcome certainty by implementing 8 key changes to their Feasibility Study practices

Deep dives next

1. **Establish a prescriptive standard for feasibility studies**, part of a broader stage gate process
2. Build in the Owner's FS approach, a **systematic and holistic value improvement step** to avoid gold-plating and maximize project economics
3. **Systematically leverage granular benchmarks** (incl. construction productivity metrics) to validate inputs and Capex / Opex estimates
4. Embed **construction planning, operations readiness & marketing strategy at every step** of project FS development to de-risk execution and operations
5. Invest time, efforts and management focus on **building and optimizing an integrated master schedule**
6. Design an **incentive scheme for the FS contractor to enable value-maximization**, out-of-the-box thinking and transparent mindset and favor relational contracting
7. Setup the **foundations of the project's contracting strategy early** during FS (identify partners, define contract scheme, negotiate terms etc.)
8. Build a **strong owner's team** with the right capabilities, mindset and behaviors

1. Owners must establish a prescriptive standard for feasibility studies, part of a broader stage gate process

Minimum checklist of prescriptive FS standards

- ✓ Ore body exploration and resource statement requirements (eg. as defined in NI 43-101)
- ✓ Requirement for site surveys, environmental & social studies and advancement of the permitting process
- ✓ Level of detail required for technology selection and test work
- ✓ Level of engineering development desired by deliverable type, extent of engineering reviews, (eg. preliminary Hazop, constructability, operability etc.), Material Take Off methodology by discipline (eg. as defined by AACE, ACostE, IPA or ASPE), and guidance for establishing design growth allowances
- ✓ Approach for developing contracting strategy and performing due diligences on potential E&C partners
- ✓ Desired level of project logistics definition, construction planning and operations readiness
- ✓ Capex and Opex estimating methodologies, desired level of firm quotes (eg. 80% of processing equipment and construction contracts in value)
- ✓ Methodology for estimating both contingencies and provisions for risks (eg. probabilistic range analysis)
- ✓ Definition of key input parameters, calculation methodologies and structure for the financial model and metrics for investment decision (eg. NPV, IRR, cash cost etc.)
- ✓ A process of independent, 3rd party reviews, integrated with a formal stage gate process

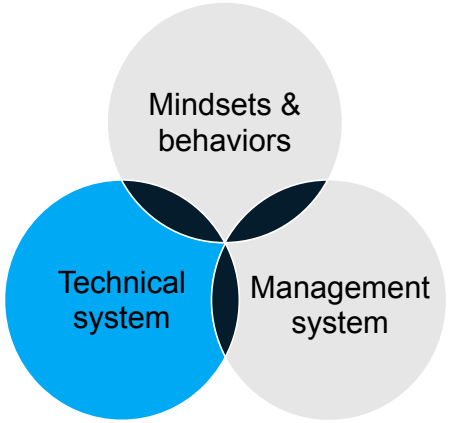
Mining project developers may design their own set of standards but could also rely on existing 3rd parties' processes when developing single asset (eg. AACE, IPA)

2. Owners and Contractors must enforce a systematic and holistic value improvement step at FS…

Focus of the effort

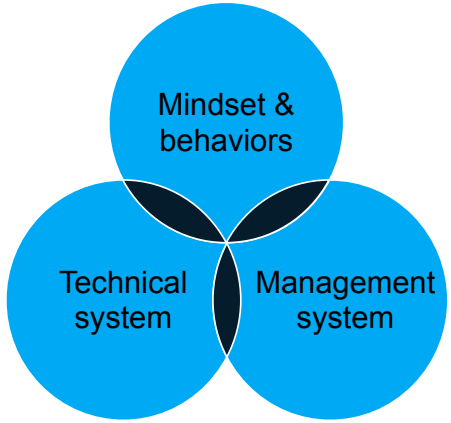
From traditional, engineering focused efforts…

Focus on **optimizing or modifying the design (value engineering)** to influence cost or schedule before a specific stage gate

