

IPA

Independent Project Analysis

Innovative Project Strategies

Presented to the Construction Owners Association of Alberta

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8 May 2019

- **Sli.do is an web-based platform to help drive engagement**
 - Asking questions
 - Taking audience polls
- **How to participate**
 - Go to **sli.do** through your computer, tablet, or phone
 - Event Code: **#COAA19**
 - Track A: **CPC-6 (A) Innovations at Capital Projects**
 - Track B: **CPC-6 (B) Innovations at Capital Projects**
 - Post questions and vote on ones you prefer

“There is a way to do it better—find it.”

Thomas Edison

“Innovation is seeing what everybody else has seen and thinking what nobody has thought.”

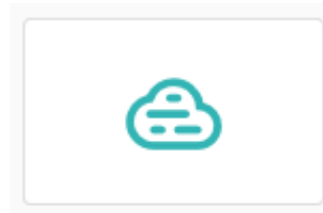
Albert Szent-Györgyi

“When you innovate, you’ve got to be prepared for everyone telling you you’re nuts.”

Larry Ellison

- **Review and discuss the proven and potential value of innovative strategies in the capital projects world**

What challenges can be addressed through innovation in the capital projects world?



Please go to [sli.do](https://www.sli.do) to submit your responses



Track A Results



Track B Results

Technical challenges: Drillers have had to innovate to access oil, gas, and mining reservoirs in deeper and more complex locations

Cost challenges: As margins become tighter, there is additional push for improving capital and operational project expenses

Execution challenges: Owners are increasingly looking at new contracting and execution approaches

Information management challenges: Owners are moving toward greater use of digitalization

Safety challenges: Companies are using technology in innovative ways to reduce the rate of recordable safety incidents

Competitive advantage and business survival: In general, innovation gives a business a competitive advantage over its peers; for this reason, businesses that fail to sufficiently innovate and adapt often are diminished or eliminated

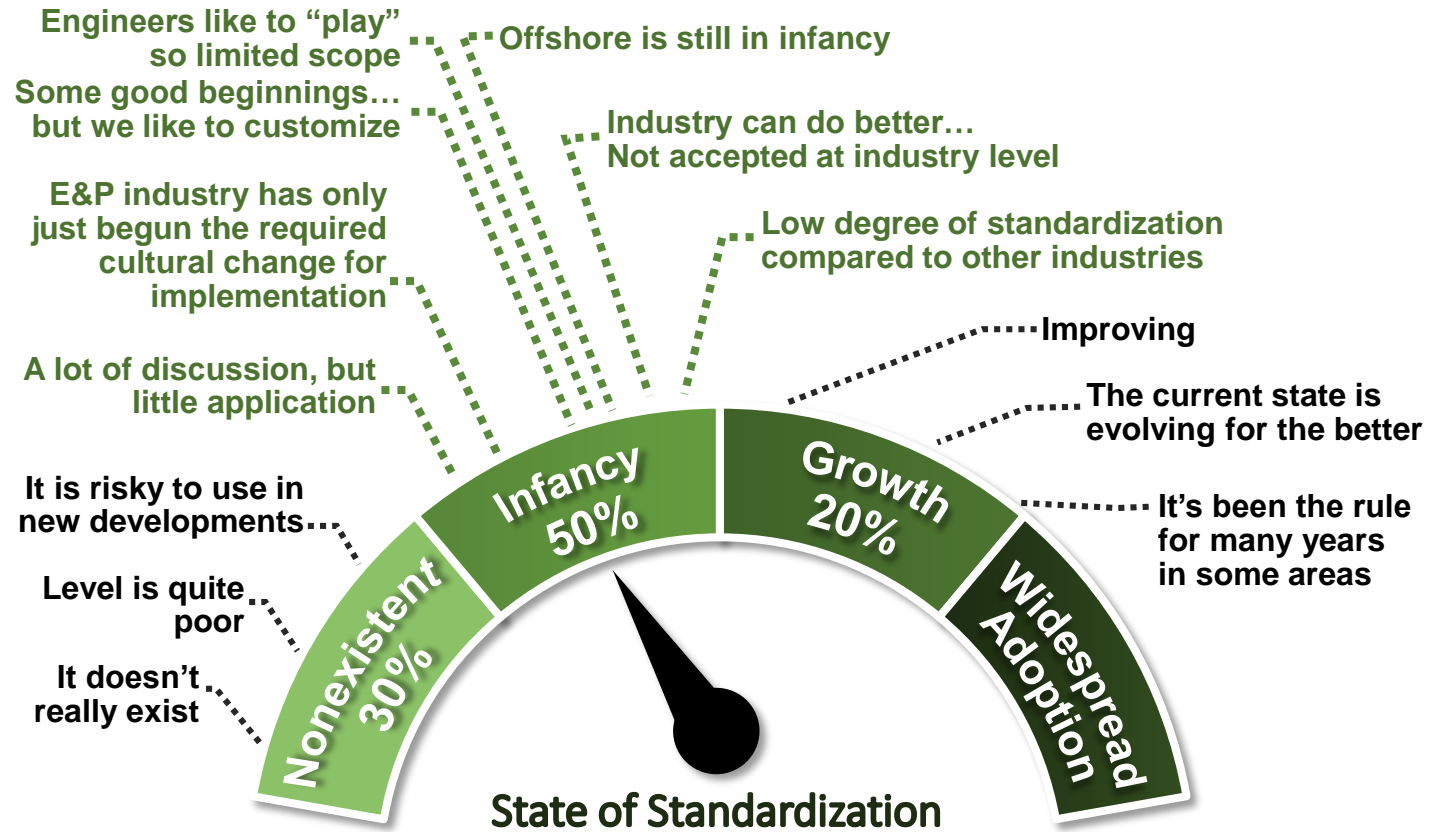
- *Design Standardization*
- **Contracting and Execution Strategies**
- **Digitalization**
- **Construction Management and Safety Strategies**
- **Conclusion**

