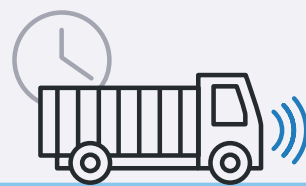# Innovation Growth in the
Lynchpin Industries

Challenges and Strategies for
AGRICULTURE, CONSTRUCTION
& TRANSPORTATION

About and Acknowledgements

The Center on Global Brand Leadership creates, gathers, and shares insights on how to build and manage strong brands.

Combining the research and intellectual capital of academia's foremost thinkers on branding with real world business cases, we show how all elements of an organization—from marketing and communications to supply chain and operations—can affect brands and their relationships with stakeholders.

The Center fosters a community of researchers, alumni, students, and business leaders from global corporations, agencies, and consulting firms to advance new knowledge, promote widespread learning, and serve as a forum to address the many challenges of brand building, brand management, and strategic marketing.

The Center on Global Brand Leadership was founded in 1999 at Columbia Business School under the direction of Professor Bernd Schmitt, a world authority on marketing and branding. The Center has also conducted global partnerships with leading business schools—in the U.S., China, Germany, Korea, Spain, and Singapore—to provide a global resource for researchers and practitioners.

Table of **Contents**

Introduction

It's easy to imagine a science fiction film panning out on the vision of a towering city of the future, filled with majestic buildings, interspersed with lush and vibrant vertical farms, while fully automated land, rail, and flying vehicles bring people and supplies to and from across the landscape.

At the same time, the key underlying industries at the core of these specific images—agriculture, construction, and transportation —are rarely viewed as innovation leaders on the cusp of such transformations. They are "lynchpin industries"[1] providing food, shelter, and mobility—all of which are at the core of supporting a stable society. However given the societal and business model changes of the digital age and global climate and resource transformations, it is more crucial than ever that these lynchpin industries are emboldened to become innovative leaders for the future.

Together, these three industries—agriculture (0.7%), construction (4%), and transportation (5.6%)—represent a roughly 10% contribution to US GDP[2], a significant impact on the global economy. And yet, consider that among the 100 largest market cap companies only eight are within these lynchpin industries—Tesla, Caterpillar, Union Pacific, Uber, Boeing, UPS, Lockheed Martin, and Deere[3]. Compare this to Professional and Business Services which have only a slightly higher contribution to US GDP at 13.2% but include four of the top ten market cap companies (at least partially)—Microsoft, Alphabet, Amazon, and Meta—and dozens of companies overall in the top 100. A changed mindset around the innovation growth potential of the lynchpin industries could drive more robust capital investment towards them.

Historically speaking, each of the lynchpin industries has been responsible for vitally important leaps forward for humanity, and each has had moments where their innovations catapulted them to the heights of societal and commercial attention—be it the lifesaving development of pasteurization, combining steel and concrete to raise buildings to the sky, or applying internal combustion engine principles to create the automobile. And yet, over the past several decades, these lynchpin industries are often mired by the perception that they lack a commitment to fresh ideas and driving transformative change—that they are innovation laggards.

So how can this change? Fortunately, as noted, robust innovation has occurred, and is occurring, within these lynchpin industries. By taking lessons from cases when these industries were quick to adopt emerging technologies, combined with the application of forward-thinking management transformation and forecasting techniques, there are clear pathways to help drive firms in these lynchpin industries to become more efficient and, ideally, accelerate their growth.

This report will detail key areas that hamper innovation, both generally and specific to the lynchpin industries. Reflecting on these challenges is important to help organizations map out where they are still held back, even amidst a desire to be more innovative.

Alongside these roadblocks, the report will offer a range of techniques and ideas about processes and best practices that can help these industries break through innovation barriers. In the interest of the flow of the report, these ideas are presented as strategies to address a specific challenge, but many of them are cross-cutting and could be applied to various challenges and issues faced by organizations.

Innovation Laggards:
a Partial Reality

The recent reputation of these lynchpin industries as innovation laggards is due primarily to their slower adoption of the interconnectivity and systems of the digital age. As an example, a 2016 analysis from McKinsey, using a range of reporting and metrics from private and public sources, examined 22 sectors on their digitization progress, including the use of digital services across spending, asset stock, transactions, business processes, market making, and worker management. The transportation sector ranked 11th, construction was 21st, and agriculture was 22nd[4].

On top of this, these lynchpin industries have also struggled to show productivity gains over the past few decades. For example, Austan Goolsbee and Chad Syverson published a 2022 NBER conference paper, "The Strange and Awful Path of Productivity in the US Construction Sector,"[5] that analyzed why production value added per worker in the sector was about 40 percent lower in 2020 than it was in 1970. The pair don't dive into specific innovation factors that might be at play, but they do examine the capital stock of intellectual property (as defined by the Bureau of Economic Analysis) and find, "The U.S. construction sector is less IP-capital-intensive than the economy overall. For instance, in 2020 IP capital accounted for 4.0 percent of the sector's total capital stock, while the same ratio for the broader economy was 7.4 percent. On a per-employee basis, IP intensity in construction is an order of magnitude smaller than in the rest of the economy."[6]

Agriculture has long suffered from telecommunications business models that leave large farmland areas without reliable broadband internet connectivity, thus losing opportunities for data gathering and automation that could support innovative processes and approaches.

The outlier of the lynchpin industries is, unsurprisingly, transportation, where automotive and aircraft manufacturing efforts and management have always incorporated a strong R&D budget relative to revenue. This created a culture more focused on the innovation potential of data and interconnectivity. Overall, however, the sector's vast scope has created a mix of leaders and laggards across the industry.

What Hampers the Pace of Innovation and How to Break it

Universal Challenges

Many organizations, arguably most, do not struggle with the development of creative ideas, whether it be among staff, management, or leadership. Converting creative ideas into an innovation pipeline is where things often break down.

There is a mixture of culture and process that must be developed, and there are a few key challenges that cause firms to stumble regardless of any leadership desire to be forward thinking.

THIS IS HOW WE DO THINGS

One prime cause that hampers an innovation mindset, and one common among the lynchpin industries, is the inertia caused by prioritizing the daily operations of running an organization. This has led to the clichéd refrain, "This is how we do things, and this is how it needs to be done." Companies that craft and execute a successful business model are expected to drive consistent and reliable results—which, ironically, hampers their attention to innovation practices, and can also make them averse to the risk inherent in adopting new ideas and processes.

BREAKING THIS CHALLENGE

One technique to help organizations to break out of this historic mindset is a technique that Bernd Schmitt, Robert D. Calkins Professor of International Business at Columbia Business School, calls "killing the sacred cows."[7] Used numerous times with corporate executives, the idea is to craft a list of all the core beliefs or activities of both your industry and firm, e.g. every project requiring vendor support starts with developing a full-scope Request For Proposal (RFP). Once crafted, small teams then work together to imagine doing the opposite; e.g., all projects start by receiving rough concept pitches before any detailed RFP is drafted. Then they craft the necessary organizational management efforts and budget requirements. Major hurdles such as regulatory requirements can be noted, but should be seen as something that can be solved rather than as hardline barriers.

FEAR

Another significant factor hampering innovation is fear. A McKinsey analysis around innovation barriers noted, "our research shows that three fears hold back corporate innovation more than others: fear of criticism, fear of uncertainty, and fear of negative impact on one's career."[8] Interestingly, among companies that reported they were mastering innovation compared to companies that felt they weren't, the main difference was a lower fear of career impact. Unless the leadership of an organization specifically rewards risk taking, employees feel little motivation to stick their necks out to present new ideas.

BREAKING THIS CHALLENGE

Simple language choice can help leadership tweak its culture to accept risk over fear and drive innovation. Erik Roth, Senior Partner, McKinsey, notes examples of successful company practices in this area, "[One] organization has replaced the word pilot with pioneer. The subtle point is that when something doesn't work, we won't call it a failure but see it as a step, backed by the full intention to keep going forward. They found this small change helped them find ways to iterate beyond initial trials."[9] Roth notes that leadership must also demonstrate actions which make it clear that, "I'm willing to take people and money out of my organization and put it toward the goal."[10]

COST

Another constant and familiar element that stifles innovation is cost. This may be tied to risk aversion, but in other cases, it is just a matter of available budget. This is particularly true in long-established industries with low-margin business models that are challenged in budgeting for idea exploration. The modern globalization and digital age vastly widen access to the means of production and distribution and has lowered the costs of experimentation. It is still necessary, however, to have a significant enough level of funding (and human capital) set aside in a company's budget for trial initiatives, which may or may not ever deliver a return.

BREAKING THIS CHALLENGE

One of the benefits of modern innovation processes is that establishing small teams with very minimal initial budgets is a best practice. The goal of getting started is to stimulate new thinking, without too many cooks in the kitchen, and launch an effort in a very minimal fashion to receive user feedback to learn and iterate (or drop) the idea before making any decisions around a scaled financial and management commitment.

The long-successful playbook of business culture (and its investors) around *sustainable competitive advantage* led to a linear, and often insular, "research, plan, decide, build" mentality towards new project development. Research was based on existing perceptions of the company, its stakeholders, and its industry without looking at any outside factors. Planning was generally done internally with no stakeholder feedback. And, final decisions, budget, and timeline were approved at the very top of the organization, often without consideration of the go-to-market challenges that might exist.

Despite tech start-ups driving widespread attention and awareness to the value of test-and-learn innovation, e.g. as agile or lean methodologies, such efforts have been very difficult for other industries, including the lynchpin industries, to adopt. For most industries, historic barriers to new entrants drove a mindset that there was no urgency to spend on digital innovation initiatives.

