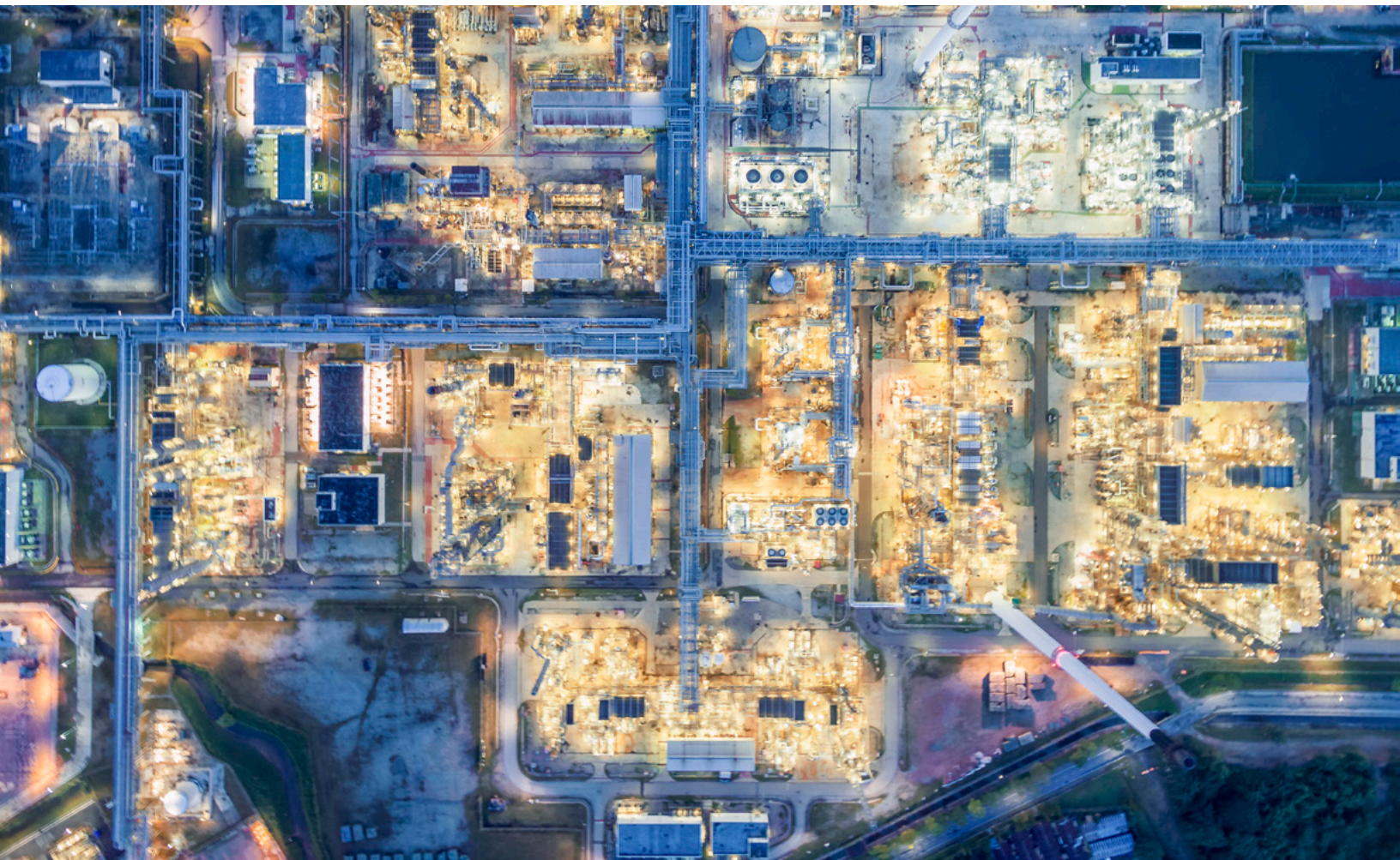


Mapping heavy industry's digital-manufacturing opportunities

Manufacturing digitization could boost heavy-industry profit margins by three to five points—but only if people can make the new technologies work at scale. The first article in a new series looks at the opportunity and the sector's progress.