The repeated use or application of common facility design or specification; standardized components are nearly identical in physical aspects.

- **Standardization in this sense has been practiced for 20+ years in the offshore E&P world, but not consistently**
- **There have been some successful examples ...**
- **Data support the benefits of standardization**

The Current State of Standardization in Offshore E&P

A Survey of IPA Oil and Gas Clients



Standardization of Offshore E&P Facilities Saves Money

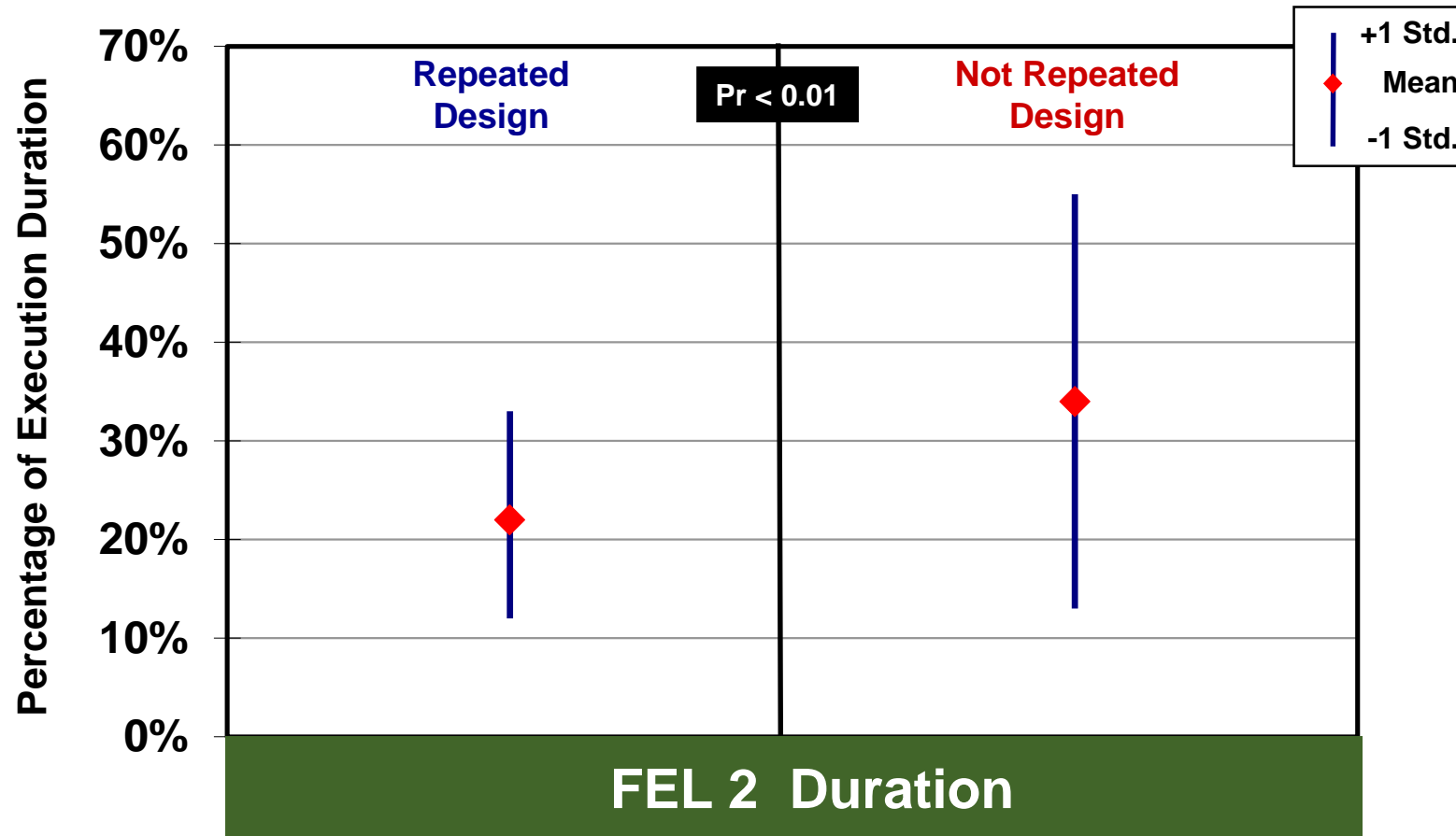


Cost Savings Summary		
Sub-Component	Concept	Cost Savings
Substructure	SPJ	28%
Substructure	FPS	19%
Topsides	SPJ/FPS	14%
Flowlines	Subsea Tiebacks	47%
Umbilicals	Subsea Tiebacks	37%
Trees	Subsea Tiebacks	23%

- **Two-thirds of offshore E&P projects that used standardization were executed in a sequence as part of a program or campaign:**
 - Multiple project teams executing multiple projects of same or similar design
 - Sometimes the program is more of a “project factory” (one team, multiple sequential AFEs)