Universal Challenges Hampering Innovation

	THE CHALLENGE	BREAKING THROUGH
THIS IS HOW WE DO THINGS	• Confidence in historic practices that drove success • Mentally locked-in "rules" for the firm or industry	**"Killing the sacred cows"** • Have teams imagine doing the opposite of an existing rule • Quickly draft the strategy and resources to make this shift
FEAR	• Fear of criticism • Fear of uncertainty • Fear of negative impact on one's career	**Leadership language and incentives that makes it clear employees can take risks** • Use of "pioneer" rather than "pilot" • Funding carved out where near-term ROI is not a KPI
COST	• Aversion to spending without assured value • Lack of budget availability	**Innovation is best with small teams and small budgets** • Testing new ideas is intended to be very small scale to start • The cost issue only needs to be a factor in the decision to scale

Specific Barriers for the Lynchpin Sectors

As David L. Rogers, author of *The Digital Transformation Playbook*, noted, "Many executives I speak with hope to talk about the unique challenges of innovation in their industry. In general, I've found that most companies suffer from the same issues, but there are usually a couple of specific industry-oriented nuances."[11] The challenges noted above are core barriers for almost all industries, but the lynchpin industries face some specific, common challenges that distinguish them from other sectors.

An Aging Workforce

Across these industries, and particularly in agriculture and construction, the workforce is graying. As an example, the USDA found that, "The average age of all U.S. farm producers in 2017 was 57.5 years… continuing a long-term trend of aging in the U.S. producer population."[12] While experience can certainly drive an

understanding of how external changes might affect an industry, it can also stifle new ideas and create a reliance of fixed thinking that can hamper an industry as the world transforms.

An aging workforce can affect a commitment to use new technologies and impede effective management of a younger workforce that is accustomed to digital change. As Jose Luis Blanco (McKinsey) noted, "About 40% of construction workers are expected to retire in the next five years. By and large, the workforce is not digitally native, and so you need to push them to rethink how to work, which is a challenge."[13]

LEVERAGE THIS CHALLENGE TO IMPROVE EFFICIENCY AND TALENT MANAGEMENT

Paradoxically, the challenges of an aging workforce may drive firm-level innovation commitments. As the workforce dwindles due to retirement, lynchpin ecosystems may employ digital innovations that drive efficiency; field sensors, data analytics, machine learning, machine automation, etc. Transitioning to more integrated digital systems and physical automation can help firms to do as much (or more), despite decreasing labor levels and an aging workforce.

And as firms make these commitments, this can also help change the perceptions of younger, digitally native generations, who may come to see these lynchpin industries as more aligned with their workplace expectations. In a 2023 report from the software company Riverbend for example, 91% of IT decision-makers believe they need to provide more digital experiences to Gen Z and Millennial employees, and two-thirds are concerned about attrition and reputation impacts if they don't offer improved digital experiences .[14]

"At Trimble we are working to adapt some of our tools, like our 3D modeling tool SketchUp, to create a Minecraft-like experience," notes Chris Keating, "so that we can excite the next generation into the potential of our industry." And Guillermo Perez-Iturbe (Trimble®) spoke about how his family's farm is having success hiring the next generation of employees who are knowledgeable and interested in working with the automated processes and machinery that have become a part of the farm.[15]

These changes can also create a more collaborative working environment across the generations in the lynchpin industry workforce. Digitally native employees can help inspire the existing workforce to adapt and embrace the benefits of emerging technologies.

Regulatory Regime

With public safety so closely tied to the lynchpin industries, they are among the most highly regulated sectors in the global economy. Compliance issues play a huge role in depressing a drive for innovative solutions, as any new practice or technique not only has to get to a working "proof of concept" level to show potential commercial advantages, but the practice must then also be able to meet regulatory requirements.

This all adds to an imbalance of the risk/reward trade-offs in committing to novel approaches. Barriers to gaining regulatory approval or facing penalties for problems with an inspection approval can depress the push for innovation. Compounding the challenges of any single regulatory hurdle, these policies vary widely from state to state, and even town to town, in the US, as well as across every global region.

Another effect of the broad regulatory variance is a decreased incentive to insights and ideas developed elsewhere. Instead, organizations often focus only on specific regions, hampering the diffusion of new ideas across regions. As Paol Hededal (Ramboll) noted, "Regulation can be both a driver of and barrier to innovation. In the EU, the regulations to protect privacy push innovation on data security, but they also hamper data sharing, which means that industry ecosystems have more of a challenge learning from each other's successes."[16]

> "
>
> At Trimble we are working to adapt some of our tools, like our 3D modeling tool SketchUp, to create a Minecraft-like experience.
>
> **Chris Keating**

PUSH FOR COLLABORATIVE POLICIES

Global regulatory agencies are constantly challenged to balance the protection of public and worker safety with the potential for innovation to create economic and societal benefits. Because technologies tend to emerge faster than regulators can review them, the challenge is becoming increasingly consequential. One technique developed to manage safety alongside rapid change is voluntary regulatory partnership programs (VRPPs). These efforts began in the 1970s and have shown promise (with some pitfalls) at improving industry standards and public safety in less punitive and more collaborative ways.

One largely win-win example in agriculture was the implementation of the Hazard Analysis and Critical Control Points program (HACCP) by the US Food Safety and Inspection Service (FSIS). The HACCP crafted an evidence-based program that, "[put] responsibility for food safety into the hands of food producers, rather than into the hands of government inspectors. Three hundred large plants implemented HACCP in January 1998, and the improvements were seen as significant within a year. Salmonella had been reduced nearly 50 percent in chicken products, 30 percent in ground beef, and 25 percent in pork products."[17]

A more recent example from the transportation arena has been regulatory guidance allowing autonomous vehicles (AVs) to drive on public roads. Numerous, and relatively fast-moving, new

regulations and pilot permissions (across the globe) have been driven by an intrinsic belief among both transportation companies and regulators that AVs have the potential to create safer road conditions and offer societal benefits.

Lynchpin industries should identify and act on opportunities to support, develop, and push for greater collaborative and voluntary partnership programs with regulators. It is important that such efforts are not perceived as "get out of jail free" cards for industry failures, but are crafted to promote liability procedures, risk management protections, and a high level of data sharing (with effective privacy protections). As emerging technologies create increased data collection and analysis, developing such partnerships between industry, regulators, and (potentially) employee unions, has the potential to drive the dual goals of innovation and public safety.

Ecosystem Complexity

Each of these sectors has a wide-ranging ecosystem of firms and stakeholders. With many parties at play, strategically sharing the risk/reward potential for innovation is challenging. Traditionally, the contracts between the owners/capital investors, and the various other stakeholders and contractors are rarely structured to incentivize innovation.

An example from the construction sector, arguably the largest ecosystem, is what Bent Flyvbjerg, the Villum Kann Rasmussen Professor and Chair of Major Program Management at the IT University of Copenhagen, has called "The Iron Law of Megaproject Management."[18] He has compiled a database of thousands of megaprojects (those with a cost of $1 billion or more) and he has found that "48 percent of big projects finish on budget, eight-and-a-half percent finish on budget and on time, and only half of a percent of big projects finish on

budget and on time, delivering the expected benefits."[19] Numerous studies across the industry have found that construction projects budget and time overruns occur in the majority of cases, no matter the project size.

Flyvbjerg finds megaprojects to be particularly interesting, because almost all of them incorporate a push for innovative engineering and design approaches; these construction projects are initiated to be beautiful and iconic structures that will raise the profile of their location. Sadly, project management efforts are often the inverse of what they should be to accomplish that goal. As Flyvbjerg notes, "You need to go slow at first (during project preparation) in order to run fast later (during delivery). But often the situation is the exact opposite. Front-end planning is rushed and deficient, bad projects are not stopped, implementation phases and delays are long, costs soar, and benefits and revenue realization diminishes and recedes into the future."[20] If megaprojects, which are aimed to drive innovative practices, are doomed to excesses in expenses or time, why would smaller efforts want to take on that risk?

Furthering the large ecosystem challenges in construction, projects are usually driven by a land/property owner who generally has a set budget and output expectation. Their RFP, and each subsequent sub-contracted RFP, is mostly going to be accepted or denied based on competitive bidding on timelines and costs. This creates

what is known as a horizontal discontinuity, in which different organizations handle different stages of a project. As Will Hughes, (University of Reading) and Lars Stehn (Luleå Technical University) note, "At each stage, work is subcontracted, and suppliers are enrolled into a project through a variety of contracting techniques. It is common to subcontract, and values up to 70% of the contract sum are not uncommon in housebuilding; moreover, it makes sense to do so because of the continuity of work. However, this involves putting the demand to the market such that parties may negotiate the terms of their contract (usually via competitive tendering) on assumptions about the kind of technology that will be eventually installed. This dominant approach to construction procurement is based on economic, organizational, and business practices that unintentionally conspire to prevent innovative technologies getting to the market."[21] Therefore, the standard practice in the construction industry has optimized timelines and costs which can stall technical or process innovations. Even if an individual contractor adopts a new technology or process to improve its efficiency or profit, there may be minimal impact on the overall project cost and timeline.

LEVERAGE NEW CONTRACTS THAT ENABLE RISK/REWARD SHARING

Given how these ecosystems can stifle innovation, shifting from the standard request-design-bid-build process to a more collaborative approach among all stakeholders—owners, contractors, subcontractors, and suppliers—can create greater efficiencies and a more shared-risk scenario to stimulate technology, process, and asset innovations.

As an example, a World Economic Forum (WEF) report from 2016 identified four key areas necessary to advance a collaborative partnership in the construction sector: project culture, tendering and contract, incentive mechanisms, and conflict resolution.[22] The overall goal is to support the ecosystem to create common goals among all stakeholders, develop more "open book" financial reviews, and use common data environments. Contracts should look at overall efficiencies rather than focus on the cheapest bid. The contracts should be multi-party with clear accountabilities and involvement of each party early in the design process. There also need to be incentives for cost optimizations and shared risk/reward decisions in which new ideas or alternative vendors or sources can be considered without unduly affecting only one party. Finally, the contracts should establish effective internal dispute resolutions among the parties and provide an advanced set-up for third-party mediation and arbitration.