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The latest revolution may have started in the world of software and services, but now heavy industries are also embracing the power of the newest wave of digitization in manufacturing. Leading companies in sectors including mining, chemicals, steelmaking and pulp and paper are applying new data sources and new digital technologies to boost the throughput, efficiency, reliability, and productivity of their manufacturing operations.

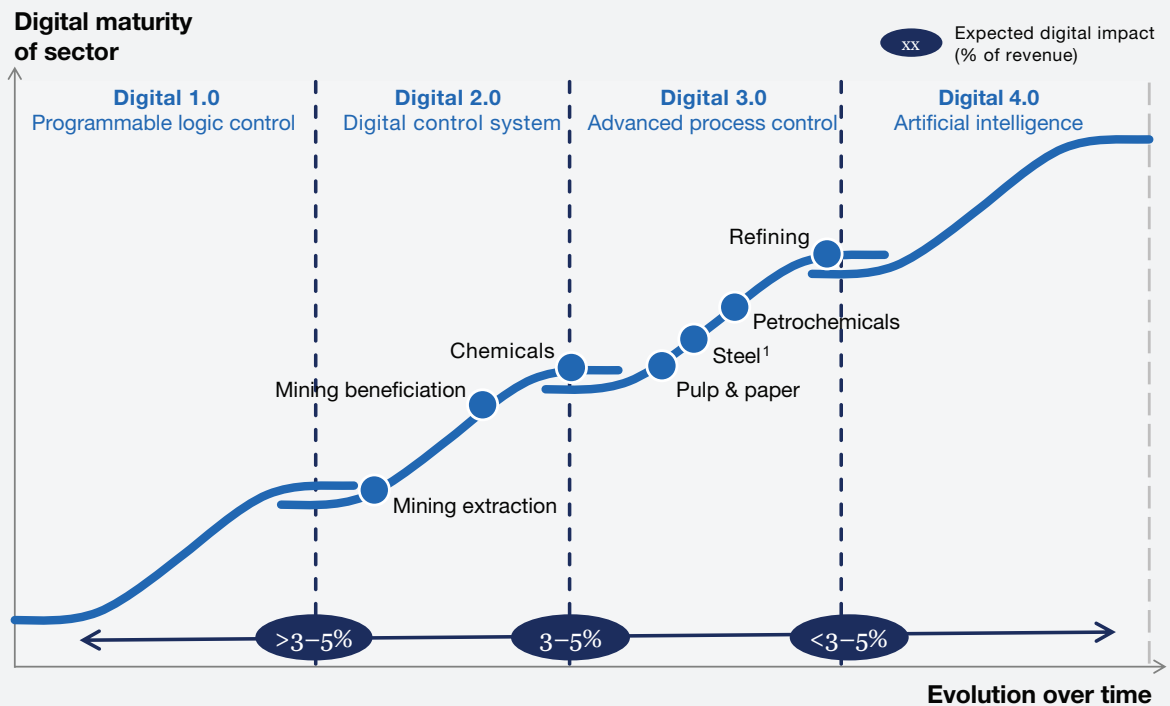
These companies are embarking on their digital journeys from very different starting points. In recent years, we've visited hundreds of plants and spent time talking with managers and operations

personnel about their current technologies and their digital ambitions. From that work, we have defined four broad levels of digital maturity: three that exist today, and Digital 4.0, a hypothetical future state based on technologies and approaches that are still under development (see sidebar, "Four stages of digital maturity in heavy industry").

Today, average digital maturity levels vary by sub-sector, although there are also considerable differences at the company and plant level (Exhibit 1). For sites and sectors operating at lower levels of maturity, that means there

Exhibit 1

Most heavy-industry sectors are at the middle stages of digital maturity.