- **All successful standardization efforts were executed by the same owner company business unit**
 - Turnover of the core owner and/or contractor teams between projects hurts performance
 - Common staffing institutionalizes the communication of learning throughout the program or campaign
 - Repeated execution of similar projects engenders familiarity, which can help a project team

- **On average, standardized projects saved money on office costs (sum of Front-End Loading [FEL], project management, and detailed engineering)**
 - Actual FEL, detailed engineering, and project management hours were lower than with non-standardized kits
- **Standardized projects also spent less time in FEL 2 and Execution**
 - This makes sense as FEL 2 is the scope selection phase, and execution is faster because the learning curve is less steep
- **Despite less time spent in FEL 2, the average level of definition for standardized projects was better than for non-standardized projects**
 - So less time spent in FEL 2 did not equal worse definition

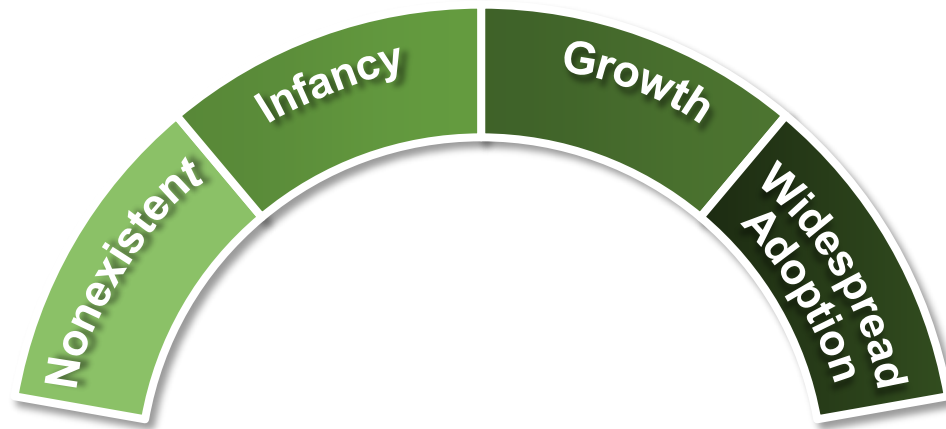
Repeated Facilities Design Shortens FEL 2