As an example, the WEF report notes a pilot project in the UK to build six wind-powered turbines. The contractor was involved from the start of the process and was able to help the owner manage increasing steel costs by adjusting the project design to be more cost-effective and working with a crane supplier to modify and improve the lifting process to reduce the amount of materials needed.

Project Uniqueness

Every piece of land, and thus every construction, transportation infrastructure, and agricultural project, is unique. A common challenge for all innovation efforts is that the risk/reward structure

is often dependent on scalability. Yet carefully crafted design plans are often adjusted on-site due to the unique environment or situation of the build. As Chris Keating notes, "Even if you have well documented design and engineering plans, they aren't always edited and updated effectively as a project is underway and completed. Thus, when inevitable maintenance or retrofit projects come online, working teams must manually rediscover the onsite infrastructure to validate exactly what work had been done and with what materials. So, there is little ability to learn from earlier approaches and scale them up, since the design and the build are rarely a perfect match."

In addition, the horizontal discontinuity of sub-contracting comes into play once again. Hughes and Stehn cite that transaction cost economics, i.e., the make-or-buy decision, tends to create an economic advantage for the buyer. "In the construction sector, this often leads to the establishment of a series of contracting-out decisions, each of which is a rational and economic decision for the buyer of the sub transaction. The rationale is that specific resources cannot be kept in-house since the need for them varies a lot between one project and the next…. The successive, contracting-out decisions make it almost impossible for innovation to take place, if innovative entrepreneurs with ideas for new technological solutions are at the end of a long chain of subcontracts."[23]

LEVERAGE CONSTRAINT TO DRIVE CREATIVITY

Unique situations lead to constraints on what is possible, but at the same time, research shows that constraints can spur creativity. The key is in managing the levels of different types of constraint. For example, the challenges of project uniqueness represent *input constraints*[24] in which there are limitations on the resources available or starting scenarios for which a solution is needed. Interestingly, with too few input constraints, people and teams can become complacent about pushing for creative problem solving; at higher thresholds the constraints are overly burdensome and similarly demotivating. Where possible within a project, aim to break the effort up into sub-projects that have a moderate level of input constraint, i.e., not too low and not too high. In this sweet spot, people can be motivated by the constraint while having a sense that solutions are achievable. As Prof. Oguz Acar, et al. note in

> "
>
> While clients had been resistant to the idea of subscription services, they recognize the need to begin the journey where shared data drives innovation and future growth and security.
>
> **Chris Keating**

their literature review on the topic, a "moderate level also prompts a mind-set to maximize the creative value generated from available resources, to search for novel combinations using what is at hand, and to think beyond traditional solutions."[25]

Siloed Data and Decisions

Stemming from the issues of complexity and uniqueness, even when innovative ideas become proven, existing legacy assets and unique digital systems make innovations hard to scale across lynchpin ecosystems. The potential for analytics and machine learning models to develop new insights and create efficiencies is lost when data is siloed among multiple parties. Jose Luis Blanco (McKinsey) stated that even larger engineering and construction firms that have been more committed to digital transitions and innovation have often grown via M&A, so even within a single firm there are often legacy software systems and assets that impede digital transformation.[26]

These siloed data issues are further exacerbated by the operational nature of these lynchpin industries. There isn't necessarily a holistic review between the financial decision-maker, the project manager, and the on-site teams on a project thus making it difficult to track potential efficiencies and process innovations. In addition, available data can be inconsistent due to the analog methods of recordkeeping that historically prevail in the field.

The value of analytics software systems and the insights and efficiencies they provide are well recognized, but the lynchpin industries still face behavioral change issues in fully adopting such systems. Subscription software tools, including those within physical assets (e.g. John Deere tractors), offer great potential for data gathering, analytics and experimentation. But at the same time, such systems shift the historical decision-making process from a one-time buy of an asset that could be used over a long period of time to an annual cost commitment requiring regular assessment. As Chris Keating states, "While clients had been resistant to the idea of subscription services, they recognize the need to begin the journey where shared data drives innovation and future growth and security."

LEVERAGE COMMON PROTOCOLS

One area where the lynchpin industries were early adopters of innovative techniques was demonstrated during the introduction of computer-aided design (CAD) in the late 1970s and 1980s. The capability to make quick edits and adjustments to designs and layouts without having to redraft them physically was a boon to all design-related development in these fields. This continued to advance as computer-aided manufacturing (CAM) systems developed and transformed physical production.

Autodesk's founding in 1982 and it's AutoCAD format became the most iconic proprietary software in the field. But a key reason CAD innovations scaled was due to government involvement. The US Air Force's Integrated Computer-aided Manufacturing (ICAM) division created the Initial Graphics Exchange Specification (IGES), a vendor-neutral file format to allow the ecosystem to integrate CAD efforts across the different software systems.

Innovations that incorporate a common protocol vastly improve interoperability within firms and across all partners in an ecosystem, thus creating the dual benefits of scalability and efficiency. In many cases, these common protocols are fostered by public sector investment and involvement. The development of TCP/IP and HTML as common protocols for the development of the internet is the most obvious modern example of the power of such efforts to drive and scale innovation.

However there are numerous examples of industry-driven common standards. Lynchpin industries are familiar with consensus-based voluntary standards as well. Utilizing these existing principles can help bridge the underlying ecosystem challenges of siloed assessments and decisions and be a key innovation driver for the future.

Barriers within the Lynchpin Sectors

	THE CHALLENGE	**LEVERAGE IT TOWARDS CHANGE**
AN AGING WORKFORCE	• Experience can lead to rigid mindsets • Impending retirements shrinking the workforce • Cultural friction with incoming generations	• Innovation efficiencies can be championed to manage a shrinking workforce • Innovation commitments drive career interest from digital natives
REGULATORY REGIME	• Imbalance of risk/reward trade-offs due to approval hurdles • High variance of rules across localities hinders diffusion of innovations	• Find shared interests with regulators around innovation benefits • Develop voluntary regulatory partnership programs
ECOSYSTEM COMPLEXITY	• Contracts push quick upfront planning whereas innovation efforts require time to test and learn • Numerous sub-contracts deflate the risk-reward equation for new ideas and processes	• Craft contracts that bring ecosystem partners into a shared experience early in the project • Create contract incentives for all players to look for and benefit from implementing innovations
PROJECT UNIQUENESS	• Plans must be constantly adjusted due to on-site conditions • Successful approaches are difficult to scale	• Use these known constraints to drive creativity • Sub-divide project planning to craft situations with a moderate level of constraint to allow sense of achievability
SILOED DATA AND DECISIONS	• Limited amount of shared or interconnected data to analyze for insights and innovations • Lack of holistic analysis of all project processes to tease out innovation needs • Culture shift challenges to adopt shared and subscription-based platforms	• Develop or use common protocols to drive greater data and knowledge sharing across the ecosystem • Highlight benefits from historic use of common protocols

Drivers to
Adopt Innovations
Common Drivers

As noted, over the past few years the lynchpin industries have turned a corner and become eager to embrace innovation. For example, a 2022 McKinsey survey among construction and building executives asked respondents to rank their top two priorities among seven future-looking choices; 70 percent ranked "get smart and invest in innovation and R&D" as one of their top two choices—more than any other option.[27] Such sentiments were also reflected by the industry expert interviewees for this report. So, what are some factors that might help encourage organizations to experiment and innovate more?

> When innovation has allowed traditional information to gain greater utility, I have seen the adoption of such technologies occur much faster.

Efficiency and Cost Reductions

Despite any aversion to risk, when new ideas can create quick wins around efficiency or cost reduction, companies are quick to adopt such innovations. The lynchpin industries, or at least core elements of them, are on the lower end of net margin across the global economy.[28] With smaller margins extra focus is paid towards cost savings.

One modern example is the ever-increasing use of Software as a Service (SaaS) systems in the lynchpin industries because of the convenience and time saving gained by the instant recording of, and access to, data via mobile tablets and phones. As Atul Khanzode (DPR Construction) noted. "For example, when PlanGrid fully established its digital blueprint capabilities, we saw every site superintendent want an iPad with the PlanGrid App on it"[29]

Access to New and Valuable Sources of Information

The modern-day parlance is "data is the new oil,"[30] as coined by Clive Humby. This speaks to the combination of information's high value, along with the need for data to be analyzed, refined, and distilled to become something actionable.

One great example of lynchpin industries becoming early technology adopters was their commitment to geospatial technology. Reliable location information quickly became a game changer in the agriculture, construction, and transportation industries. The ability to reduce the time needed to generate measurements, along with the ability to consider and evaluate multiple location point possibilities, proved extraordinarily valuable to these industries. This technology and information-rich development also happened to be driven by one of the lynchpin industries, aerospace transportation. The US government developed geospatial technology with satellite launches in the 1970s and officially made its Navstar GPS technology publicly available in 1983.[31]

Lynchpin Industry Drivers

Consistency

Anything that adds consistency and reliability to a common process has been an innovation driver, with Henry Ford's assembly line as an iconic example. Consistency could certainly be viewed as a subset of efficiency in cases involving the automation of a process, but it can also include service elements—e.g., better 'on time' delivery—that engender stakeholder trust rather than, or in addition to, cost reductions.

In fact, the lynchpin industries have fostered a leadership role in the development of automated mobile machinery. Onsite conditions in some construction and agricultural industries provide well-regulated, controlled, and consistent environments. This creates test beds for how autonomous, moving machines and people can effectively use an integrated space. The broader transportation sector continues to add automation into various types of vehicles being used in pilot situations on roadways, but the pace is slowed by the regulatory, insurance, and public perception challenges this sector faces.

In addition to the core issues that drive all innovation efforts, it is important to examine some specific areas within the lynchpin industries that are likely to be most impactful in the near term.