¹ We estimate that other metals fall between chemicals and steel on the maturity curve.

Four stages of digital maturity in heavy industry

Digital 1.0

The beginning of the digital journey. At this level of maturity, companies use data only for immediate control and decision making. Sensors installed on equipment and connected to local logical controllers that enable the automation of basic plant functions. In all sectors, the majority of companies have now passed this stage.

Digital 2.0

The most common level of maturity in heavy industries today. Here companies make more extensive use of automation, including basic robotics and distributed control system (DCS) technologies. These companies often use dedicated software such as enterprise resource planning (ERP) systems to manage their operations at the corporate level. They will also have the infrastructure in place to capture and store data on their operations, although their visualization and analysis capabilities may be limited to static models using spreadsheets and similar tools.

Digital 3.0

The most advanced current stage of digitization. At this level of maturity, companies use highly sophisticated automation and control technologies, including multi-purpose robotics, advanced process control (APC) systems and real-time optimizers that can manage processes at the plant level. A robust data infrastructure, often based on a sophisticated production information management (PIMS) platform, allows them to use modelling and analytics

to optimize the performance and value of assets. Data also plays a bigger role on the shop floor, with manufacturing execution systems (MES) used to automate tasks such as production planning. Today the most advanced digital 3.0 companies are in the refining sector, where some plants are almost fully automated, only a minimum number of operators to ensure the safe start up and shut down of the plant.

Digital 4.0

This represents a future state of digital maturity, not a level not currently achieved by any heavy industrial player we have examined. At this stage, we envision companies using machine learning and even artificial intelligence in process controls, asset performance optimization, and asset value maximization. Real-time information should flow automatically across industrial sites, enabling all decisions to be centralized and data-driven. The plant information management system (PIMS) is no longer linear, as it is now operated in the cloud, where brute-force optimization can be used to solve for non-linear optima. Many management tasks will be fully automated, from information collection to problem resolution, with data flowing rapidly and seamlessly between owners. Digital 4.0 software solutions are also likely to be more flexible, with a standardization of solutions across different industries, while wireless options bring data collection and management to all people in the plant and beyond.

are opportunities to improve EBITDA by 3 to 5 percentage points or more. For more mature sites the potential might be lower, although a one- to three-percentage-point increase in EBITDA is still

a substantial improvement. The chemical industry can be used as a good reference point, where the average impact of recent large-scale digitization programs has been in the order of 3 to 5 EBITDA

percentage points, although some companies have achieved remarkable performance improvements, such as throughput increases of over 30 percent.

The digital landscape

Today's Industry 4.0 manufacturing opportunities for heavy industrial players are concentrated in four main areas (Exhibit 2). These levers represent the current sweet spot for digital investments, since they rely on relatively mature technologies and can deliver proven value.

To help companies decide where to focus their efforts, we have developed a heat map of digital opportunities by sector (Exhibit 3). In the first three of the four main areas, our experience suggests companies can expect their investments to pay back in three years or less.

Data analytics

The largest sources of value for all sectors except mining extraction come from the application of data analytics to improve throughput, yield, energy efficiency, and quality. Most heavy industrial players companies have rich historical data resources collected from their manufacturing operations. Advanced analytical techniques can help them learn from this data: combing through it to extract valuable insights into the underlying drivers of manufacturing performance, balancing the complex trade-offs between variables, and enabling higher levels of real-time control performance. In today's high-demand market, throughput is clearly the winning value proposition, as extra output not only adds to the full profit margin, but also dilutes the full cost base. Downturn markets will benefit more from a focus on costs, such as energy, yield and quality.

Exhibit 2

Four levers help business units capture digital value and overcome industrial challenges.