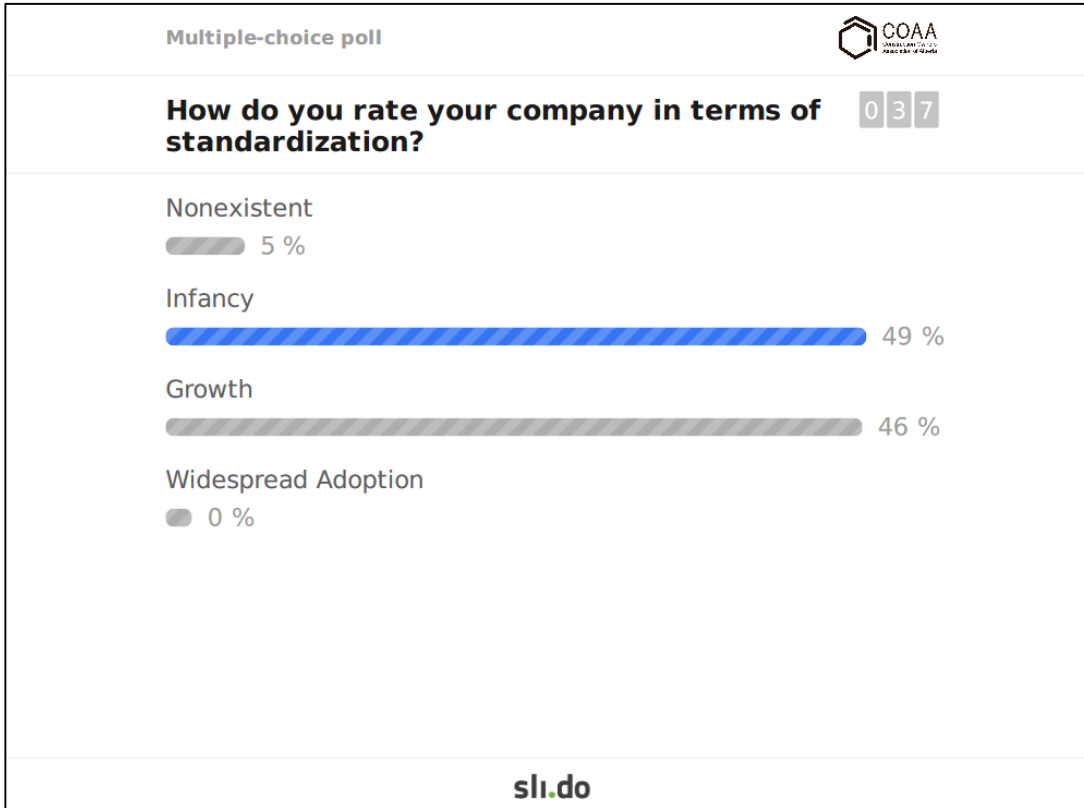
- **Standardized projects show extreme cost sensitivity to changes in design/approach**
 - Changes as little as 5 percent of a physical dimension have demonstrable negative cost effects
 - Sometimes changes viewed as “tweaks” started a barrage of change
- **There is no such thing as a “minor modification” in a program**
 - This is not to say that changes based on lessons learned should not be made; often, these changes are required for project success
 - The first application of a single change in the standardized design adds ~11% to the cost, eroding most of its cost benefits

- **Companies have also been using standardization to a lesser degree onshore for decades**
 - For example, some pipeline companies have a standardized compressor/pump stations, storage tank, and even line pipe designs
 - Companies that specialize in a particular service (e.g. air separation, sulfur recovery) also often standardize their designs
- **However, there has been less standardization of large process units themselves (e.g., hydrotreater or PDH plant)**
 - Largely because only a few downstream companies build more than one large process unit in sequence
- **Nonetheless, as owners face tighter margins on their projects, companies are looking closer into standardization as a viable way to improve their competitiveness**

How do you rate your company in terms of standardization?



Please go to sli.do to submit your response



Track A Results



Track B Results

- **The same basic lessons from the E&P world can be applied to downstream onshore projects**
 - **Standardization of a particular type of scope should be executed and championed by a single business unit**
 - **There is value in a common owner/contractor team moving from scope to scope**
 - **Teams should expect to spend less time in the scope selection (FEL 2) and execution phases and generally less on office costs on standardized scopes**
 - **However, the potential cost and schedule savings are entirely predicated on not making changes**
 - **Any deviation from the standard design essentially eliminates the benefit of the standardization**

- **Design Standardization**
- ***Contracting and Execution Strategies***
- **Digitalization**
- **Construction Management and Safety Strategies**
- **Conclusion**

- **Industry has long viewed the “right” contracting strategy as something of a panacea**
 - If we pick the right contractor and contracting approach, it can make up for other project deficiencies
 - IPA data show this is simply not true
 - There is no substitute for project fundamentals (clear objectives, fully integrated project teams, excellent definition)
- **Although contracting is not a panacea, it can and does affect results**
 - That is, the wrong contracting strategy can harm an otherwise well-positioned project
- **Owners are always looking for contracting approaches that will deliver better value for money or approaches that better fit with the company’s goals and culture, but typically use EPC or Split options**

EPC Options



EPC Lump Sum

EPC Reimbursable*

EPCm*

Split Options



Reimbursable*/Lump Sum
Re/LS

Reimbursable*/Reimbursable
Re/Re

Lump Sum*/Lump Sum
LS/LS

* FEED is usually included

Contracting Approaches for On-shore Facilities

The EPC Options

EPC Lump Sum*

Contracting scheme where detailed engineering, procurement and construction are performed on a fixed-price basis, usually by tendered bid, by the same firm or consortium or where multiple EPC-lump sum contracts are let

EPC Reimbursable

A single contractor (or contractors in multi-prime situation) perform E, P, and C on a reimbursable basis

EPCm

An engineering contractor (or contractors in multi-prime situation) perform E, P, and construction management on a reimbursable basis

