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Operations Practice

Capital Projects 5.0: Reimagining capital-project delivery

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What could your business do if your projects were 30 to 50 percent faster and cheaper? The opportunity is more real than you think.

This article was written collaboratively by the global leaders of the McKinsey Capital Excellence Practice, a group that spans regions and includes Shankar Chandrasekaran, Shakeel Kalidas, Mina Mir, Gerhard Nel, Prakash Parbhoo, Anuradha Rao, and Siddharth Srikanthan.

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Executive summary

Projects 5.0 is a new model for the delivery of large capital projects in heavy industry. In this report, we make the case for a radically different approach in the sector, and outline the six fundamental changes that could transform project-delivery performance.

Cost and performance benchmarks in many industries have been redefined in recent years, as incumbents and new market entrants alike adopt new technologies or unconventional operating models. In space flight, for example, the cost of putting a payload into orbit has fallen by 75 percent.

Applying the same underlying principles to large capital projects in heavy industries could achieve a similar step change in performance, with the potential to reduce actual project cost and time by 30 to 50 percent, more than doubling project returns. Yet the sector has struggled to achieve even moderate rates of productivity improvement or to deliver projects on time; a recent survey of senior project executives found that on average, projects overrun their budgets and schedules by 30 to 45 percent.

The coronavirus crisis has further accelerated the urgency for change. Lockdowns, labor shortages, and supply-chain disruptions have set construction programs back by months. The prospect of a long, uncertain period of recovery is forcing companies to rethink future project plans.

At the root of the sector's unenviable record is a project-delivery model that has remained largely unchanged for a quarter of a century or more. It is a model plagued by issues and inefficiencies: a lack of integrated systems thinking; prioritizing short-term cost management over long-term outcomes; poor communication between stakeholders; and bespoke projects and rigid planning systems that struggle to identify or adapt to changing demands.

Industry leaders are experimenting with a growing list of new technologies and processes, from digital twins to artificial intelligence–(AI–) enabled planning algorithms. A real transformation of capital-project delivery will require more than targeted interventions, however. At best, narrowly focused tools and technologies can address only a small part of the overall value at stake. At worst, poor technology and process deployment can end up adding unnecessary complexity and confusion to a project.

In this report, we make the case for Projects 5.0, a clean-sheet approach to capital-project delivery. Projects 5.0 is so named because it builds on the Fourth Industrial Revolution's advances, which introduced automation, machine learning, smart technologies, and the Internet of Things into conventional manufacturing and industrial practices. Incorporating these techniques into a broader set of changes—including stronger partnership networks, greater agility and flexibility, and thoughtful future-proofing—promises to unlock capital projects' full potential to deliver lasting value.

We have examined the approaches of multiple leading companies, in sectors from energy to software development, to see how they have addressed similar challenges in the delivery of complex projects. Studying the most successful elements of their models allowed us to identify six design principles that could act as building blocks for a better approach:

1. An ecosystem of partners that collaborates across multiple projects to maximize end-to-end value.

2. Industrialization and innovation, with the adoption of standard processes for repeated tasks, while challenging traditional ways of working to drive productivity.

3. Agility, flexibility, and resilience, combined with a stable backbone of disciplined processes, progress monitoring, and management.

4. Sustained capability building with a redesigned "people supply chain" that ensures companies acquire, develop, and retain the labor and talent they need.

5. A data-driven operating model including a robust digital architecture, shared by all stakeholders in the ecosystem.

6. Future-proofing of projects, with metrics and incentives that consider future opportunities and risks, and which promote innovation for long-term commercial and environmental sustainability.

In a survey we conducted in September, 2020, more than 300 senior decision-makers from across the capital-projects value chain estimated that applying these principles at scale could reduce both cost and delivery time by 30 to 40 percent.

More than 75 percent of respondents said that a significant shift in project delivery model was part of their organization's agenda—but 85 percent admitted that their organizations have not scaled either the design or implementation of actions to address any of the six principles.

The transition to the Projects 5.0 model entails a fundamental shift in the way businesses approach and execute capital projects. That will require senior leaders to establish bold aspirations and communicate a clear call to action for their organizations. They will want to move fast to capture quick wins and plan the implementation of longer-term interventions. And the final prerequisite: a willingness to invest real resources to drive change on the ground.

Projects 5.0 represents a significant break from the sector's long-established delivery model. In this effort, capital-projects players will want to draw heavily on insights and expertise from other sectors. For ambitious players in the sector,

An imperative for change

As other industries reinvent their project-delivery models, capital projects have seen little productivity improvement or process innovation in decades. Leaders in the industry tell us they believe there is an indisputable need for change.

choosing the right partners to help design and implement their transformation will be critical in unlocking the value at stake.

As the whole world battles to overcome the coronavirus pandemic, leaders of complex capital projects face an especially challenging journey. Lockdowns, labor shortages, and supply-chain disruptions have set construction programs back by months. The prospect of a long, uncertain period of recovery is forcing companies to rethink future project plans.

Industry players face difficult choices as they move into the next-normal world. Those decisions would be considerably easier if companies could find a way to cut project costs and delivery times by 30 to 50 percent, with high confidence that projects would meet their budgets and schedules.

For an industry with a poor record of productivity improvement, that might seem like an unrealistic goal. Yet there are plenty of levers that the sector could pull, from advances in technology to planning and process-management approaches that have proved remarkably effective in other sectors (see sidebar, "Other sectors show the way"). If these tools and techniques can be adapted to suit the unique demands of capital-project delivery, the sector could unlock an unprecedented wave of performance improvement.

Other sectors show the way

Other industries have already transformed their ability to deliver complex projects. For example, lean-management techniques helped manufacturing companies achieve year-on-year productivity and quality improvements that reshaped the sector. Since the 1990s, the adoption of digital tools and new processes in product development have helped car makers reduce the time required to design a new vehicle from more than three years to less than two. Most recently, the digitization of manufacturing using Industry 4.0 technologies has allowed some early adopters to double productivity and factory output, while others have reduced manufacturing lead times by as much as 90 percent.