Interoperability

The value and interoperability of digital design efforts is becoming well established, and is driving interest in how interconnected systems within a firm, and potentially across an industry ecosystem, can drive innovation—not only across design, but also cost estimates, progress payments, project inspections, compliance, and possibly other areas.

Several key technologies and processes will continue to advance innovation across the lynchpin industries via increased interoperability:

- **Cloud-based Data Systems**—trust and use of cloud software solutions and applications will continue to drive interest in data sharing across the ecosystem. In addition, such systems offer efficiency improvements to both collaborative planning and real time updates of site conditions.
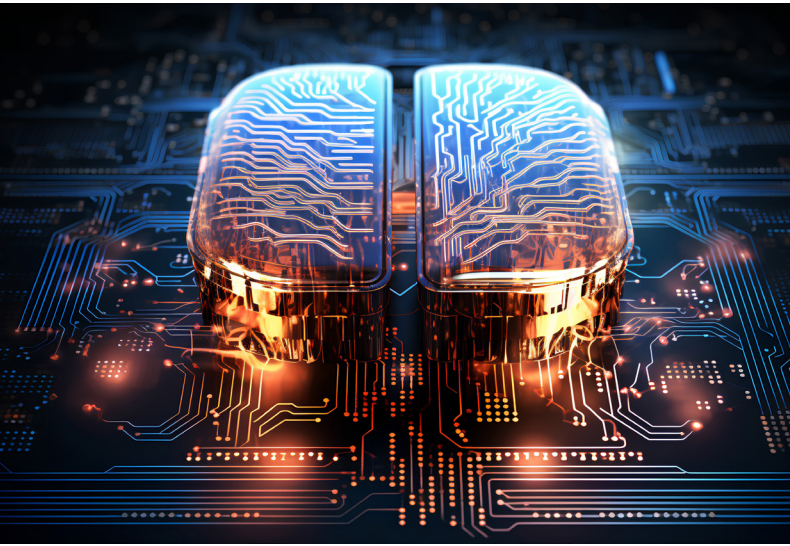
- **Machine Learning/Artificial Intelligence (AI)**—the ever-increasing power of computer AI systems is rapidly increasing the ability to run predictive simulations on digital designs prior to a project being started in the physical world. In addition, as things are built, they will now have a "digital twin" within these platforms that can be updated on a real-time basis and can be retained through their lifecycle, with the potential to do predictive modeling to uncover scenarios that will require real-world action at the time that is needed.

- **Faster Human Feedback**—given the access capabilities of these systems, garnering input and feedback from a range of affected stakeholders will be improved. With these multi-player and complex ecosystems, there are added efficiencies to come from incorporating all affected stakeholders into the design, execution, and lifecycle of a project.

In the near-term, the overall interoperability of these efforts will, in most cases, still be driven by larger, trusted software providers and cloud system companies. But they will also incorporate, and often contribute to, open-source software. Small and medium-sized firms will be resource challenged to use solely open-source systems given the skillsets and experience needed. Plus, fully open-source systems have added risks of unanticipated problems, cyber security failures, and the need to directly execute real time fixes.

SCALING THIS IMPACT: STANDARDIZATION

To generate the full value of this digital shift, continued pushes around standardization will be needed, whether voluntary or through a standards body. The power of IGES, noted above, fanned the flames of CAD usage across the ecosystems. And the impacts of the digital age, after all, were driven by the development of common protocols and languages (TCP/IP, HTML) that drove the rapid scaling of the internet.

A crucial factor in how fast ecosystem-level impacts can occur from data sharing and advance analytics will be the balance of competition and cooperation among the software services vendors that serve the lynchpin industries (Autodesk, Bentley Systems, Trimble, etc.), and their relationships with major cloud providers (AWS, Microsoft Azure, Google Cloud, etc.). When the economics and business models of these platforms heavily favor "walled garden" systems that restrict integration with other parties, this pace of innovation across the sectors is negatively impacted.[32] The development of data and analysis platform systems that are technology agnostic will provide the agility for greater ecosystem innovation over the long-term. Companies can also benefit in the near-term via opening up a larger potential customer base.

Growth of Venture Capital

The 21st century brought rapid changes in market share across many consumer-oriented industries, e.g. Apple and Samsung taking over smartphones, Amazon going from books to an ecommerce behemoth, and PayPal and Venmo growing peer-to-peer consumer payment systems. "The market side in the world of B2B, however, can slow down disruptive innovations a bit," noted David Rogers, "as there are longer decision-making cycles and often multiple stakeholders within a contract."[33]

The 2022 McKinsey Building Projects survey confirms a similar sentiment among construction executives. When respondents were asked to prioritize the most important trends affecting their business, only one in five respondents expected "competitors with new tech/more sustainable solutions" to be important over the next 5-10 years.[34]

And yet, the lynchpin sectors have been added to the ever-growing list of "Your Industry Tech" terms in the business and investment press lexicon. Taking the agriculture sector as an example, Crunchbase data between 2017 and 2021 indicates that the number of AgTech deals increased from 267 to 440, and the total investment expanded from $1.1 billion to $4.9 billion.[35]

The venture capital (VC) now being poured into innovative firms and projects is coming not just from the world of finance, but also from established firms within the lynchpin industries. A non-comprehensive list of lynchpin firms and vendors with venture divisions includes Autodesk, Bechtel, Bouygues Construction, BMW, CEMEX, Denso, GM, Hensel Phelps, JetBlue, John Deere, KLM, Monsanto, Ryder, Suffolk, Syngenta, Trimble, UPS.

As just one example, Suffolk Technologies closed its first $110 million fund in July 2023 with investments in over 30 ConstructionTech companies working across the needs of the construction ecosystem. These included projects like OpenSpace (using the AI image analysis to capture photo and 3D models of construction sites through their progress), Moxion (working on mobile battery power to reduce on-site emissions), and Canvas (which has developed a drywall finishing robot).[36]

SCALING THIS IMPACT: TALENT GROWTH

Beyond just development of innovative ideas, this VC investment can entice younger demographics into these fields. In a 2021 IPSOS survey of global consumers, they found that Millennials had the most "entrepreneurial mindset" among all age demographics. In addition, the largest growth in this mindset, as compared to a 2018 survey, were among those with lower levels of education and income,[37] who view the lynchpin industries as among their top career paths.[38]

These pushes of investment can also spur interest among a wider array of Millennial and Generation Z workers with entrepreneurial and technical interests. The high potential financial and career windfalls from being involved in a

consumer-oriented software start-up has waned a bit. So, interest in industries that are expanding their commitments in venture efforts and innovation labs is on the rise. In addition, these generations are also more concerned by climate change and social justice, and they recognize the impact that all three industries have on those issues. Highlighting investment commitments to innovation and a start-up ecosystem provides an opportunity for the lynchpin industries to drive talent recruitment among both traditional and non-traditional demographic audiences.

Government Investment and Commitment

Government actions vary across regions and countries, and are too vast to fully encompass here, but there is a growing interest in driving innovation in the lynchpin sectors across the globe. This is, in part, propelled by the potential of widespread economic advantages that can come from infrastructure improvements. In a 2014 analysis, the International Monetary Fund estimated that if advanced economies invested an extra 1% of GDP into infrastructure construction, they would achieve a 1.5% increase in GDP after four years.[39]

Such forecasts helped drive a bipartisan commitment in the US to break through its frequent partisan deadlock and pass the Infrastructure Investment and Jobs Act at the end of 2021. This bill authorized $1.2 billion of spending in such areas as roads and bridges, water infrastructure, resilience, internet infrastructure, and more. Of course, every major new government initiative tends to hit hurdles, as described in the earlier details around megaprojects and an understanding of its real impact may take several years to fully analyze.

In expert interviews, there was cautious optimism about the potential for this to deeply impact all three industries where they intersect with infrastructure-related projects. The very nature of a large amount of committed capital can drive increased risk taking and change the norms of business sectors.[40] However, the nuances involved in any project in these industries requires flexibility in terms of regulation and government contracts.

SCALING THIS IMPACT:
PUBLIC-PRIVATE PARTNERSHIPS

Due to shifting regional and global economic trends, and the effects of climate change, regulatory regimes are now recognizing that they need to function as partners in promoting innovation. Several regulatory organizations have, for example, initiated hackathons to help get exposed to the latest technology and innovative approaches within the industries they regulate. New York City's Department of Buildings (DOB) ran a "Hack the Building Code" innovation challenge in 2020 and 2021 with the aim to get exposed to ideas (and people) that would improve the city's built environment. The effort includes a focus to improve core construction practices, safety techniques, sustainability and resilience innovations, and outdated regulations.[41]

> "
>
> When respondents were asked to note their expectations of what would affect their industry in the next 5-10 years, "carbon reduction/sustainability" was ranked fifth among 36 trends.[45]

McKinsey Building Projects survey 2022

Importantly, public-private partnerships can only innovate and scale effectively when proper needs assessments are conducted for any individual project. At times, government-supported projects begin with a few pilots and then, in the interest of efficiency and limited funding, the most successful effort is scaled across a broad region. This habit can be particularly wasteful due to the varying site conditions within lynchpin industry projects as well as differences within local communities—there's no single effective solution that fits all situations. Both governments and firms should take the time to analyze site and community needs, and involve other local

and national stakeholders, to push forward projects that will most effectively use any public resources. A balance between common needs with low-variability, alongside high-priority and site-specific projects can create the greatest impact.

