

CalPERS Board of Administration Discussion

DIGITAL & INNOVATION IN ENGINEERING AND CONSTRUCTION

July 16th, 2018

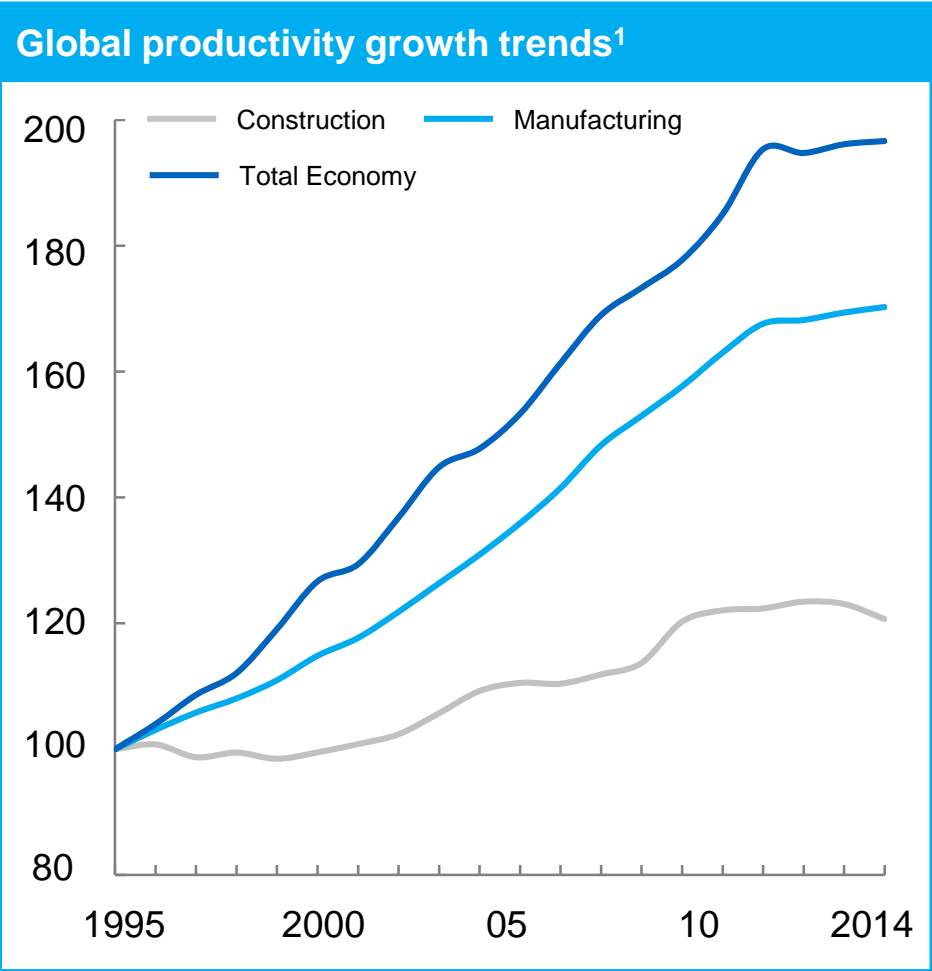
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Opening thoughts

- **A major disruption** is occurring in the Capital Projects & Infrastructure industry
- **We believe that a 20-45% reduction in the cost of major development projects** is possible through emerging innovations; this is true across asset classes, e.g., energy, public infrastructure, real estate
- **In order to capitalize, greenfield Infrastructure Investors, must identify partners** who are leading in this area, as well as internal approaches to structure data & insights
- **What follows is a summary of the major digital trends** in the capital projects industry to help spur our discussion today

Lagging labor productivity has been a critical challenge for major projects and has led to disappointing project outcomes