Construction is generally performed by disciplinary sub-contractors on fixed-price, unit rates or reimbursable basis

EPC

**Under all contract schemes the owner may novate some procurement, usually long-lead equipment*

Contracting Approaches for On-shore Facilities

The “Split” Options

Re/LS

Engineering contractor(s) performs F, E, and P on a reimbursable basis
Construction and construction management are performed lump-sum by *another* contractor or contractors
Sometimes disciplinary packages are bid lump-sum and the owner performs CM

Re/Re

Engineering contractor(s) performs F, E, and P on a reimbursable basis
Construction and construction management are performed by *another* contractor(s) on a reimbursable or unit rate basis

LS/LS

Engineering contractor(s) performs E and P on a lump-sum basis; usually FEED was done in-house
Construction and construction management are performed lump-sum by *another* contractor(s)

EP

C

- **The majority of large process projects are contracted using one of three strategies:**
 - **FEED-EPC reimbursable or F-EPCm (~35%)**
 - **An EPC lump-sum based on bidding competition after FEED (~32%)**
 - **Split forms F-EP with CM and construction by other than the F-EP firm (~24%)**

- **A few projects are contracted with other approaches:**

**Functional
Specification**

**Design
Competitions**

**Convert-to-
Lump-Sum**

**Guaranteed
Maximum Price**

- **Results of these “unconventional” contracting approaches are mixed**

Functional Specification

Entails minimum definition of a project's facilities before going to the market (also referred to as Duty Spec)

Basic parameters covering capacity, product requirements, safety, and operability are developed into a package for interested providers to bid FEED and EPC, usually on a lump-sum basis

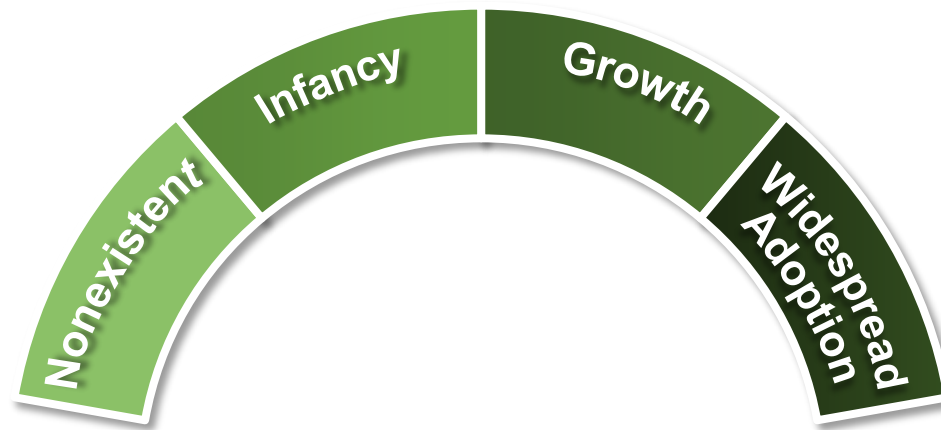
- Level of definition is roughly the equivalent of FEL-2A—mid-Select—the basic scope is selected but the details of the scope are left to the contractor to fill in
- Typically three or more contractors are invited to provide a solution, usually accompanied by a set of guarantees
- Sometimes the contractor will also be expected to commission and start up the facilities and in a few cases even operate or build-own-operate-transfer
- Usually used only when a well-developed market exists for the package; there must be multiple experienced and competitive suppliers, e.g., air separation, gas turbine power generation, sulfuric acid plants, etc.
- The biggest problems are site conditions, outside battery limits scope, and interference from other projects or site activities

- **Although functional spec is used sparingly (about 3 percent of projects) it is used occasionally by every industrial sector**
- **The approach is usually reserved for very standard packages and in those cases it is more likely to deliver cost and schedule competitiveness**
- **Attempts to use functional specifications with complex projects usually went badly awry**
- **Even some of the package projects veered far off course when site conditions were not as expected**