Sustainability and Climate Change

There is an ever-growing global chorus—from governments, from citizens, from NGOs, and from companies—encouraging all business practices to evaluate and moderate their environmental impacts. Whatever global or regional data one looks at, the lynchpin industries are massive contributors to CO_2 emissions and climate change. Some examples include:

- According to the UN Environmental Program, the global buildings and construction sector accounted for over 34% of energy demand and around 37% of energy and process-related CO_2 emissions in 2021.[42]

- The transportation sector contributes 28% of 2021 greenhouse gas emissions in the US, according to the Environmental Protection Agency.[43]

- The agriculture sector contributes 10% of 2021 greenhouse gas emissions in the US, according to the Environmental Protection Agency.[44]

Whether it be government regulations, shifting expectations of controlled capital, or social pressures, all of these ecosystems are under increasing pressure to find ways to reduce greenhouse gas emissions and other environmental impacts. The lynchpin industries recognize this, and many firms applaud it. In the McKinsey Building Projects survey in 2022, when respondents were asked to note their expectations of what would affect their industry in the next 5-10 years, "carbon reduction/sustainability" was ranked fifth among 36 trends.[45]
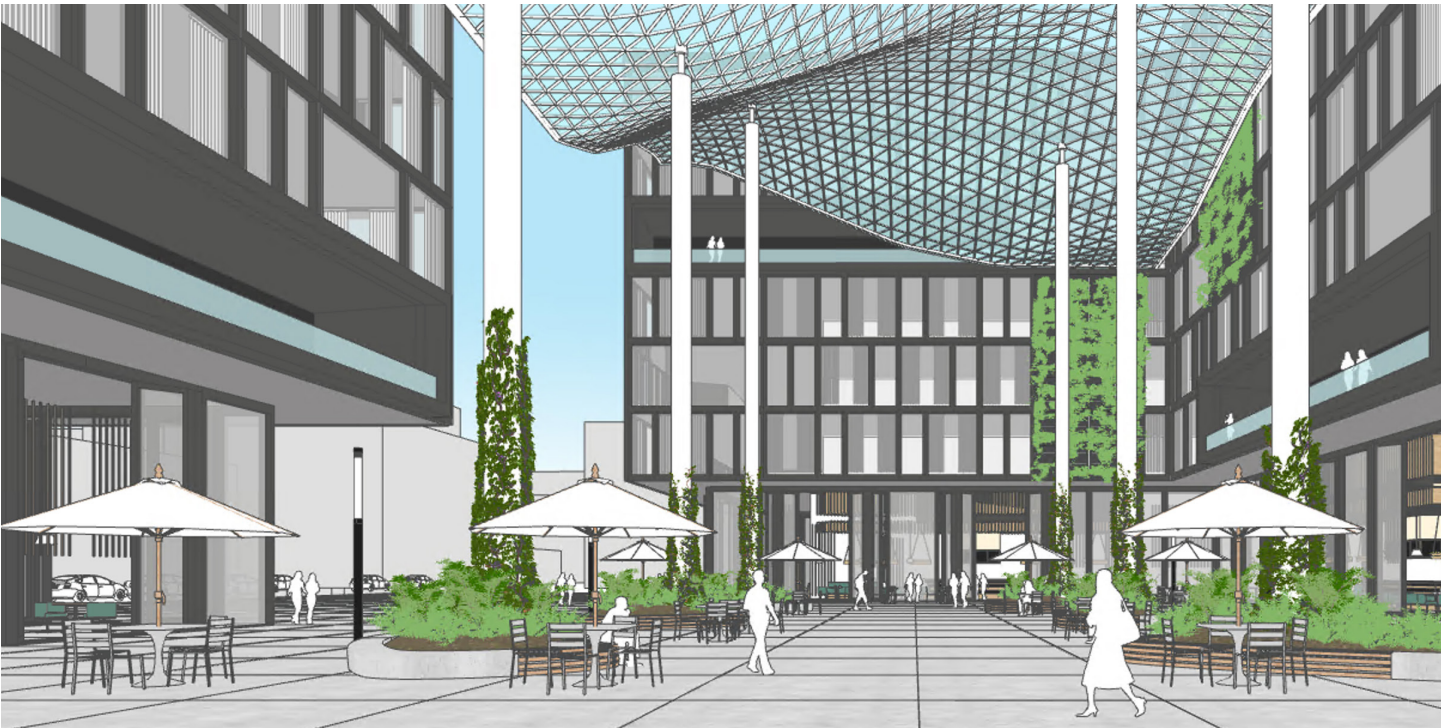
Across the lynchpin industries there are examples of the growing commitment to sustainability and the innovations that enable such efforts:

- **Agriculture**—there is growing commitment to use technologies that more precisely target pests and diseases, which can reduce pesticide use and increase crop yields.[46] Efforts here include low-cost solutions for greater global impact, as demonstrated by an example from Wardha (India) which better target bollworm treatment needs via simple traps, smartphone cameras, and a leanly built, open-source AI image detection system.[47]

- **Construction**—between 2017 and 2021 the US Green Building Council's Leadership in Energy and Environmental Design (LEED) registration for future projects had an average annual growth rate of 20%. That included projects across the board, from building and interior design and construction to operations and maintenance.[48]

- **Transportation**—the International Energy Agency's April 2024 Electric Vehicle Outlook notes that electric vehicle sales, despite some challenges, continue to grow at a significant pace. "In the first quarter [of 2024], sales grew by about 25% compared with

the same period in 2023—similar to the growth rate seen in the same period a year earlier, but from a larger base. The number of electric cars sold globally in the first three months of this year is roughly equivalent to the number sold in all of 2020."[49]

SCALING VIA SYSTEMS THINKING

While sustainability efforts were often thought of as a financial burden, the efficiencies and long-term cost reductions combined with (generally) government support of such efforts has shown that continued sustainability innovations can drive positive financial and organizational impacts.[50]

Sustainability, by definition, is a systems change effort. Small, incremental efforts will not have a deep enough impact to affect the global climate. Because of this, there are opportunities for more cross-cutting efforts across the lynchpin industries. The potential financial growth from any lynchpin sector innovating or developing best practices around the use of sensors, batteries, environmental modeling etc. can be even larger if there is consideration from the start of each sustainability-driven innovation to consider cross-industry uses.

Lynchpin Landscape Drivers and Scaling Their Impact

	CURRENT TRANSFORMATIONS	FURTHER STRATEGIES
INTEROPERABILITY	• Efficiency improvements from cloud systems • Improved analytics, design iteration, and testing tools from ML/AI • Greater action and feedback from experts and teams due to real-time access to dashboards	• Impetus on the ecosystem to develop standards for various design and planning systems to drive interoperability and insights for the entire ecosystem • Where proprietary elements exist, develop API access for use by more common protocols and systems
GROWTH OF VENTURE CAPITAL	• Financial commitments are growing around start-ups looking to solve problems for the lynchpin industries • Growth is occurring both from financial firms and from venture initiatives within established ecosystem players	• Pathways and rewards that promote an entrepreneurial spirit can help drive next generation talent interest and recruitment into the lynchpin industries
GOVERNMENT INVESTMENT AND COMMITMENT	• Global competitiveness is driving government commitment to focus on infrastructure development and innovation • Uncertainties around the impacts of new government investment remain	• Foster opportunities for new models around public-private partnerships to advance innovative ideas that can be stalled by poor risk/reward scenarios in regulatory processes
SUSTAINABILITY AND CLIMATE CHANGE	• Historic contributions of the lynchpin industries to CO_2 and GHG emissions put them on the front lines of climate challenges and the push to take action • Movement in these areas is already underway within the lynchpin industries and evidence of innovative sustainable practices providing financial benefits are growing	• Create increasing lynchpin industry expertise around systems thinking practices • Climate change will require interconnected action among and between industries and systems thinking expertise can drive innovative partnership ideas and win-win scenarios as new models of business continue to develop

Change Management Requirements **for Innovation**

Digital Transformation

Both a business buzzword and a real need, digital transformation has been at the forefront of business strategy over the past six to seven years. The influence and success of so many firms founded in the digital age has lit a fire under well-established firms to catch up. Such transformations are not about technology; they are about creating a holistic integration of digital methods in ways to better deliver on your business promise. It isn't easy. Reports from all the major consulting firms over the past few years reveal that roughly 70% of executives believe their firm's digital transformation efforts have failed.

So, what does it take to be successful in a digital transformation effort?

In his latest book, *The Digital Transformation Roadmap* (2023), David Rogers (Columbia Business School) notes five key areas at the core of driving a successful transformation: **vision**, **priorities**, **experimentation**, **governance**, and **capabilities**.[51]

- **Define a Shared Vision**—by its nature, no major transformation will be effective without a shared vision across the company. All levels of management and staff need to buy in to the *why* of the transformation and the value it will bring to the

company. It requires a clear understanding of how the vision is connected to business goals and what metrics will be evaluated. And the vision needs to spur both financial benefits for the firm and direct improvements to the businesses needs and lives of stakeholders.

- **Pick the Problems that Matter Most**—Michael Porter has noted that, "the essence of strategy is choosing what not to do."[52] Any new digital strategy must be about solving

problems—among any types of organizational stakeholders, external or internal. As problems are identified, they must then connect to the opportunity solving it will have for the firm and its stakeholders. In some cases, the opportunity may be directly tied to growth, but it could also be tied to driving customer delight that promotes loyalty. Firms can then evaluate a range of problem/opportunity propositions and begin to prioritize what the biggest wins are and then focus on those areas to begin experimentation.

"

> You can do so much testing in a virtual modeling environment… that you can move forward with [inexpensive] pilots with much more confidence.

David Rogers

- **Validate New Initiatives**—the most successful digital and innovation efforts incorporate experimentation with testing a hypothesis—with the tests designed in ways that could prove a hypothesis wrong or right. A range of terms surround these processes, which Rogers calls "the Four Religions" of digital innovation: lean start-up, design thinking, agile, and product management. Experimentation is at their core and is usually tied to the development of a "minimum viable product" (MVP). Rogers notes the importance of splitting such efforts into "illustrative MVPs" where you demonstrate an idea to a stakeholder for feedback and "functional MVPs" in which you can demonstrate the idea at some level in the real world.