In IT, many companies have abandoned their unwieldy "waterfall" project models in favor of agile techniques that use small, cross-functional teams, rapid, iterative development cycles, and continual testing. As early as 2013, an analysis of more than 1,300 software projects found that those delivered using agile methods demonstrated 27 percent higher productivity, 30 percent less schedule slip, and three times fewer residual defects at launch. Since then, agile concepts have become widespread : an oil and gas company's piloting of agile, cross-functional teams designed wells in 50 to 75 percent less time than the historical average—and, during the pandemic, an analysis of telco operators found that the ones with the most experience in agile techniques responded twice as fast as their least-agile peers.

Impact potential for capital projects

We asked more than 300 industry leaders to estimate the potential impact of reimagining the project-delivery approach, using a range of tools and techniques that have already delivered significant improvements in other sectors. They believe that potential exists to reduce both cost and delivery time by 30 to 40 percent, while improving both quality and repeatability by more than 20 percent (Exhibit 1).

Capital projects: a history of poor performance

Capital projects stand to gain significantly from an improved delivery model because there is so much untapped value on the table. Construction is the world's single largest industry , worth around $11.5 trillion a year, or 13 percent of global GDP. Yet despite its size and economic importance, the sector's rate of performance improvement lags well behind most others.

Over the past 20 years, for example, labor productivity in construction has increased by only 1 percent annually. That compares poorly with the annual productivity growth of 2.8 percent achieved by the global economy as a whole over the same period. The global manufacturing sector has done even better, boosting productivity by an average of 3.6 percent every year since the turn of the century.

Capital-project delivery has also earned an unenviable reputation for low margins. In 2017, average profit margins for construction-sector players were estimated at 4.5 percent, putting them among the bottom quartile of businesses globally. By comparison, companies in the machinery sector typically achieve margins of 7 percent, while utilities manage 8.5 percent.

Rampant value losses with unsolved root causes

At the heart of the capital-projects sector's challenges is a project-delivery model that has seen little fundamental change for over a quarter of a century. In surveys and conversations with industry participants, we have identified multiple sources of value loss across the rigid, stage-gated model used by the overwhelming majority of capital projects today (Exhibit 2).

Exhibit 1

Projects 5.0 could transform the financial viability of large capital projects.

We surveyed 300+ industry leaders (including owners, contractors, and operators) to quantify the **potential improvement across 4 dimensions of cost, time, quality, and repeatability** in capital-projects delivery

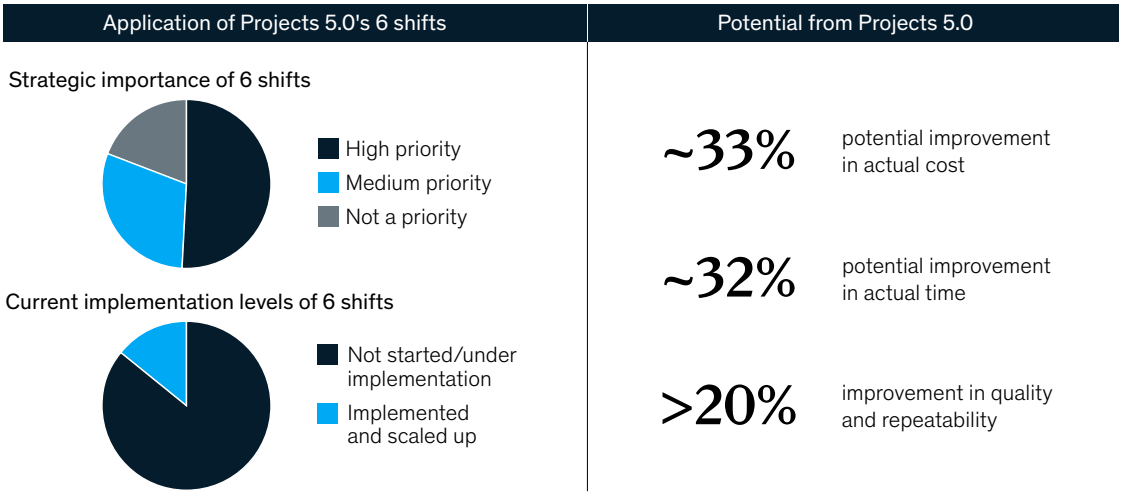


Exhibit 2

Today's delivery model for capital projects suffers from multiple sources of value loss.

Project lifecycle	Concept →	Feasibility and engineering →	Execution →	Commissioning and ramp-up
Major sources of value loss	Choosing the wrong projects Myopic contracting arrangements Siloed, transactional relationships Misalignment and dynamically changing customer needs Poorly developed feasibility and feed studies	Lack of effective planning Siloed approach to project delivery: individual custodians of knowledge and risks Reinvention rather than reuse: underemphasis on modular, prefab, precast, and offsite construction techniques Insufficient focus on constructability Limited crowdsourcing of ideas from vendors Little use of predictive analytics Few proactive risk-management procedures and tools	Unclear criteria for vendor approval; insufficient use of standardized rate cards Overuse of low-skilled contractors and labor forces with high churn Poor measurement and capturing of real-time progress Last-minute, unplanned design changes Poor communication protocols Weak or nonexistent claim-management systems	Incomplete or poor-quality handovers (often via paper records) from construction Operational ease and efficiency not considered

Source: McKinsey analysis of expert conversations

Industry recognizes the need for change

In September 2020, we conducted a worldwide survey of more than 300 senior executives and decision-makers in the capital-projects sector (Exhibit 3). We asked them to share their perceptions of the strengths and weaknesses of today's project-delivery model, and the opportunities available to make improvements.

Among the significant sources of value leakage industry leaders identified were: choosing the wrong projects; lack of effective planning and progress measurement; and incomplete, poor-quality handovers at the end of construction.

Respondents to our survey told us that on average, these losses result in construction projects taking 38 percent longer to finish than scheduled, and costing 40 percent more than their original budgets. Losses were broadly consistent across industries and regions, with respondents indicating that the largest losses occurred during project execution.

Respondents indicated other issues as well; for example, that quality and repeatability both typically undershot targets by an average of 25 percent.

The executives in our survey were clear about the need for change: 76 percent agreed on the need to fundamentally redesign the current project-delivery model. Around 40 percent of respondents believed that this needed to be a joint effort among all players involved in a project (Exhibit 4).