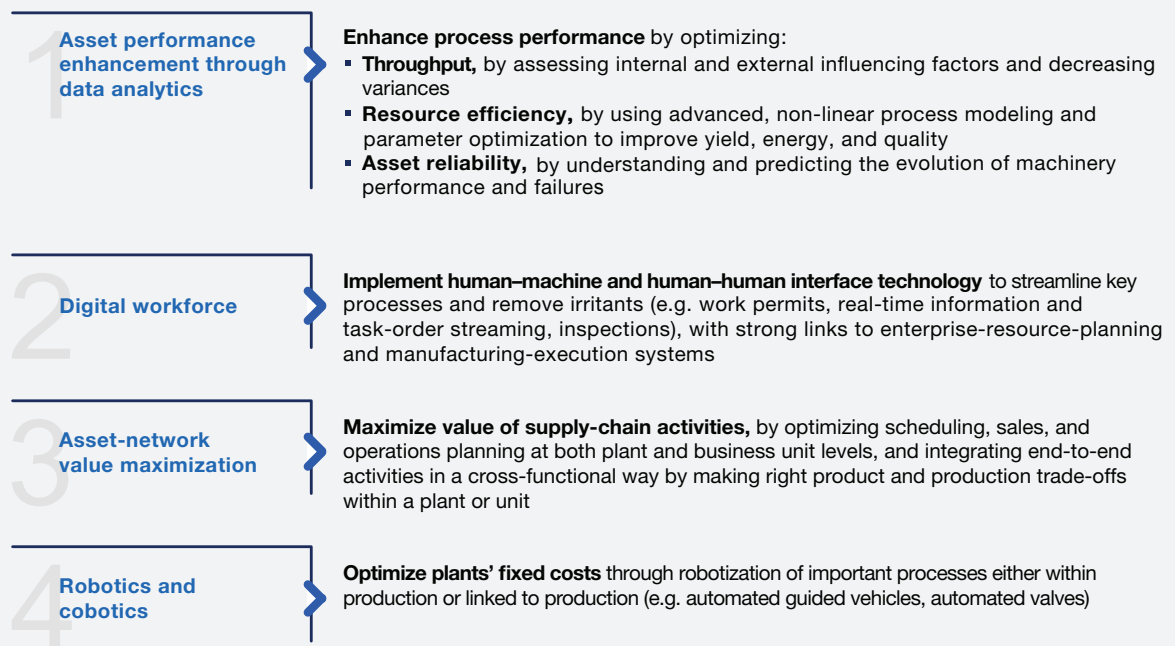
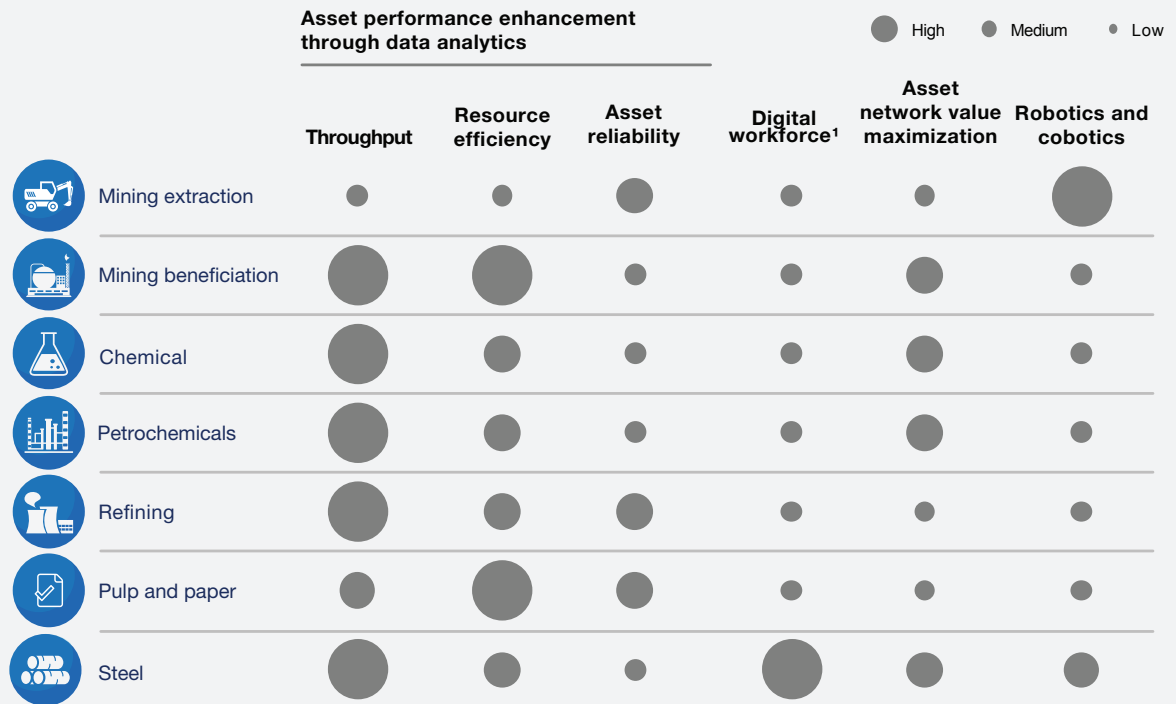