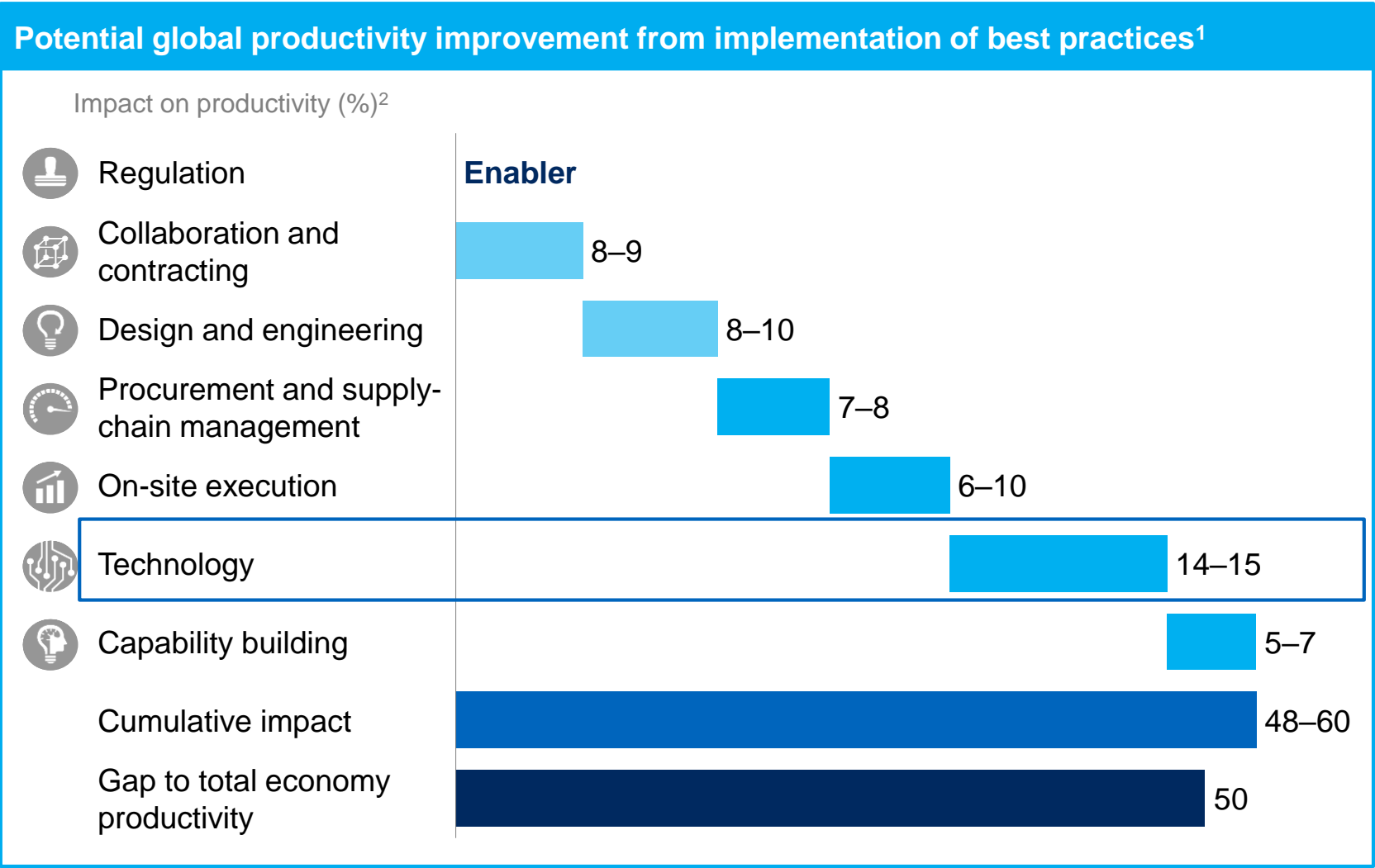


Recent major project performance

Average cost overrun	~80%
Average schedule overrun	20 months
Percent of projects over budget	98%+

¹ Based on a sample of 41 countries that generate 96% of global GDP; real gross value added per hour worked by persons engaged, 2005 \$
SOURCE: OECD; WIOD; GGCD-10, World Bank; BEA; BLS; national statistical agencies of Turkey, Malaysia, and Singapore; Rosstat; MGI analysis
SOURCE: IHS Herold Global Projects Database (Nov. 19, 2013); Companies' public annual reports; press releases