From localized improvements to a redesigned project-delivery model

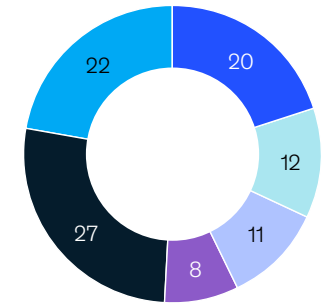
Recent years have seen significant investment in new approaches and technologies intended to

Exhibit 3

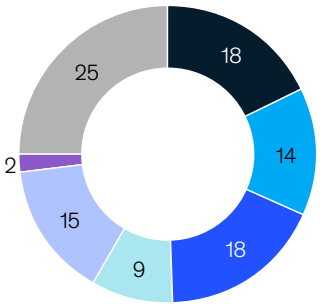
We surveyed more than 300 decision-makers, CXOs, and top executives from midsize and large organizations.

The 306 survey respondents largely reflect the industry's composition (September 2020)

Geography, %



Industry, %



Subsector (role in value chain), %

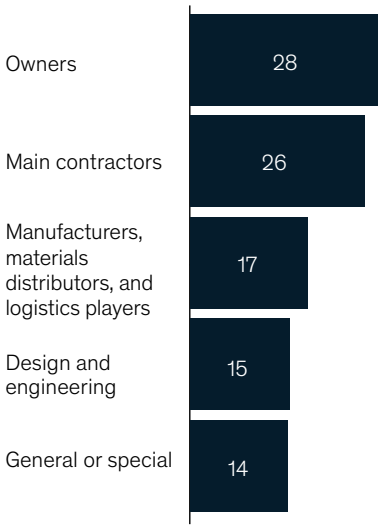
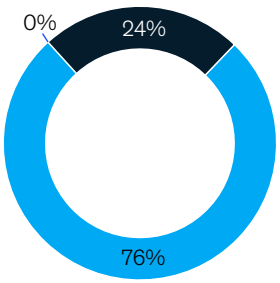


Exhibit 4

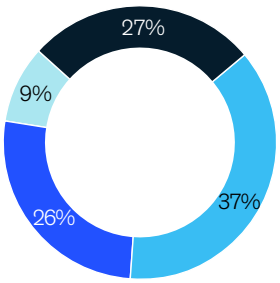
Three-fourths of respondents believe a change in capital-project delivery is needed.

Leaders say talent shortages, rigid mind-sets, cost, and poor collaboration are holding the industry back

Degree of change required in project-delivery model
Respondents, %



Who should lead the change?
Respondents, %



Executives identified the top roadblock to change in their organization
Respondents, %

19
Talent and skill shortages

18
Clients', managers', and team members' mind-sets

17
Cost

10
Poor collaboration and few win-win opportunities

[1]Engineering, procurement, and construction/engineering, procurement, and construction management
Source: Global survey of >300 industry leaders in capital projects

address losses in capital projects. These range from the use of augmented and virtual reality in design reviews to the application of artificial intelligence to optimize build schedules.

One mining company, for example, built a digital twin of a major recent construction project. The comprehensive 3D model allowed the company to automate many formerly manual progress-tracking activities, and acted as a common data source and visualization tool to streamline communication and problem solving among the various contractors operating on the site. Despite technical challenges, and the need for significant upskilling of the project-delivery team, the approach helped the company accelerate the project by more than six months.

While many of these new approaches have been applied successfully, each of them seeks to address only a small part of the overall project lifecycle. We believe that the industry has an opportunity to move beyond point solutions and take a more fundamental approach, starting with a clean sheet and reimagining its whole delivery model.

Redesigning the project-delivery model

In this work, we set ourselves the challenge of envisioning an optimized delivery model for capital projects. Such a model would integrate the best technologies and working methods currently available, while also paving the way for sustainable innovation and long-term continuous improvement.

To address the industry's needs, we set a bold aspiration of a new project-delivery model, Projects 5.0, to achieve five key objectives:

— Reduce both project time and cost by 40 to 50 percent

— Produce safe and predictable outcomes

— Provide a platform for innovation and continuous improvement

— Maximize total project value for all stakeholders, including the end user

— Enable projects to meet sustainability goals

To create our vision, we explored solutions including (but not limited to) digital tools. We delved into fundamental aspects of the wider project lifecycle, such as the working methods and relationships within the network of organizations involved in capital-project delivery.

Six building blocks

The core of our work has been the application of lessons for capital projects from the advanced project-delivery models that have had a significant impact in other industries. We examined the approaches of leading companies in sectors from energy to software development to see how they have addressed similar challenges in the delivery of complex projects—and the results that their approaches demonstrated.

These lighthouse examples come from a wide range of different industries, and address a multitude of challenges. Studying the most successful elements of their various approaches, and identifying the approaches most applicable to the capital-projects sector, allowed us to identify six design principles that could act as building blocks for a better approach (Exhibit 5):

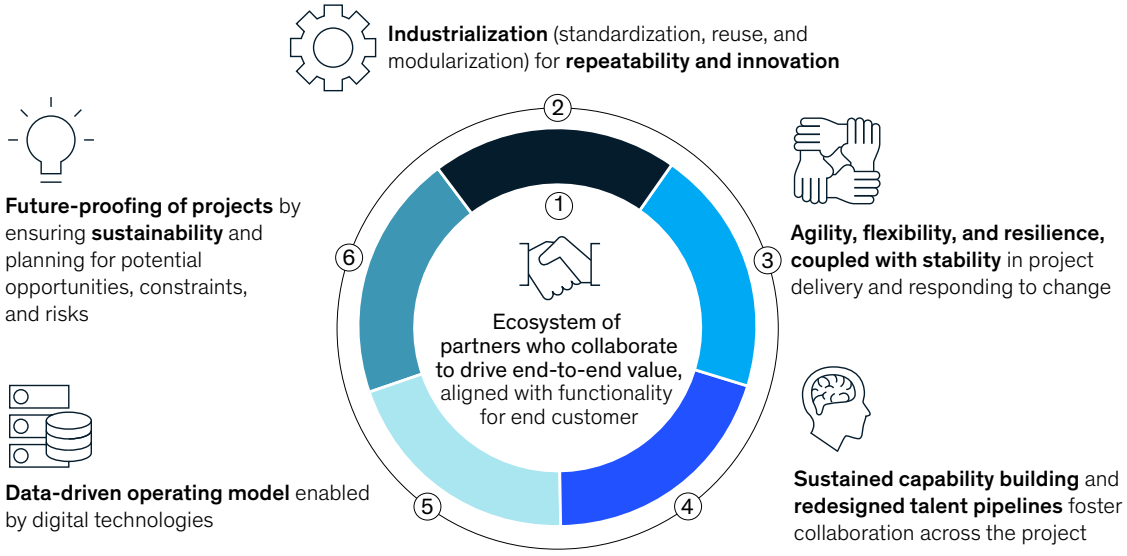
1. An *ecosystem of partners* that collaborates across multiple projects to maximize end-to-end value and deliver optimal functionality for the end user.