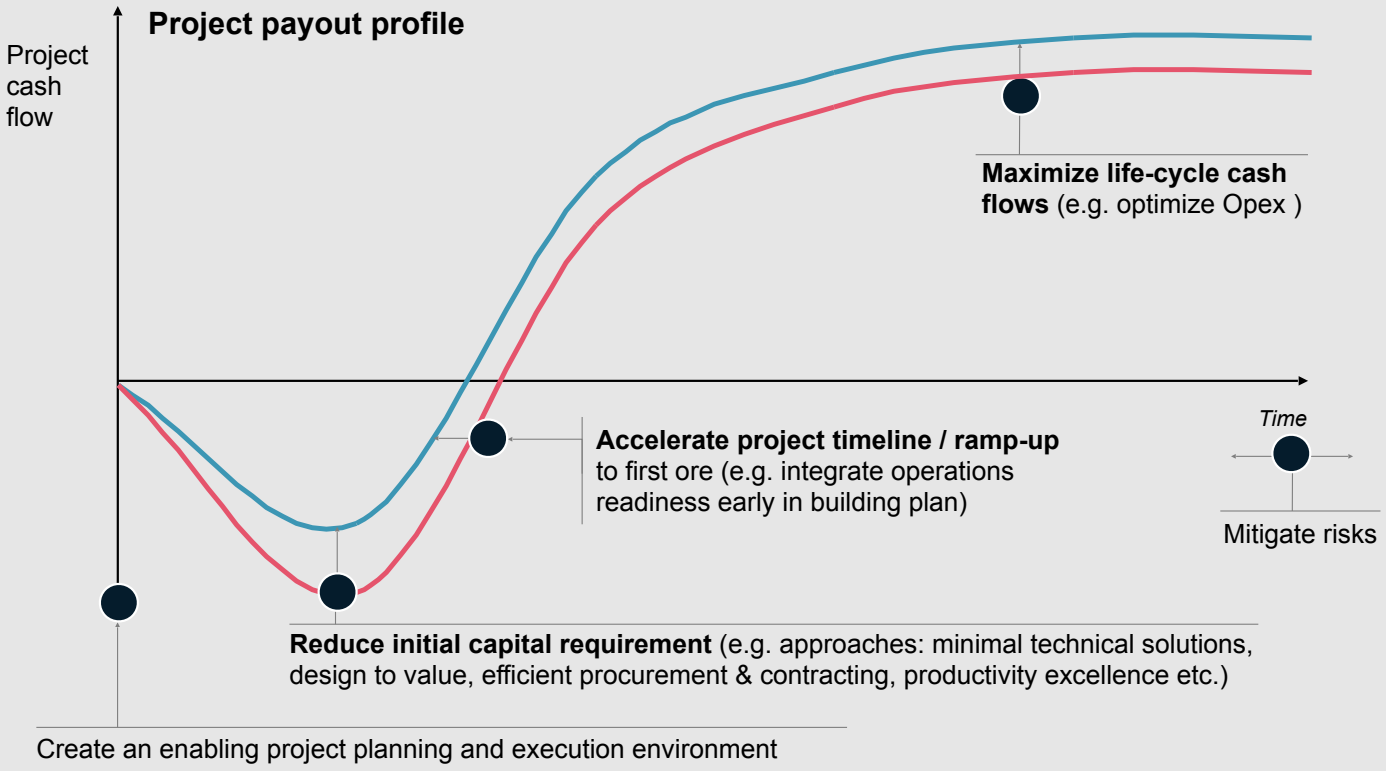


… to a holistic program

Focuses on **maximizing the financial value of the project** across the full lifecycle with proven tools to improve the technical system, rigorous management practices that pursue the full value-at-stake and codify decisions & knowledge, and an approach to build project team capabilities, mindset and behaviors required to capture and sustain that value



2. … delivering value by optimizing across all stages of asset lifecycle



6. We see three levers to incentivize the FS ecosystem to maximize value …

Conduct competitive feasibility studies

Conduct **competitive feasibility studies** with multiple contractors competing for the project

- Add tension to de-gold plate, increase throughput, and maximize NPV
- Opportunity to cherry pick best of best ideas
- Additional upfront cost of multiple studies small in comparison to overall project and offset by significant savings
- Can be converted into lump sum execution contracts to minimize risk to escalating cost once awarded and tension removed

Contractors with "skin in the game"

Contractors shall **tie part of their fees to successful FS outcome**

- Contractors receive share of cost savings identified and captured vs. PFS
- Bonus or project completion payments could be payable on achieving start-up date and design throughput
- In some cases, contractor could also take an equity stake in the project to better align incentives

Operations are part of the team

Operation team should be part of the project team, not external engagement points