  The key in such efforts is to develop as many MVPs, at small scale, as possible to truly enable experimentation and test viability and costs before scaling these efforts into a firm's core

offerings. In thinking about these three industries, Flyvberg's core lesson to "act slow, think fast" was also shared by Rogers, "For innovations of built environments, it is hard to test lots of low-budget functional MVPs. This is another part of the power of digital twins as it lets firms try lots of illustrative MVPs. You can do so much testing in a virtual modeling environment in terms of design, environmental impact factors, and customer feedback that you can move forward with pilots in the tens or low hundreds of thousands of dollars with much more confidence."[53]

- **Manage Growth at Scale**—effective experimentation and validation requires an organizational structure that fosters, incentivizes, and rewards (with an acceptance of failure) these efforts across the organization. Successful governance generally requires establishing very small, autonomous teams that incorporate staff with a mix of expertise and push them to develop problem/opportunity ideas and MVPs with very small budgets to begin. Scaling decisions should then be made by a group of a few leaders in the firm who evaluate pitches from the small teams, provide feedback across experimentation stages, and have sole authority to approve funding to scale up initiatives (in other words, you don't want the CEO or CFO to decide to cut an idea without input from others, or the teams may censor their idea generation efforts from the start).

- **Grow Tech, Talent, and Culture**—firms should aim to develop modular IT architectures—a lesson Amazon itself learned several years after its IPO when product development was laborious within its monolithic IT architecture. Developing these and other modular digital solutions where possible can promote greater flexibility and lower costs when digital changes are needed. Data structures must incorporate access, integration, quality assessment, and security protocols to extract the most value while protecting sensitive information.

  It's also necessary to cultivate a talent pipeline that incorporates a range of skillsets and expertise. Domain experts can then be mixed with, and effectively collaborate with, other experts in data science, finance, design, or marketing/communications. Tying back to the firm's vision, the firm must also create and communicate a clear set of values and expectations to develop an innovation-focused organizational culture that drives day-to-day operations and behaviors across the firm.

Forecasting

Many successes of the fast-moving digital age are tied to forecasting when changes are coming that might affect your business. Most importantly, this requires looking outside the "known world" of your business, or your customers, or your industry.

As Rita McGrath (Academic Director in Executive Education, Columbia Business School) notes in her book *Seeing Around Corners*, many organizations and managers do now pride themselves on being data-driven, the challenge is that often the analysis isn't looking towards the future. Most of the data are lagging indicators (i.e., an outcome or consequence that has already occurred) or a current indicator (a snapshot of what is going on right now). For example, revenue growth from the current quarter as compared to the same quarter a year ago. These data points have value and, when business environments are slower to change, have often been decent proxies for what to expect in the future.[54]

The challenge is that organizations must find ways to look at leading indicators, i.e., not existing data and facts but "suppositions, conjectures, and assumptions." Such efforts are often built around hints in lagging and current indicators, but they also require looking outside established data to patterns of human behavior and society that may hint at changes to come. McGrath uses an example around customer experience in which customer churn is a lagging indicator, customer satisfaction is a current indicator, and employee engagement may be a leading sign—in other words changes to churn and satisfaction may be related to changes in their experience with employees.

An obvious larger scale example is to consider the potential impact on the retail industry at the dawn of the internet. Amazon had a relatively early IPO in 1997, but soon after the "dot com" bubble burst, and numerous ecommerce companies ceased to exist entirely. Some still believed the hype, but many others took an "I
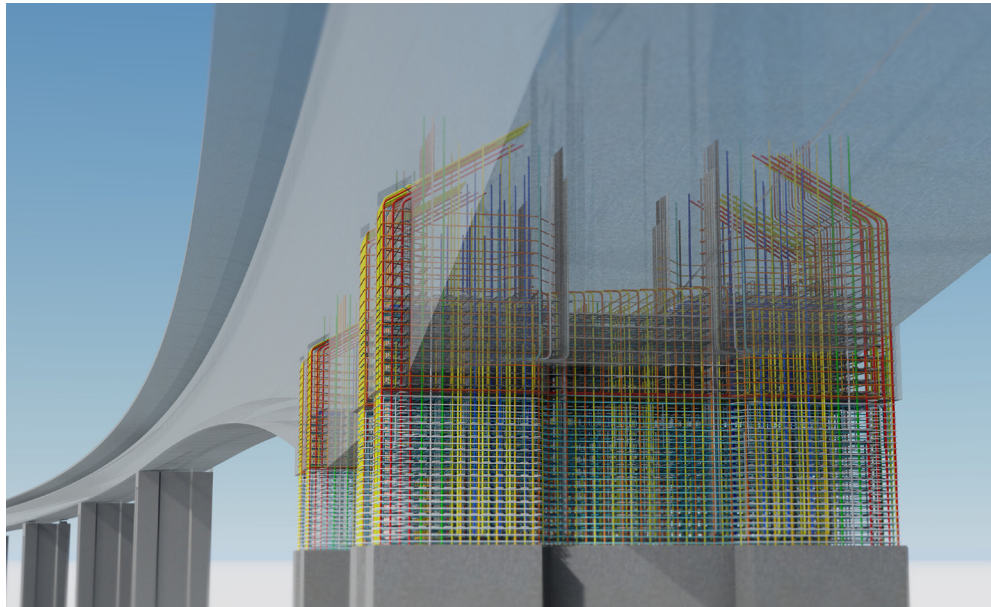
Copyright Oystein Ulvestad

told you so" attitude. The problem with dismissing the potential impacts at the time was that the internet ecosystem was still nascent (slow broadband, no web-enabled mobile phones, sparse website secure protocols). However, the fact that any adoption of these new business models was taking place, combined with historic power growth curves in information technology, provided leading indicators that the growth of ecommerce and streaming content marketplaces was only a matter of time.

There are leading indicators already at play within the agriculture, construction, and transportation sectors. Once could look at indoor vertical farming within agriculture as an example. Two of the well invested new brands in the sector, AeroFarms and AppHarvest, just filed for bankruptcy reorganization in 2023. However, stresses on land use and the pressures of climate change are clear leading indicators that this innovative process is likely to scale and develop successful business models in the near future. A new $300 million facility from Plenty Unlimited broke ground in California this year and the major grocery chain Kroger has announced a commitment to expand its offerings of vertical farmed produce.[55]
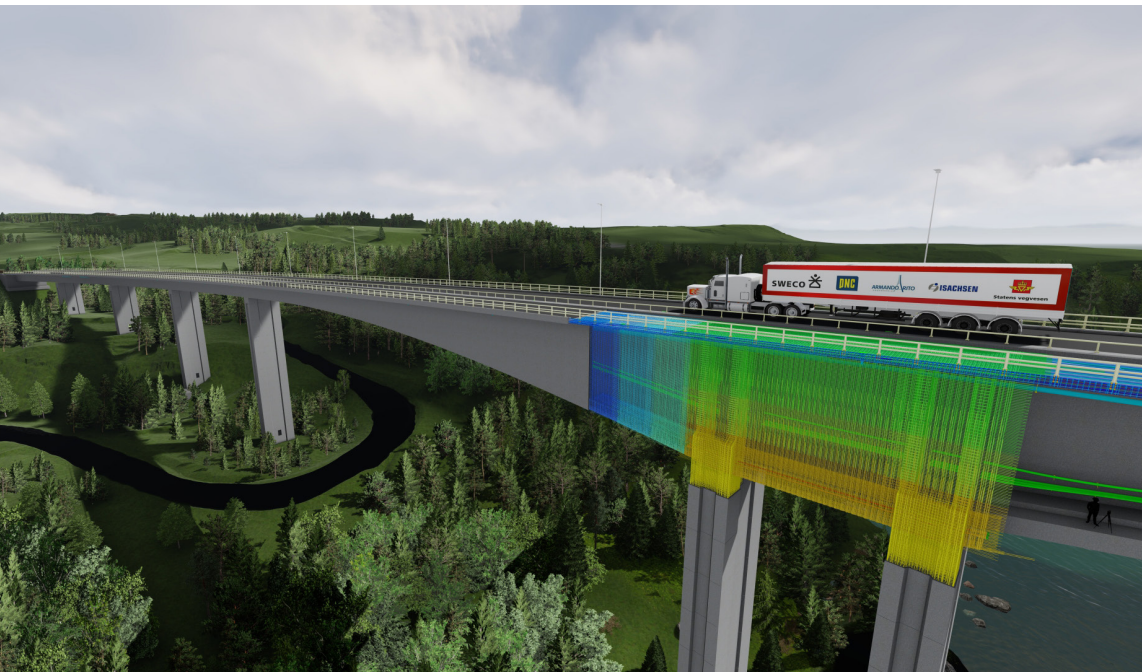
Copyright Oystein Ulvestad

While the integration of mobile robots into our everyday lives is still evolving at a very slow pace, the more rapid increase of various industrial robots being used in construction and agriculture (as well as manufacturing and energy exploration) hints at the value to come from human and mobile machine collaboration in the future. The early hype of fully automated vehicles in the transportation sector has not been realized, as the challenges over public risk acceptance and regulation present greater hurdles. Encouragingly however, interim steps in which sensors and automation are aiding passenger safety have already become more commonplace.

These kinds of forecasting efforts require examining trends and advancements going on in technology, consumer behavior, and business models. Hints of the future, and the need to develop a strategy to respond to it, occur when there is a potential merge between the three areas. As an exercise in considering an organizational response, Bernd Schmitt's thought experiment technique "killing your sacred cows" (noted earlier) can also be effective.[56] In this case, imagine how the key norms of your industry, and your firm, need to be broken to better adapt to the technology, cultural, and business changes you see around you.