2. *Industrialization*, with the adoption of standard processes for repeated tasks and extensive use of standardization and modularization to reduce recurring design costs and enable off-site construction. Innovation challenges traditional ways of working to drive productivity.

3. *Agility, flexibility and resilience*, combined with a stable backbone of disciplined processes, progress monitoring, and management. Cross-functional teams work together to develop and deliver project elements, solve problems, and respond to change, with resources rapidly allocated within and between projects according to need.

Exhibit 5

Six fundamental changes underpin a new approach to capital-project delivery.



Shift in mind-sets to adopt disruptive ideas and ways of working to **unleash value from Projects 5.0**

4. *Sustained capability building* with a redesigned "people supply chain" that ensures companies acquire, develop, and retain the labor and talent they need for consistent, high-productivity work across all project phases.

5. A *data-driven operating model,* including a robust digital architecture, shared by all stakeholders in the ecosystem. A project technology platform enables real-time visibility of progress, facilitates collaborative design and problem solving, and promotes data- and insight- driven decision making.

6. *Future-proofing* of projects, with the use of lifecycle cost analysis, along with metrics and incentives that consider future opportunities and risks, and which promote innovation for long-term commercial and environmental sustainability.

In our survey, over 70 percent of capital-projects executives identified each of the six design principles as important and implementable with an additional investment of less than 5 percent of total project cost. Only a minority of respondents believed that their organizations have successfully implemented any of the six levers at scale, however.

Across industries, geographies, and stakeholders, most respondents suggest that successful implementation of a new delivery model encompassing all six major shifts could cut project cost and schedules by 30 percent or more.

Projects 5.0 in practice

Implementing the Projects 5.0 model will require companies to adopt new processes, systems, and mind-sets not only within projects, but also across multiple projects and throughout the project-delivery organization. In the chapter, we outline the shifts required to make the change.

An ecosystem of partners

A few leading players in the automotive, aerospace, and high-tech sectors have moved beyond traditional supplier relationships to highly collaborative long-term partnerships (see sidebar: Toyota's model).

Capital projects today are often conducted with arms-length relationships between owners, main contractors, vendors, and other players. They are characterized by a narrow focus on minimizing cost and maximizing transfer of risk. Often, poor communication between stakeholders and misaligned incentives result in suboptimal decision-making and value loss.

Capital-project owners can benefit from an ecosystem approach, which entails five major shifts:

1. Drive end-to-end value creation through long-term, multiproject, collaborative engagement
2. Actively curate and develop an ecosystem of players with complementary skills
3. Fully align incentives, with optimal risk sharing
4. Create transparency and trust, anchored on a common data- and information-sharing platform and tools

Ecosystem of partners: Toyota's model

Toyota, Japan's largest carmaker, chooses its supply partners with great care. Evaluation of potential vendors can last for several years, and the company invests significant effort helping new suppliers develop engineering and manufacturing approaches that suit its needs.

Once projects are underway, the carmaker expects complete openness. Suppliers share details of their costs, margins, and manufacturing methods, enabling constructive joint problem-solving and value-improvement activities. For its part, Toyota involves those suppliers in new projects from the concept-development stage. Other carmakers commonly wait until the prototype stage—often two years or more into a project—before bringing suppliers fully onboard. Starting collaborations early helps both sides identify and resolve potential issues faster, and gives suppliers more time to prepare and optimize their own manufacturing facilities and supply chains.

Supplier companies that become trusted members of the Toyota ecosystem have a lot to gain from the relationship. The company rewards suppliers that meet its demanding targets with higher order volumes and a larger role in future projects. Toyota says that its collaborative approach was one of the factors that helped it to reduce the development hours required to create its recent vehicle platform by a quarter and cut per-vehicle costs by 10 percent.

5. Align project objectives with the external context, including the regulatory environment

Creating and sustaining such a collaborative ecosystem would require changes on several fronts.

Develop a through-cycle value-creation mind-set. A long-term perspective results in incentives to invest in quality over cost, innovate, build capabilities, and future-proof projects for sustainability. This mind-set means owners prioritize the multiplier effects of long-term collaboration over the mirage of short-term savings under the least-cost contracting paradigm.

Develop a comprehensive partner-selection methodology. Unlike traditional contracting that focuses only on cost and execution capability, partner selection within Projects 5.0 involves additional criteria, such as a shared mind-set of long-term value creation, cultural fit, willingness to collaborate and share information, and the existence of complementary competencies.

Construct a fair and transparent contracting framework. This involves a shift from fragmented, opaque contracts to a single contract among all delivery partners that enables sharing of value commensurate to risk.

Design a joint governance model. Projects 5.0 is governed by a joint management structure comprising representatives of all partners, who sit on the same side of the table and "discuss, rather than review" each other.

A collaborative ecosystem of partners is the foundation of the Projects 5.0 model. Transparent, trusting, long-term relationships among organizations with complementary capabilities provide the space in which other elements of the solutions—from standardized processes to a common digital backbone—can thrive.

The ease and effectiveness of these shifts will be determined by an organization's existing practices, by the sector in which it operates, and

"Once companies have worked in a multiparty agreement, most of them won't go back to the old way. It's not easy, and things can get heated, but it is what's best for the project. This model can generate maximum impact in complex projects with high level of uncertainty, where there is immense value in having the stakeholders come together from the validation phase."

—Mike Staun, chairman of the board, Lean Construction Institute

by wider economic and governance conditions. For example, a set of partners with proven track records of successful project delivery can accelerate this shift, while immature contractor ecosystems lacking trust and openness prevent this shift.