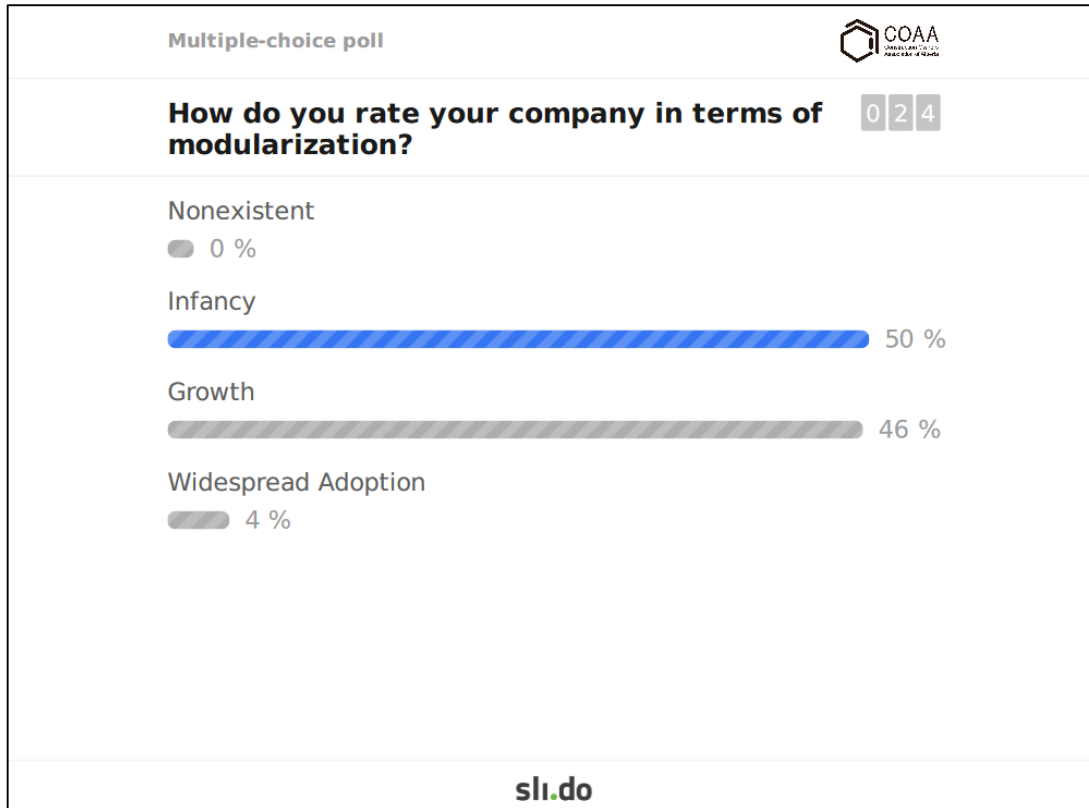
Has your company used an unconventional or innovative contracting approach that has worked well or bad?

- **Modularization has been used for several decades in an attempt to move labor hours out of the field into a controlled environment**
- **However, the scope that is able to be modularized has progressed significantly**
 - **1st generation modularization (starting in the 1990s) was primarily around pipe racks**
 - **2nd generation modularization (starting in the 2000s) incorporated equipment into the module design**
 - **3rd generation modularization (starting in 2010s) has increasingly incorporated electrical and instrumentation scope into the modules**
 - **Latest modularization efforts are using extremely large modules that encompass the entire ISBL scopes of processing plants**
 - **Limited to facilities located near large waterways**

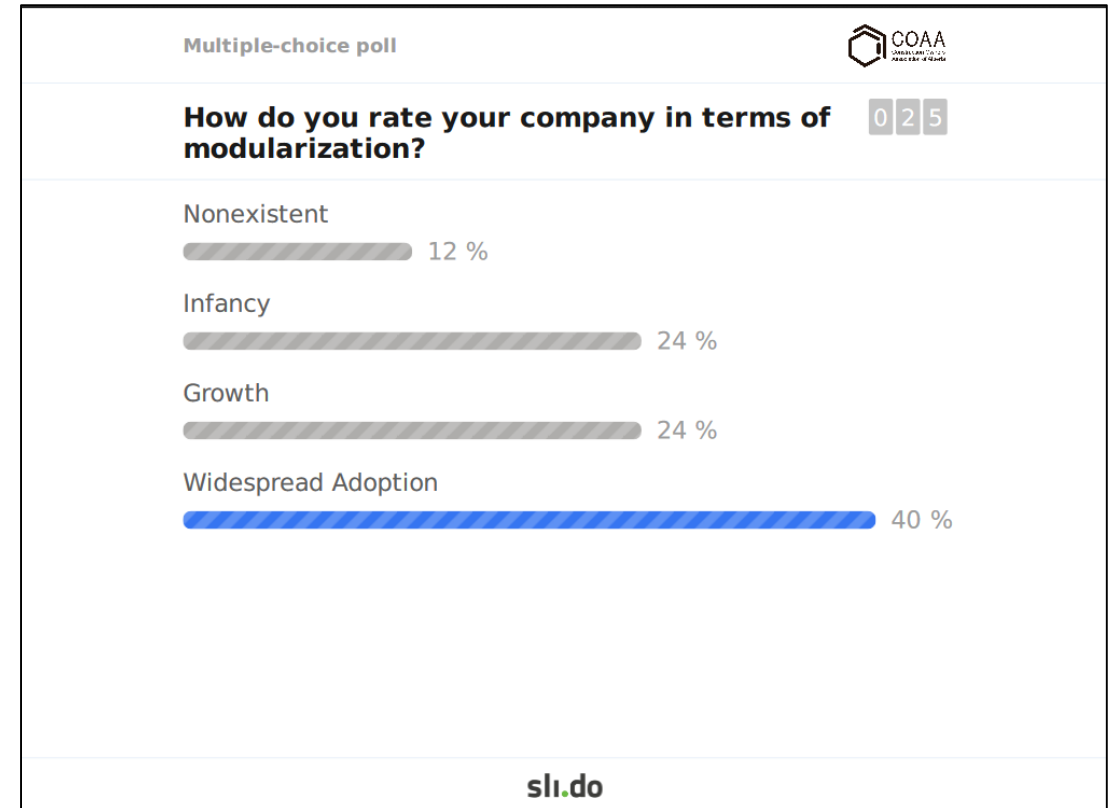
How do you rate your company in terms of modularization?