The piloting of self-driving consumer vehicles, for example, may have been rushed to accommodate some "sacred cow" assumptions of the broader automotive industry. As McGrath notes, "Most of the current efforts on autonomous cars are only considering swapping the driver for a computer, without any other change to the current system. [There was] no consideration of changing the design of the vehicles and no consideration of the effect on the overall transportation system if people didn't have to drive themselves." In fact, a few years ago Mustapha Harb, a Ph.D. candidate at the University of California Berkeley, and his colleagues decided to examine the implications on a small scale by offering 13 people chauffeurs to drive them around for one week after having tracked their driving habits for a week without the chauffeur. They found that people drove around a collective 83% more miles during that period.[57] While some of this may be due to the novelty of the experience and might settle down over time, such changes expanded to the population at large would have major ripple effects on transportation and, potentially, climate change. While the primary goal of automation is to create a safer transit system, rushing forward with publicly piloting the technology without contemplating the broader effects of the change could potentially cause as much harm as good.

The above example shows how crucial it is to do thought experiments, and ideally research and experimentation, which break down all built-in assumptions to consider a wide range of ways that an innovation is going to change an industry sector and its societal impacts. While every impact scenario may not be accessible with foresight, the stability of an innovation effort is stronger when various future pathways are tested.

Habit Formation

Almost any push to get value out of an emerging technology throughout an organization will require social techniques around change management and workforce development. People have formed habits and knowledge that they use professionally and innovation efforts often require these habits to change.

As Charles Duhigg outlines in his book *The Power of Habit*, the first thing organizations need to understand is what he terms "the habit loop."[58] Psychological research has uncovered that nearly every habit is built on three things:

- The cue—a trigger for an automatic behavior to start
- The routine—the behavior itself
- The reward—the boost that drives your brain to repeat the habit in the future

The key to change a routine and build a new habit is to work on the cue and the reward.

So, what specifically should a lynchpin organization do to break down some of the embedded and long-established habits of their workforce? How can they develop people and teams to avoid falling back on the standard way of thinking and acting and embrace improved processes and techniques?

- **Research the cues**—work with teams and individuals that will need to adapt to a new, innovative process to understand what prompts their current routine. Some of these may be strict work procedures, others may be more flexible and driven by situational factors.

- **Train the new routine**—this is the obvious need to explain and train individuals and teams on using the new processes. Most importantly, tying into the reward, this effort needs to demonstrate the concrete value that this new routine will provide to the organization and to their work effort.

> **"**
>
> Almost any push to get value out of an emerging technology throughout an organization will require social techniques around change management and workforce development.

- **Craft a reward**—develop and incentivize people and teams when immediately implementing these new procedures. These rewards should not be tied to any end result of the new procedure, but only to effectively implementing the training. The expectation is that early testing has been done and that scaling these new routines will drive positive changes for the organization over time.

What studies have shown, most importantly, is that if new routines have their own intrinsic value, over time the rewards are no longer necessary for the new habit to stick. A classic example is driving people to exercise more by encouraging them to conclude the effort with a small reward, like a piece of chocolate. Over a few months, the changes to the body and the hormone boosts that come from exercise are enough that people give up eating the piece of chocolate.

UPS offers an example in pushing the formation of new habits tied to the use of predictive analytics to improve the efficiency of package delivery. About 20 years ago, Jack Levis, senior director of process management, was in charge of implementing a new machine learning process to create a more optimized package flow system. The new model was aiming to solve a logistics issue by using updated real-time delivery information and making estimated predictions, incorporating historic data, to account for the final packages that would come in for loading after most of the trucks were already packed.

The hurdle was getting the UPS loading teams to abide by the central recommendations coming from the model. Historic familiarity with certain routes and locations led the loaders to make on the fly package loading selections they felt were improvements, and those decisions weren't fed back into the model. With missing data, the model's directions and the on the ground loaded trucks were mismatched and no optimization was occurring.

Hence, Levis and his management team developed a new mantra— "The data is as important as the delivery"—and began a massive training effort across all the shipping centers to spread the mantra. In this case the cue was an already established procedure. The routine change was to adhere strictly to the truck assignments provided by the model. Importantly, Levis's team created reward incentives based on the short-term success of following the training, since fully improving the package flows and the resulting benefits of that would take place over time as the model improved with more and more data. "Because those early transition days are not

necessarily profitable, we had to use a balanced scorecard that would reward managers who achieved leading indicators," Levis noted. "If you're doing these leading things that are in your control, how can the lagging indicators of dollars saved not follow?"[59]

In cases where loaders were struggling to break from their old habits—stuck on believing more in the value of their own experience—they were moved to different service centers. As Eric Siegel notes in his article on this transformation, "You cannot take the knowledge out of a person, but you can take the person out of their domain of knowledge."[60] This location shift provided a new cue and enabled these loaders to adapt to the new procedural habits.

In the end, this UPS effort received numerous internal and external accolades for its expansion and success, including being one of *InformationWeek's* "20 Great Ideas to Steal" in 2013.[61] All due to the combined need for technology innovation to be connected alongside the change management efforts that drives its positive impact.

Change Management Needs for Innovation

KEY STRATEGIC ELEMENTS

DIGITAL TRANSFORMATION	• **Define a shared vision**: clarify the firm's mission and how digital transformation will help the firm's business goals and workforce development • **Pick the problems that matter most**: narrow the scope of digital and innovation efforts to experiment on solutions for the highest value business goals • **Validate new initiates**: develop a hypothesis around the value of new initiatives, start small, test and learn before scaling or canceling an effort • **Manage growth at scale**: create organizational structures from disciplines across the firm to evaluate, make recommendations, and authorize the decision to scale successful test projects • **Grow tech**, **talent**, and **culture**: craft software and database systems in a modular and interoperable fashion so IT doesn't hamper innovation and develop talent with interdisciplinary capabilities to be able to get better feedback and smooth the rollout of transformation initiatives
FORECASTING	• Lynchpin industries have generally been less impacted by the pace of innovation change, but developments of the digital age have shown that all industries need to be prepared for the potential of systematic change • A shift is necessary to analyze leading indicators that look both within and outside the lynchpin industries to craft suppositions, conjectures, and assumptions about the near- and mid-term future • Look at existing innovative efforts within the lynchpin industries that may still be struggling to gain wider-scale acceptance and adoption (e.g., vertical farming) and analyze not just why they are struggling, but what possible conditions might lead to a tipping point where they would become more and more successful
HABIT FORMATION	• Organizational change and workforce development go hand-in-hand and will only succeed with the development of new habits that embrace systems, process, and technology changes within and organization • For any transformation initiative analyze the existing cues, routines, and rewards that exist in current operations in the area being transformed • Then find the highest impact cue that starts a process, systematically train the new routine that must be followed after that cue, and create incentives and rewards for effectively following the new routine

Conclusion

Despite the sense that the agriculture, construction, and transportation industries have been perceived—both accurately and inaccurately—as slow to adopt the innovations spurred by the digital age, there is clear shift in mindset within these lynchpin industries to shed this laggard image.

This report outlines both the challenges and a range of techniques and tools that can help executives and investors in each of these industries continue to think and act in ways that will take advantage of both current and emerging technologies in ways that will benefit these industries from a financial, human capital, and societal perspective.

Each section of this report could stretch out to its own full report (or book). Please use it as a chance to review your organization's current innovation strategies and look for starting points that might help break through any roadblocks you face, whether strategic, tactical, or managerial.

The future of these lynchpin industries will have outsized impacts on the everyday lives of people in society and deeply affect the economic prospects of every individual across the world. The companies in these industries who resist this transformation are liable to be left behind and forgotten while those that lead it will likely be rewarded and remembered

APPENDIX

Interviews conducted in 2023 with:

- Chris Orban, VP, TMS Product Management, Transportation, Trimble

- Chris Trevillian, Marketing Director, Geospatial GNSS, Trimble

- David Rogers, Academic Director in Executive Education, Columbia Business School; author, *The Digital Transformation Playbook* and *The Digital Transformation Roadmap*

- Rita M. McGrath, Academic Director in Executive Education, Columbia Business School; author, *The End of Competitive Advantage* and *Seeing Around Corners*

- Atule Khanzode, Technology and Innovation Leader, DPR Construction

- Guillermo Perez-Iturbe, Senior Marketing Director, Agriculture, Trimble

- Jonathan Mullen, Director, Finance, Accounting & Analytics, Duncan Family Farms

- José Luis Blanco Álvarez, Senior Partner, McKinsey & Company

- David Epp, Global Leader - Industrial Software Partnerships, Microsoft

- Patricia Boothe, Senior Vice President, Autonomy, Trimble

- Poul Hededal, Group Director, Knowledge and Innovation, Digital & Innovation, Ramboll

ENDNOTES

1 The lynchpin industries in this report refers to agriculture, construction, and transportation. Other industrial sectors also underpin civilization growth, e.g., manufacturing and energy, but they will not be covered in detail in this report.

2 Federal Reserve Bank of St. Louis, "Value Added by Industry: Construction as a Percentage of GDP," Q3 2018 – Q3 2023. https://fred.stlouisfed.org/series/VAPGDPC (Construction), US Department of Agriculture Economic Research Service, "What is agriculture's share of the overall U.S. economy?" accessed January 2024. https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=58270 (Agriculture), US Department of Transportation, "Contribution of Transportation to the Economy: 2022 Year in Review." https://data.bts.gov/stories/s/smrm-36nv (Transportation)

3 Since several of these lynchpin firms are primarily manufacturing oriented (e.g., making cars or tractors) or defense contractors, a significant portion of their contributions to US GDP is recorded by the US Federal government in other categories.

4 McKinsey & Company, "Imagining Construction's Digital Future," June 2016. https://www.mckinsey.com/capabilities/operations/our-insights/imagining-constructions-digital-future

5 Goolsbee, Austin and Syverson, Chad, "The Strange and Awful Path of Productivity in the US Construction Sector," National Bureau of Economic Research, March 2022 https://www.nber.org/books-and-chapters/technology-productivity-and-economic-growth/strange-and-awful-path-productivity-us-construction-sector

6 Ibid. In Goolsbee and Syberson's research they note that IP capital spending was at near zero during the productivity growth period from 1950-1970 so they discount it as a defining factor of productivity decline after 1970. Nonetheless, their research shows that investment in R&D, software purchases, and design originals in the construction sector has not kept pace alongside other players in the US economy.