Industrialization and innovation

Design and construction in most capital projects today are conducted in an environment of high variability and uncertainty. By default, the majority of design is bespoke; there is limited automation and little investment in innovation. Productivity is low across the project lifecycle.

Capital projects could address many of these shortcomings by adopting the principles of standardization, modularization, and a focus on innovation, all of which are common practice in other manufacturing fields (see sidebar, "Industrialization and innovation at SpaceX"). Doing so would entail five shifts:

- *Optimize work sequencing, processes, and workflows* and minimize rework or waste
- *Standardize design libraries* for low-value elements to eliminate rework
- *Modularize and productize* to enable off-site construction and inject manufacturing-like efficiencies and quality
- *Automate desktop activities* and simple, repeatable construction tasks using robotics
- *Innovate relentlessly with a license to fail,* challenging traditional ways of working and driving productivity

Industrialization and innovation: SpaceX

Using a fleet of in-house developed rockets, SpaceX provides orbital launch services to governments and private organizations from around the world. The company has used standardization, reuse, and innovation across its operations with the aim of radically reducing the cost of spaceflight.

The stage-1 boosters and other key components of its Falcon rockets are designed for reuse: for example, for example, landing under their own power or floating back to earth on steerable parachutes. The first and second stages of Falcon rockets use the same type of engine, providing significant economies of scale in design and production. The company's Falcon Heavy variant shares many major components with its smaller sibling.

SpaceX uses its modular architecture as a platform for rapid innovation. The company engineers continually refine and improve the design of components and systems, within a culture that encourages experimentation and is tolerant of failure. The first three SpaceX Falcon 1 prototypes failed during launch, for example, but at the fourth attempt, a Falcon 1 became the first privately funded, liquid-fueled rocket to reach orbit.

By 2018, SpaceX had captured more than half the global market for commercial satellite launches. It charges customers between $60 million and $90 million per launch, depending on the size of the payload and the type of rocket used. That's about 75 percent less than the equivalent cost in the pre-SpaceX era.

> **"While there are plenty of high-impact interventions, such as modular, agile, digital and more, the required foundation is to work with the right partners across projects."**
>
> —Project head of a large mining player

Bringing industrialization and innovation to capital projects requires owners to make changes in several areas.

Regularly redesign workflows and practices based on experience. During and after each project, organizations pursuing Projects 5.0 will need to thoroughly review their processes and workflows, understand where they can be improved, and implement the changes through a process of continuous improvement.

Conduct a thorough exercise to standardize, catalogue, digitize, and refresh. This applies both to business processes as well as designs. Creation of a design library, by identifying and codifying repeatable designs used across projects, allows for smoother design and engineering.

Proactively design for modularity and off-site manufacturing. By moving from a project-centric approach to seeing construction projects as a product offering, organizations can identify opportunities to "manufacture" off-site, and leave only assembly to be done on-site.

Crowdsource ideas for value engineering. Work with ecosystem partners in the design phase to identify value-engineering opportunities, and involve all parties from the early stages of the project.

Use open-source design and simulation software to achieve optimal results, faster. Identify and track readily available software packages that can be used to enhance existing processes, adopting them as required to bring impact.

Set up a dedicated innovation fund, along with idea-incubation centers. Invest in innovation and experimentation by carving out dedicated funds, as well as physical hubs, to drive pilots. Develop appropriate incentives to reward innovation and treat potential delays due to pilots as part of the investment in moving to new ways of working.

Accelerators that will aid the adoption of the industrialization and innovation approach include *advancements in automation technology*, along with computer-aided design and manufacturing processes. *Highly bespoke projects* (making it difficult to standardize designs or use of off-site manufacturing approaches) and *lack of knowledge of modular manufacturing* processes among designers can inhibit the shift.

Agility, flexibility, and resilience

Agile development methods have transformed the delivery of complex software projects. And the approach is now gaining traction in industries from car making (see sidebar, "Agile engineering at Tesla") to aerospace (see sidebar, "Saab's agile fighter jet").

Agile engineering at Tesla

Electric carmaker Tesla has become one of the most disruptive players in the automotive industry, growing its revenues by 50 percent per year between 2014 and 2019. While the company's focus on pure-electric vehicles across its portfolio is the most obvious difference between it and its established competitors, Tesla has also shaken up the way products are designed, developed, and manufactured.

Reflecting its founders' backgrounds in technology-related sectors, Tesla has brought a software-engineering approach to automotive products. The company applies many of the principles of agile development across its operations. Designers and engineers work together in small teams. Only 11 designers were involved in the development of the Model S, for example. Regular cross-functional "scrum" meetings are used to review progress and maintain alignment between teams. Improvement is continuous, through incremental updates rather than the industry's conventional annual release cycles. Products undergo up to 20 engineering changes a week to optimize performance or manufacturing efficiency, while regular over-the-air software updates are used to resolve issues and add new features to customer vehicles.

Tesla also follows the software industry's agile principles in its modularization strategy. Clearly defined interfaces between major components give the design teams responsible for those parts the freedom to innovate and improve, while ensuring plug-and-play compatibility with the rest of the vehicle.

Saab's agile fighter jet

In the development of the new Gripen E fighter jet, Swedish aerospace and defense manufacturer Saab Aeronautics applied agile practices across all disciplines, including hardware engineering, fuselage design, and software development.

In the program, Saab applied a set of agile catalysts. One was to define a modular architecture for the new aircraft and align the organizational design accordingly, assigning clear responsibilities to each team and allowing them reasonable independence from one another. Another was investment in advanced virtual simulators of the aircraft, which enabled every team to evaluate their latest design choices in short feedback loops. The company also located its test pilots at the same site as the engineering teams, promoting a tight collaboration between pilots and engineers so that feedback could be provided at the end of every development sprint.

The effect of the agile-engineering model was impressive: the total project cost was a small fraction of the cost of developing other comparable fighter jets, and the manufacturing cost for each unit was less than half that of similar fighters.

> **"Applying platform-based standardization allowed us to deliver for a UK-based hospital chain in just weeks rather than years. What works best will depend on the complexity of a specific project and customer needs, but this thinking (the principles of industrialization) can absolutely be applied to most projects, with potential to halve the time taken to completion."**
>
> —Mark Reynolds, CEO, MACE

Today, capital projects are characterized by their sequential, stage-gated approach, with multiple independent teams working in silos on different components of a project. Across asset classes, time overruns result from a lack of flexibility and speed in responding to changes on the ground, as well as delays in tracking potential issues.