Please go to sli.do to submit your response



Track A Results



Track B Results

- **Reduces direct craft and craft supervision hours on site**
- **Reduces required construction facilities (parking, lunch rooms, etc.)**
- **Reduces site laydown area requirements**
- **May reduce project effect (traffic, noise, etc.) on local communities**
 - However, movement of modules through communities can be quite disruptive
- **May reduce earthwork, u/g (E&I and pipe), concrete, and/or paving due to more vertical construction**
- **Weather delays are drastically reduced**
- **Can reduce construction schedule through multiple work fronts**
- **Should allow for better quality control**
- **Construction can start without site access**
- **Can lead to lower cost primarily due to better productivity in the yard**
 - However, this is often offset by transportation costs, more structural steel, etc.

- **Significant early engineering is required**
 - Envelope sizing, weight management, SS design, etc.
- **Because logistics are more complicated, a much better owner project execution plan is required**
- **Engineering and procurement schedules must be accelerated**
- **Delivery of owner/contractor supplied materials to yard must be timely**
- **Due to the accelerated engineering schedule, late design changes are more costly**
- **Increased steel quantities for transport and additional shipping and transportation costs**
 - Shipping, dock, module offloading facility, etc.
- **Module design dimensions may be affected by transportation limitations**
 - Roads, bridges, power lines
- **Owners have to alter controls approach**
 - Rather than systems, the focus is on units
- **Not well suited for new technology projects**

- **Design Standardization**
- **Contracting and Execution Strategies**
- ***Digitalization***
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- **Conclusion**

“Digitization”

Conversion of information into digital form (photos, music, paper, old drawings, etc.)

“Digitalization”

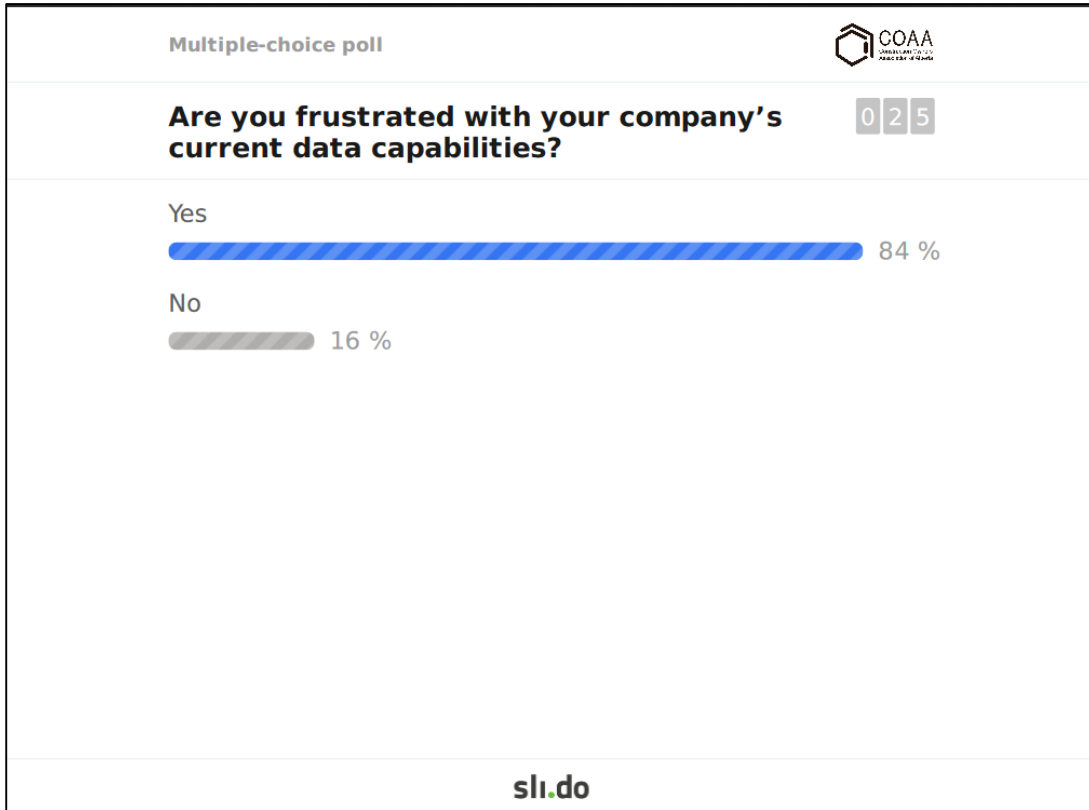
Process of getting separate collections of digitized information to communicate; can also be referred to as “data integration”