7 Schmitt, Bernd H., *Big Think Strategy: How to Leverage Bold Ideas and Leave Small Thinking Behind*, Harvard Business Review Press (2007).

8 Furstenthal, et al., "Fear factor: Overcoming human barriers to innovation," McKinsey & Company, June 3, 2022. https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/fear-factor-overcoming-human-barriers-to-innovation

9 Furstenthal, et al., "Taking fear out of innovation," McKinsey & Company, March 29, 2022. https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/taking-fear-out-of-innovation

10 Ibid

11 David L. Rogers (Columbia Business School)) interview, September 13, 2023

12 US Department of Agriculture, "2017 Census of Agriculture Highlights: Farm Producers," April 2019. https://www.nass.usda.gov/Publications/Highlights/2019/2017Census_Farm_Producers.pdf

13 Interview with Jose Luis Blanco, McKinsey & Company, March 6, 2023.

14 Riverbed, "Global Digital Employee Experience (DEX) Survey 2023." https://www.riverbed.com/riverbed-wp-content/uploads/2023/09/global-dex-survey-2023-report.pdf

15 Interview with Guillermo Perez-Iturbe, Trimble, March 14, 2023

16 Interview with Paol Hededal, Ramboll, April 11, 2023

17 Kamensky, John M., "Regulatory Partnerships: Good or Bad?" *The Business of Government*, Fall/Winter 2010, pp. 61-64. https://www.businessofgovernment.org/sites/default/files/Viewpoint_Kamensky.pdf

18 Flyvbjerg, Bent (ed.), *The Oxford Handbook of Megaproject Management* (2017)

19 Flyvbjerg, Bent and Gardner, Dan, "How Big Things Get Done," March 23, 2023. https://nextbigideaclub.com/magazine/big-things-get-done-surprising-factors-determine-fate-every-project-home-renovations-space-exploration-everything-bookbite/40952/

Innovation Growth in the Lynchpin Industries

[20] Flyvbjerg, Bent (ed.), *The Oxford Handbook of Megaproject Management* (2017)

[21] Havenid, Malena Ingemansoon, et. al., (eds.), *The Connectivity of Innovation in the Construction Industry*, Routledge, 2019, pg. 55.

[22] World Economic Forum, *Shaping the Future of Construction: A Breakthrough in Mindset and Technology*, prepared in collaboration with The Boston Consulting Group, 2016. https://www3.weforum.org/docs/WEF_Shaping_the_Future_of_Construction_full_report__.pdf

[23] Hughes, W. and Stehn, L., "Entrepreneurial innovation in the construction sector: overcoming process discontinuities in projects," *The Connectivity of Innovation in the Construction Industry*, Routledge, 2019, pp. 52-67

[24] Acar, Oguz, et. al., "Creativity and Innovation Under Constraints: A Cross-Disciplinary Integrative Review," *Journal of Management*, Vol 45, Issue 1, 2018. https://journals.sagepub.com/doi/10.1177/0149206318805832

[25] Ibid

[26] Jose Luis Blanco, McKinsey & Company, interview, March 6, 2023

[27] Bereman, Matt, et. al., "Building products in the digital age: It's hard to 'get smart'," McKinsey & Company, June 6, 2022. https://www.mckinsey.com/industries/engineering-construction-and-building-materials/our-insights/building-products-in-the-digital-age-its-hard-to-get-smart

[28] Damodaran, Awath, "Margins by Sector (US)," New York University, data as of January 2024. https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html

[29] Interview with Atul Khanzode, DPR Construction, June 23, 2023

[30] Clive Humby Profile, University of Sheffield. https://www.sheffield.ac.uk/dcs/people/academic-visitors/clive-humby

[31] McDuffie, Juquai, "Why the Military Released GPS to the Public," *Popular Mechanics*, June 19, 2017. https://www.popularmechanics.com/technology/gadgets/a26980/why-the-military-released-gps-to-the-public/

[32] Interview with Jose Luis Blanco

[33] David L. Rogers, Columbia Business School. interview, September 13, 2023.

[34] Bereman, Matt, et. al., "Building products in the digital age: It's hard to 'get smart'," McKinsey & Company, June 6, 2022. https://www.mckinsey.com/industries/engineering-construction-and-building-materials/our-insights/building-products-in-the-digital-age-its-hard-to-get-smart

[35] Metinko, Chris, "Why VC Investors Are Plowing Record Sums Into Agtech," *Crunchbase News*, February 10, 2022. https://news.crunchbase.com/startups/agtech-startups-vc-funding-data/

[36] Thibault, Matthew, "Suffolk's tech VC arm closes $110M inaugural fund," Construction Dive, July 12, 2023. https://www.constructiondive.com/news/suffolk-vc-arm-closes-110m-inaugural-fund/686712/

[37] College, Mike and Martyn, Chris, "Entrepreneurialism alive and well in the time of the pandemic," IPSOS, January 12, 2021. https://www.ipsos.com/en/entrepreneurialism-time-pandemic. The "entrepreneurial mindset" is an index developed within the survey by incorporating self-reported professional and character traits.

[38] Ross, Martha and Bateman, Nicole, "Meet the Low-Wage Workforce," Brookings, November 2019. https://www.brookings.edu/wp-content/uploads/2019/11/201911_Brookings-Metro_low-wage-workforce_Ross-Bateman.pdf

[39] International Monetary Fund, "Is It Time for an Infrastructure Push? The Macroeconomic Effects of Public Investment," *World Economic Outlook* 2014, chpt 3. Washington DC: IMF

[40] Interview with Jose Luis Blanco, McKinsey & Company, March 6, 2023.

[41] City of New York, "DOB Launches 'Hack the Building Code' Innovation Challenge," October 4, 2021. https://www.nyc.gov/site/buildings/dob/pr-hack-building-code-innovation-challenge.page

42 UN Environment Programme, "CO2 emissions from buildings and construction hit new high, leaving sector off track to decarbonize by 2050," November 9, 2022. https://www.unep.org/news-and-stories/press-release/co2-emissions-buildings-and-construction-hit-new-high-leaving-sector

43 US Environmental Protection Agency, "Sources of Greenhouse Gas," accessed January 2024. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

44 Ibid.

45 Bereman, Matt, et. al., "Building products in the digital age: It's hard to 'get smart'," McKinsey & Company, June 6, 2022. https://www.mckinsey.com/industries/engineering-construction-and-building-materials/our-insights/building-products-in-the-digital-age-its-hard-to-get-smart

46 OECD, "Adoption of Technologies for Sustainable Farming Systems Wageningen Workshop Proceedings," 2001. https://www.oecd.org/greengrowth/sustainable-agriculture/2739771.pdf

47 Dalmia, Aman, et. al., "Pest Management In Cotton Farms: An AI-System Case Study from the Global South," KDD '20: Proceedings of the 26th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining, August 2020, pp. 3119–3127. https://www.wadhwaniai.org/wp-content/uploads/2021/10/13_Pest-Management-in-Cotton-Farms-KDD.pdf

48 Jhunjhunwala, Aalok Vinod, "LEED data trends from the past five years," U. Green Building Council, October 12, 2022. https://www.usgbc.org/articles/leed-data-trends-past-five-years

49 International Energy Agency, "The world's electric car fleet continues to grow strongly, with 2024 sales set to reach 17 million," April 23, 2024. https://www.iea.org/news/the-worlds-electric-car-fleet-continues-to-grow-strongly-with-2024-sales-set-to-reach-17-million

50 Eccles, Robert G., et al., "The Impact of Corporate Sustainability on Organizational Processes and Performance," *Management Science* (Vol. 60, No. 11, 2014) https://doi.org/10.1287/mnsc.2014.1984

51 Rogers, David L., *The Digital Transformation Roadmap: Rebuild Your Organization for Continuous Change*, Columbia Business School Publishing, September 5, 2023.

52 Porter, Michael E., "What Is Strategy," *Harvard Business Review*, November-December 1996. https://hbr.org/1996/11/what-is-strategy

53 David L. Rogers interview, September 13, 2023

54 McGrath, Rita M., Seeing Around Corners: *How to Spot Inflection Points in Business Before They Happen*, Houghton Mifflin Harcourt, 2019.

55 Malling, Melina and Lafleur, Kendria, "Lots of indoor farms are shutting down as their businesses struggle. So why are more being built?" *The Associated Press*, September 17, 2023. https://apnews.com/article/indoor-farming-vertical-plenty-kroger-aerofarms-28d360b3c8d7fa424892e23fe1c85c93

56 Schmitt, Bernd, *Big Think Strategy*.

57 Harb, Mustafa, et.al., "Projecting Travelers into a World of Self-Driving Vehicles: Estimating Travel Behavior Implications via a Naturalistic Experiment," *Transportation*, Vol. 45, pp. 1671-1685, November 1, 2018. http://www.joanwalker.com/uploads/3/6/9/5/3695513/mustapha_et_al_-_final_transportation.pdf

58 Duhigg, Charles, *The Power of Habit: Why We Do What We Do in Life and Business*, Random House, 2013.

59 Siegel, Eric, "To Deploy Machine Learning, You Must Manage Operational Change—Here Is How UPS Got It Right," *Harvard Data Science Review*, January 2024. https://www.predictiveanalyticsworld.com/machinelearningtimes/to-deploy-machine-learning-you-must-manage-operational-change-here-is-how-ups-got-it-right/13348/

60 Ibid.

61 O'Neill, Shane, "20 Great Ideas To Steal In 2013," *Information Week*, August 27, 2023. https://www.informationweek.com/it-sectors/20-great-ideas-to-steal-in-2013

Innovation Growth in the
Lynchpin Industries

Challenges and Strategies for

AGRICULTURE, CONSTRUCTION & TRANSPORTATION

Columbia Business School
Center on Global Brand Leadership

Trimble