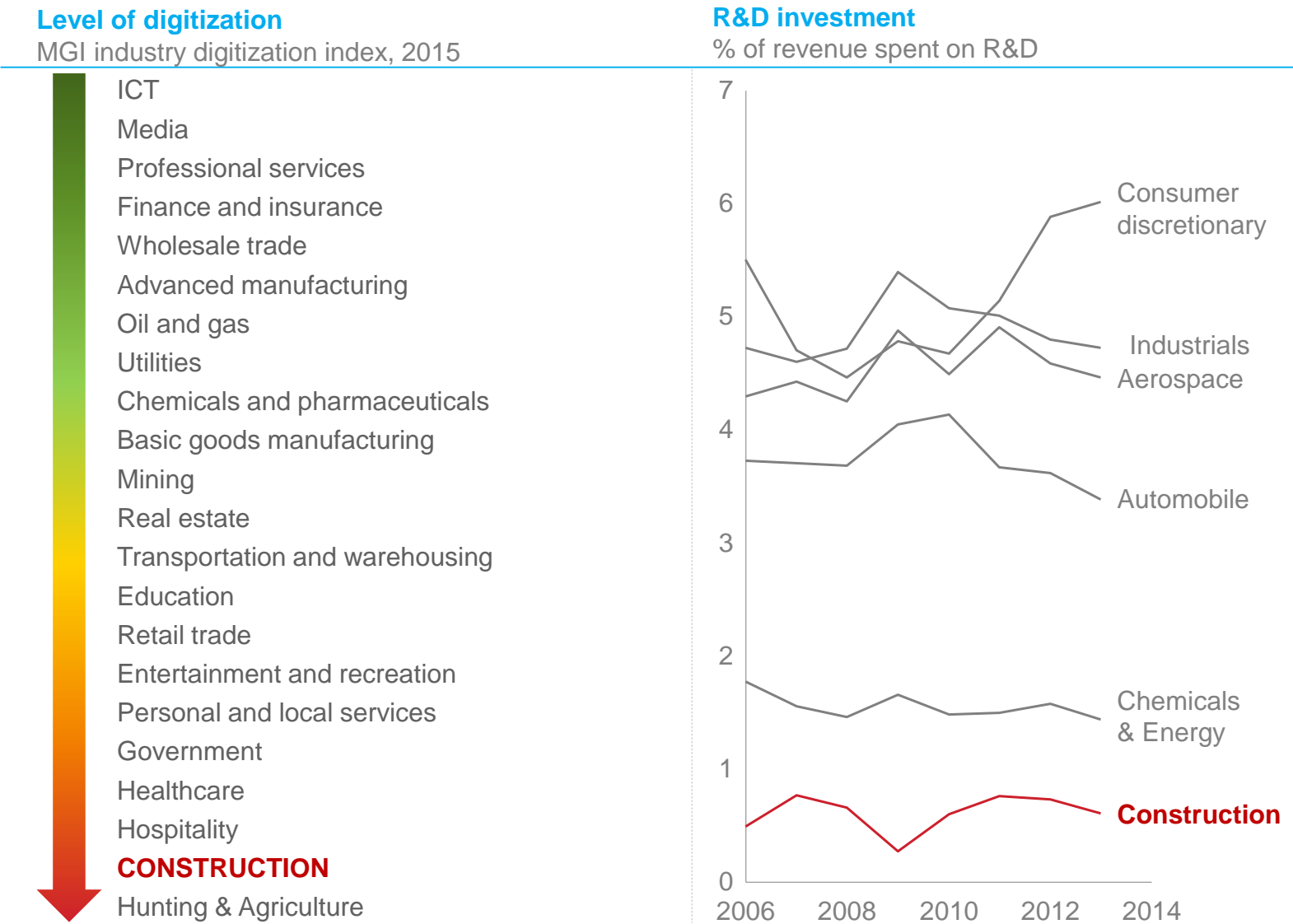
Technology is the most promising avenue for productivity improvement...



¹ The impact numbers have been scaled down from a best case project number to reflect current levels of adoption and applicability across projects, based on respondents to the MGI Construction Productivity Survey who responded “agree” or “strongly agree” to the questions around implementation of the solutions.

² Range reflects expected difference in impact between emerging and developed markets.