- Embedding operations engineers, maintainers and operators into the project team will bring in-depth knowledge of the companies operating processes and challenges
- Opportunity to accelerate ramp-up and handover from projects to operations
- Reduces re-work of facilities after handover to make the "ops-ready"
- Operations will co-own solution and have to "sleep in the bed they made"

6. … plus Owners must reinvent the contractor relationship to stop the insanity of doing the same things repeatedly while expecting different outcomes

From rigid, adversarial …

Mining & metals owners and E&C contractors **do the same things repeatedly while expecting different outcomes**:

- Same contracts with inappropriate risk transfer
- Same rigid, adversarial relationships and same arguments
- Same behaviors, where “mystery is money”

… to relational contracting

Owners shall **consider their supply chain as a strategic partnership** and consider relationship contracting:

Enter **long-term, multi-project relationships** when possible

- Favor **one-team approach** (Owner’s project team, operations readiness, key OEMs and E&C contractors) supported by integrated forms of agreement
- **Pool delivery risks** and share profits among all parties
- Dedicate **pools of money specifically to pilot improvement ideas** (including digital) across multiple team members

8. Strong team is paramount to success : Owner's must invest in coherent teams with the right capabilities, operating model, mindsets and behaviors

Invest in building team purpose, identity and culture

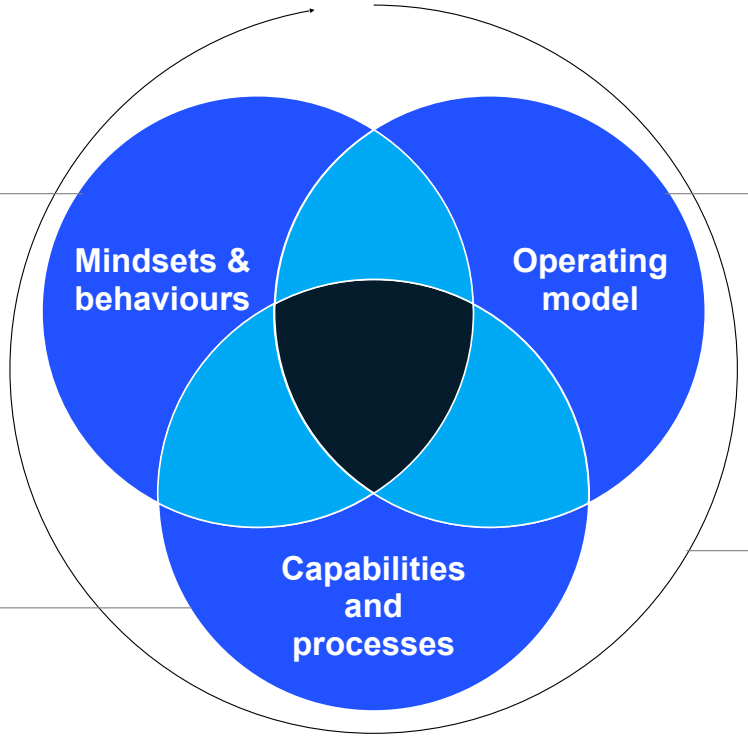
Enforce:

- Full ownership of outcomes (E2E accountability)
- Transparent communication
- Problem solving vs. finger pointing

Put in place a proven team, not a collection of individual experts with capabilities ranging from project economics, geology to execution planning and ops readiness

Supplement with rigorous project management science:

- Strong processes and controls
- Standards of excellence
- Reinforcing mechanisms



Owner's team operating model must embrace the following principles:

- Projects addressed as a whole, not just pieces
- Focus on value creation
- Quick to process changes
- Favor integrated project delivery, and lean execution

The 'art' of project leadership integrates the priority mindsets and practices that every leader should implement to ensure FS success

Source: McKinsey & Company mining capital projects service line

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Q&A and experience sharing

Do not hesitate to reach out to us for capital excellence questions

$1 trillion
Value of Capex supported over the last 5 years, **including +$300b in mining**

500+ clients
Across industries and geographies, **including ~150 in mining**

400+ experts
Bringing project experience from world class owners and EPC contractors

#1 ranked capital consultancy
Ranked externally by ALM intelligence in last 4 years

Consistent track record of impact
20% to 40% average productivity increase, 15% to 30% average schedule compression, 10% to 15% average capex savings

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