Exhibit 3

A heat map identifies the most promising digital opportunities in heavy industry.



¹ Building a foundation as a future data source for 'data analytics': a key enabler today, larger potential in the long term

The use of data analytics to increase asset reliability is often heralded as a major digital opportunity, but so far, the approach has fallen short of expectations—except where large fleets of similar assets are present, like rolling stock in mining. Most industrial operations tend to lack the quantities of data needed to apply these predictive-maintenance techniques: big assets do not yield enough failures and small assets are more cost-effectively served by a redundancy strategy. Our experience suggests that, while digitization can deliver significant value in maintenance and reliability activities, doing so requires companies to adopt other levers in addition to analytics. This is especially true for the digitization of the workforce, as this creates new

sources of data: each human coordinates a multi-sensor flow into the data environment, opening a new world for maintenance strategy, management, and execution.

The digital workforce

Supporting an organization’s human workforce with new digital tools can deliver tremendous value in the long term. Digital approaches in this area can include tools to accelerate and simplify planning, scheduling, and permitting activities, boosting workforce productivity while providing significant health and safety benefits. Workers can also benefit from real-time access to documentation, decision-support, and troubleshooting tools. And the flow of

information runs both ways: when staff record their activities and observations in digital form, that data can be stored and analyzed as an additional source of insights for future improvements—the base for the next wave of data analytics.

Asset network value maximization

Thinking about manufacturing assets as an integrated network, rather than a collection of individual machines, helps companies eliminate bottlenecks, improve responsiveness, and streamline their end-to-end value chains. Heavy industry players see a smaller improvement opportunity here than some other industries, since many already run highly integrated manufacturing operations. We believe most could still capture value from the use of digital tools to optimize schedules, cutting lead times, trimming in-process inventories and ensuring that capacity is put to the most profitable use available.

Robotics and cobotics

Robotics is a major opportunity area in the medium term, thanks to the rapidly falling price and increasing capability of robot systems, but low-cost multifunctional mobile robots suitable for heavy industrial environments are not yet available. Whenever autonomous guided vehicles can be applied, however, a clear business case is likely to be found.

Creating a digital vision

Heavy industrial manufacturers won't be able to grab the available digital value in one hit. The scale and complexity of their assets means they will need to apply new digital tools and approaches at multiple places across their operations. Like any large-scale transformation effort, success will require companies to develop a clear, compelling vision of the kind of digital organization they want to create.

It will also require them to be honest about their current strengths and weaknesses. Digitization is

about much more than technology, it can only be achieved if a company's people are willing to change their way of working, and if they have the right skills and expertise, along with a true "digital" mindset. In this regard, the digital transformation is very similar to the lean or manufacturing-excellence transformation that many companies have already undergone, with very similar success factors.

In future articles, we will look in more depth at the different ways heavy industrial companies can approach the challenge of digital transformation, and at the resources, infrastructure and enablers they need to make it work. ■

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