... but engineering and construction has historically been one of the least digitized and lowest technology-focused industries in the world



1 Based on data of top 20 E&C companies by market value Globally 2 Top 20 companies by market value
SOURCE: Capital IQ, Gartner IT key metrics data 2012

Industry leaders are separating themselves by deploying new innovations that can lead to cost improvements of up to ~45%



Production systems

Software-enabled lean construction and supply chain management.



LiDAR as built verification

Frequent LiDAR drone scans capture precise quantities and identify as built errors

3D printing

3D printing removes construction delays, reduces freight costs, and simplifies supply chain



Automated construction

Robots complete activities more productively, accurately and safely



Advanced analytics

Advanced analytics optimizes integration across teams and execution



Capital portfolio management

Specialized software optimizes capital investment and portfolio management



Virtual reality

Operations staff review facilities and identify hazards during design or construction



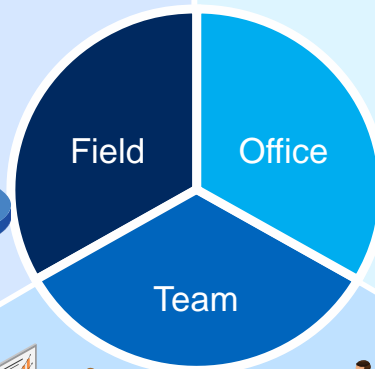
5D BIM and beyond

5D BIM is used to unify the 3D model with schedule and budget, adding clarity



Digital performance management

Project leadership assess performance, anticipate issues, and develop action plans



Advanced scanning and virtual reality have created multiple sources of value for capital projects

Survey and geolocation



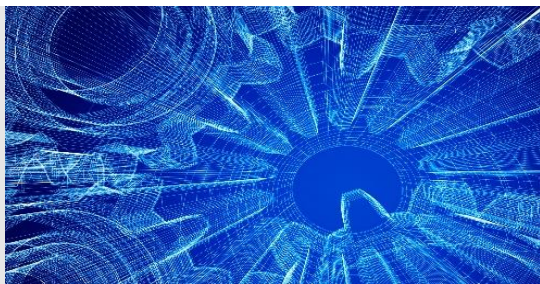
- Drone and 3D-imaging technology create precise, millimeter-level site maps

3D modeling and virtual reality






- Virtual reality 3D modeling overlays site location to optimize site layout, prevent hazards, and remove clashes

As-built to as-designed validation



- Precise validation (i.e., mm level) of as-built configuration against 3D design models

Field automation drives productivity across three levers: labor availability, labor productivity, and rework avoidance

	Challenges	Automation solution
<div>Labor Availability</div> <div></div>	<ul style="list-style-type: none">A mismatch between labor availability and project demands	<ul style="list-style-type: none">Reduces demand for front-line craft labor
<div>Labor productivity</div> <div></div>	<ul style="list-style-type: none">Labor pool in the construction is increasingly aging and skills are not increasing	<ul style="list-style-type: none">Elimination of low skill tasksEnhancement of high skill tasks
<div>Rework avoidance</div> <div></div>	<ul style="list-style-type: none">Rework has widespread negative impacts to project execution	<ul style="list-style-type: none">Mitigation or elimination of opportunity for human error

Automation is being deployed in both predictable and ad-hoc physical tasks

Drones



Weld machines



Automated excavation



Vehicles



Brick laying



Automated timber construction



SOURCE: McKinsey Capital Projects & Infrastructure digital and innovation service line; <http://www.constructiondive.com/news/bots-on-the-job-the-past-present-and-future-of-robotic-builders/446000/>, http://www.masonryconstruction.com/business/technology/wasco-brings-masonry-robotics-to-new-tenn-college-campus_o

Final thoughts

- **This is a rapidly changing landscape...but being able to get the digital basics right** will continue to be a large differentiator for major project outcomes in the next few years
- **Ultimately, the digital tools and innovations** we discussed today are just that – tools; organization and culture remain paramount to effective implementation
- Understanding the digital capabilities and innovation programs of contractors and project partners will be an increasingly **important value differentiator for greenfield infrastructure investments** in the years to-come