An agile delivery model would allow project owners and partners to collaborate more effectively, solve problems faster, and respond more rapidly to changing requirements. Implementing agile principles at scale in capital projects would require three changes:

- Enhance the current stage-gated execution methodology with a *rapid, iterative approach* to design and execution, with regular feedback loops
- Establish clear decision-making responsibilities within the project team to *empower and drive change*, facilitate collaboration, and encourage cross-functional communication
- Ensure delivery teams have ownership of processes and outcomes, to enable *dynamic responses* and *proactive risk mitigation*

An agile model would involve new approaches across the capital-project lifecycle:

- *Design and engineering:* Agile principles from software development can be applied directly to arrive at a new way of working. Small, cross-functional teams with joint representation from the owner, engineering-services firms, and the construction team work on the design in multiple short sprints. At the end of each sprint, the design would be reviewed and the feedback incorporated in the next sprint. This cross-functional setup helps organizations to balance value engineering with constructability.

— *Procurement:* Companies can create digital marketplaces to procure standard items with well-defined specifications at standard rates—seamlessly and at the click of a button, with real-time tracking as they arrive at the site. That helps managers plan for materials, people, and parts to arrive on site only when required, and for delivery directly to the location of the work.

— *Construction:* Implementing virtual construction via building information management (BIM) software and digital twins helps resolve clashes and access issues before construction starts.

The rapid and effective adoption of agile processes will be aided by a bench of experts (including external advisors, past employees, and freelancers from other industries) who can be contracted for support. Companies can also address hierarchical mindsets and rigid rules that encourage teams to comply with non-value-adding processes.

Sustained capability building

Capital-projects players face an inherent challenge in building and retaining a capable workforce because of the traditional view that each project is independent of the next. This reinforces the transient nature of a majority of the labor force on a project. Contractors working to complete work at the lowest costs rarely have an incentive to develop capabilities of their labor force. Yet there are significant gains to be made by investing in building capabilities and creating a culture of continuous learning (see sidebar, "Sustained capability building: Upskilling at Tideway").

Players will want to move away from a model that staffs on a project-by-project basis and toward one that considers the capability requirements of the organization over the longer term. This requires three adjustments:

— *Systematically acquiring capabilities to deliver the portfolio over a longer horizon* and taking a "talent supply chain" view versus merely "staffing" a particular project

— *Investing in targeted training* to enhance the skills of people engaged in delivery, both upfront and throughout the project

— *Taking an agile approach to allocating and optimizing resources* across projects

These changes require organizations to take action on two fronts at once.

The first step is to develop a *comprehensive plan of the skills required* across the project portfolio,

Sustained capability building: Upskilling at Tideway

The Tideway project is a new, 25-kilometer sewage tunnel underneath the River Thames. Scheduled for completion in 2025, the project will collect millions of tons of wastewater that currently flow directly into the river and transport them out of London for treatment. To minimize disruption, Tideway decided to use the Thames as its primary route for the movement of materials and equipment.

Tideway has made significant investments to ensure access to the right skills and capabilities to support the project. It supplied new equipment, developed a code of practice for safe operations, and required all contractors providing water transport to undergo a specially designed training and validation course. The company has also worked with other organizations on the Thames to create a new, permanent skills academy for the river workforce.

> **"We encourage experimenting with new and creative ways of approaching challenges. We leverage design-thinking and 'trystorming' methods among our teams to ideate, prototype, and test for solutions. We're accepting of failure and constantly challenging established norms."**
>
> —Jon Hines, development executive at M. A. Mortenson

identifying gaps and setting up programs to close them. Organizations will want to take a portfolio-based view of capability and staffing, planning ahead for long-term requirements as opposed to simply assigning people for the next project in the pipeline. The use of partners and external parties (such as national academies or local government programs) for sustainable skills development can be explored to build talent at an industry-wide level.

The second requirement is a *mechanism for managing and optimizing resource allocation*. Once talent has been hired and developed, allocating it optimally between projects is the next challenge for organizations to tackle, ideally through an agile, need-based critical-skill assessment and resource-allocation tool that applies across all parties based on project priorities.

Systematic, long-term capability building works best in the presence of a number of accelerators, such as *learning alliances* with other organizations and training providers to support large-scale capability building. A major blocker in some project organizations is the lack of a comprehensive *talent strategy*, often due to an overreliance on contract staff with limited retention of personnel—and skills—between projects.

A data-driven operating model

While capital-projects players are actively adopting a wide variety of digital solutions, decisions about which technologies to adopt remain highly subjective. Moreover, today's solutions are typically isolated and rarely talk to each other.

To capture the full benefit of existing and emerging digital technologies, capital-project owners will need to move away from today's fragmented, ad hoc approach. Future projects can be built around a common, comprehensive digital infrastructure, facilitating seamless, real-time data exchange between project participants and ecosystem partners (see sidebar, "Digital: Scale and integration at Amazon").

Digital: Scale and integration at Amazon

E-commerce giant Amazon has used its strengths in digital technologies and data analytics to offer higher service levels and lower costs than many of its competitors. The company's data-driven operating model has allowed it to offer a wide range of products through multiple delivery channels. It sells both physical goods and digital services on its own behalf, and acts as an intermediary for thousands of third-party sellers.

Managing all these activities on a common platform has enabled Amazon to maximize efficiency and exploit economies of scale across its operations. The company's fulfilment and logistics system, for example, makes extensive use of automated forecasting and inventory-management systems to optimize the distribution of products and the productivity of its warehouses and transport networks. Continual refinement of its processes and inventory strategies has allowed Amazon to optimize its overall logistics costs.

Achieving this vision will involve:

- Creating *real-time visibility* on project parameters for all stakeholders in the ecosystem
- *Driving data- and insight-based decision making* and risk management
- Developing a *robust digital architecture* that is flexible enough to allow scaling and the integration of new solutions and functionalities as it matures
- Setting up a *mechanism for technology investments and innovation*

"We knew from the outset that our success depended on the availability of a safe, professional, and productive work-force, and we would have to invest in processes, equipment, and capabilities to meet that goal."

—Chief technical officer, European infrastructure project

As they design, develop, and deploy new digital tools and infrastructure, capital-projects players can apply lessons that other industries have learned in their own digitization efforts.

Focus disproportionately on rewiring business processes based on data. Digital and technology interventions are only a small part of the solution. The real value of improved access to data depends on business processes that are adapted to take advantage of it. Typically, this means addressing mind-sets, starting from the top of the organization. Companies can ensure projects have access to the right talent to operate analytical tools and enable data-driven decision making.

Avoid pilot purgatory. Rather than picking up and trying every potential intervention that could benefit the project outcome, it is often better to be targeted and focused in choosing what to change. After the initial experimentation phase, picking the two or three highest-potential interventions and scaling them successfully is better than dabbling with multiple solutions.

The implementation of a data-driven operating model is simplified by the presence of a number of accelerators, including robust training and a long-term focus on a data and technology—especially for managers and senior leadership.

Future-proofing and sustainability

Sustainability is important on two fronts: maximizing the lifetime value of an asset, as well as reducing environmental impact in the end-to-end process, from development design through to construction, operation, and potentially even to decommissioning.

With the working life of most major capital projects measured in decades, owners need a farsighted perspective. But many capital-projects players still evaluate and optimize projects purely on financial and risk criteria, with little consideration of long-term sustainability and total lifecycle costs.

For projects in development today, through-life environmental and social impact is an increasingly central consideration (see sidebar, "Sustainability: Sustainable development at Equinor"). In many sectors, the regulatory environment is expected to become considerably more demanding in the coming years, and some projects will be expected to operate through the global transition to a low-carbon economy.

"One reason digitization can fail is that new systems have been applied to legacy operating processes. A successful digital strategy must transform people, processes, and systems."

—Mark Timbs, head of digital and CIO—Europe, Lendlease

Sustainability: Sustainable development at Equinor

Norwegian energy company Equinor evaluates all potential offshore oil projects against rigorous targets not only for cost, but also for carbon emissions per barrel produced.

The new approach has already led to significant changes in the field. Offshore facilities in the company's Johan Sverdrup field, which commenced operations in January 2020, get their electricity from onshore renewable sources. Eliminating the gas turbines that power conventional platforms reduced carbon emissions during production by 80 percent. Equinor now plans to electrify a number of other North Sea production platforms using cables from the mainland. It is also exploring the use of floating wind turbines to supply energy to deep-water sites.

"One of the lessons we learned is that too much time is being spent making digital tools talk to each other. The solution is an end-to-end digital platform that can aggregate and analyze data from multiple disparate systems, and make it accessible, usable, and visible across the asset lifecycle."

—Alex Fleurant, enterprise account executive, Scott Benesh, VP of client solutions, and Rob Southon, CTO, VEERUM

A future-proof approach to project delivery involves three new practices:

— *Assess project feasibility on sustainability metrics* in addition to traditional financial metrics, such as net present value.

— *Conduct a comprehensive asset-lifecycle value assessment,* by expanding financial metrics to include both direct and indirect costs across the project lifecycle.

— *Include innovation towards sustainability* in projects' lifecycle and scope.

Building these skills will require companies to undertake a series of practical steps.

Evaluate the full cost of a project, not just the initial capital costs. A renewed focus on lifecycle cost analysis (LCCA) at the early stage of a project will increase resilience by allowing engineers, planners, and decision-makers to assess not just the up-front cost of a project, but also the operation and maintenance costs, as well as the cost of retiring the asset.

Incorporate sustainability KPIs and targets for all project delivery teams and partners. This step helps embed sustainability into each stage: development, design, execution, and operation. Building adaptation strategies into design typically costs much less than incorporating them after construction or in response to a major event.

Align and incentivize partners to work towards common sustainability goals. Provide sustainability training across the project lifecycle to ensure KPIs are understood and implemented. Establish sustainability-linked incentives to encourage innovation and maximize compliance.

Drive a technology-innovation agenda that supports project innovation and sustainability goals. Scientific research in a variety of fields is sparking development of technologies and processes that can be used to extend the life of infrastructure, expedite repairs and replacements, and increase cost savings. Innovation targets can encompass design, procurement, execution, and operation: eco-friendly materials, construction practices that minimize waste and environmental harm, and installation of energy-efficient equipment all contribute substantially.

A focus on sustainability and the future-proofing of projects can be aided by incentives from governments, regulators, and customers. But a common barrier is the view of sustainability as merely a cost and compliance issue, rather than as a priority in defining organizational strategies.

"By implementing 'Future Ready,' our global sustainability program, we think ahead about all the different uses of an asset over its life-time—right from the design phase. For instance, we recently designed a car park that can be turned into a residential unit at a later point."

—David McAlister, global director of transport & infrastructure, WSP

The way forward

Our survey and interviews suggest that while companies are ready for change, few industry leaders have begun the transition to a better project-delivery model. Change will require bold ambition and a systematic approach, with careful planning, smart sequencing, and sustained investment in new capabilities, tools, and approaches.

More than 75 percent of respondents to our survey said that a significant shift in project model was part of their organization's agenda, with more than half putting it at the top of their priority list. Yet 85 percent of leaders also said that their organizations had not scaled either the design or the implementation of actions to address any of the six levers discussed above.

Changing a model that has been in use for decades is always going to be challenging, especially when the work involves multiple stakeholders and multimillion-dollar capital investments are at stake. We believe, however, that companies can accelerate their journey to Projects 5.0 by taking four key steps.

Establish bold aspirations and a call to action
Projects 5.0 will require every organization involved in capital-project delivery to develop new capabilities, new mind-sets, and a new culture. A critical first step in that process is to understand the current state of the organization. Companies can step back and take a hard look at themselves, assessing their level of maturity in each of the six dimensions. This involves comparing their own processes and capabilities against those of best-in-class players.

Once they know where they stand, companies can determine the changes they need to make in order to transform their project-delivery model. They can set this ambition out in a clear and detailed way as part of a high-level strategic roadmap, explaining exactly what aspects of the organization will be altered, and setting ambitious targets for improved performance within projects and in the business as a whole.

Capture quick wins; plan the longer term
In any large-scale change project, rapid results matter. Actions that begin to generate value quickly don't just help the bottom line, they also serve to energize the organization and help build support for the transformation to come.

For capital-projects organizations, there are a number of opportunities for rapid improvements, many of which require limited investment and can start to pay back in weeks. For example, one effective strategy is to invite partners to the drawing board to crowdsource ideas for value engineering.

A strong implementation plan should include milestones, activities, owners, and timelines spanning the short, medium, and long-term horizons. A company can sequence and prioritize its Projects 5.0 initiatives based on two primary dimensions. The first is the scope of the change: at the enterprise or portfolio level, or at a project level. Some initiatives, such as the development of new partner-selection methodologies or contracting frameworks, apply across projects and hence can be done independently of specific project contexts. Some initiatives necessarily require piloting and operation within projects, such as the setting up of real-time monitoring systems, which needs a test bed within a particular project context.

The second dimension is the degree of collaboration required. For example, standardizing internal processes can be done entirely in-house, allowing a company full control of the changes it makes. Other initiatives, such as off-site construction, must be developed jointly with ecosystem partners. Broadly, the more stakeholders involved in effort, the higher its complexity and the greater the time and management resources required for success.

Invest real resources to drive change

The final, critical ingredient of a successful transition to a new project-delivery model is investment. An important prerequisite is to establish a separate budget for the program, with a dedicated task force to drive the transformation. In the wider organization, leadership metrics and incentives should be adjusted in line with the goals of the change effort. Beyond the management of the change program itself, organizations will also need to invest up-front in crucial platforms, such as their end-to-end digital infrastructure.

Once the building blocks are in place, the process of change on the ground can begin. This will be an transformation journey lasting an estimated 12 to 18 months. Through waves of pilots driven by a central transformation office, organizations can validate the impact, and move to rapid scale-up of priority interventions.

Find the right partners

Projects 5.0 represents a significant break from the sector's long-established delivery model. Implementing such a major transformation requires a different approach to change management. Organizations will not be able to achieve that through incremental adaptation of their existing processes, tools, and management approaches.

Instead, companies should begin with a clean sheet, designing their new delivery model based on the best available approaches within the sector and beyond it. In this effort, capital-projects players will want to draw heavily on insights and expertise from other sectors, where methods such as agile development and industrialization are already well-understood.

A collaborative ecosystem of partners is a central pillar of the Projects 5.0 approach, and the same will be true of its implementation. For ambitious players in the sector, choosing the right partners to help design and implement their transformation will be essential in unlocking the value at stake.

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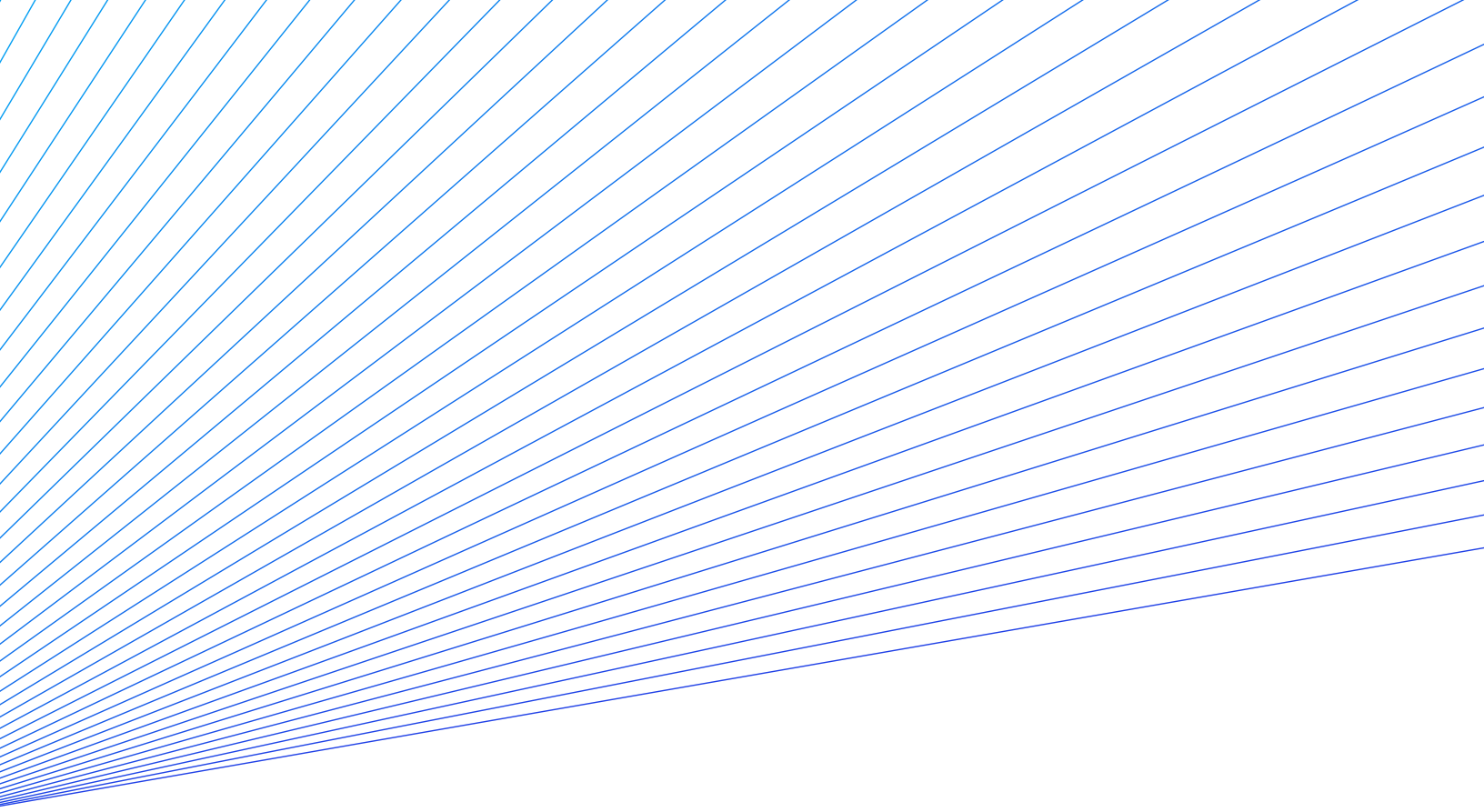

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