- **Capital projects produce an enormous amount of data**
- **Businesses can use past data to make better future decisions**
- **However, as an industry, we do not do an excellent job of capturing past data to use on future projects**

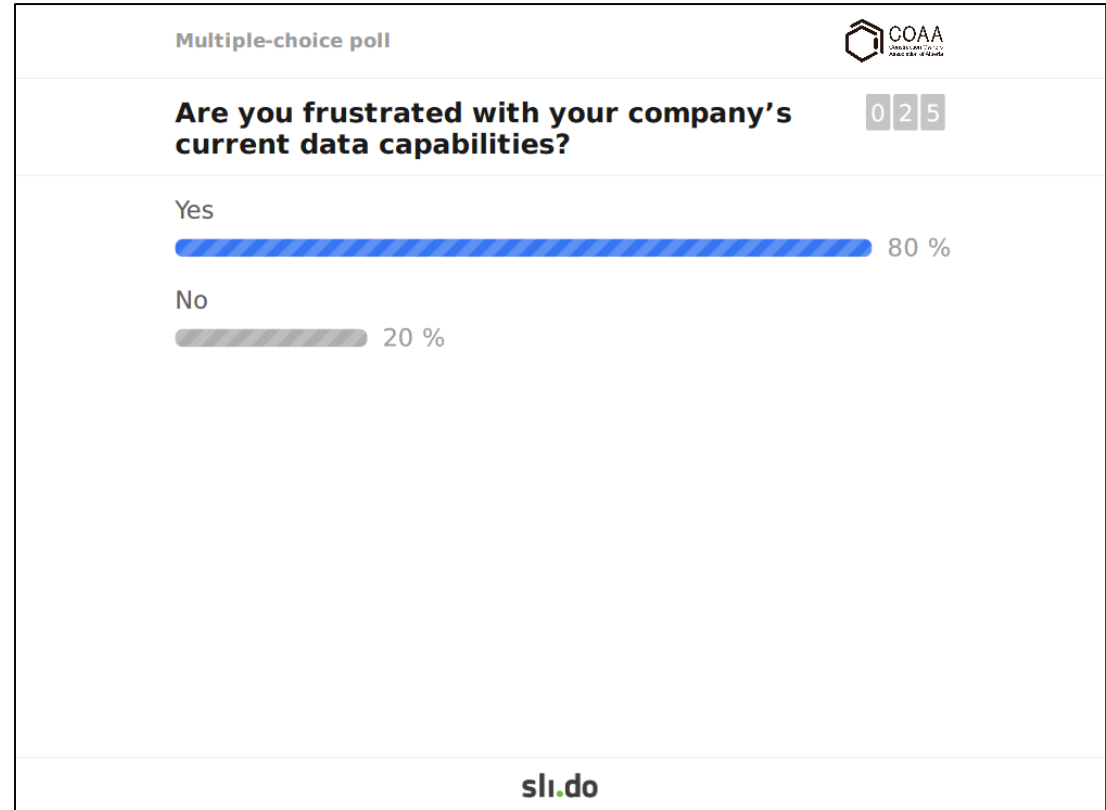
Are you frustrated with your company's current data capabilities?

- **Yes**
- **No**

Please go to [slido.com](https://www.slido.com) to submit your response

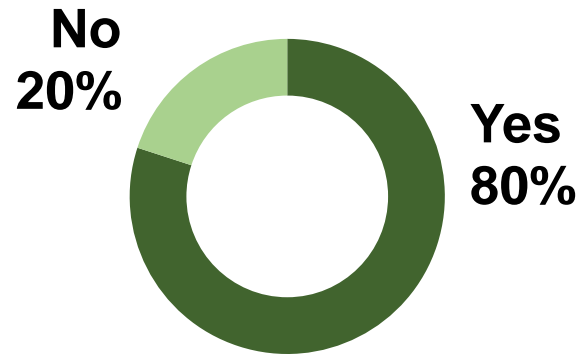


Track A Results



Track B Results

Are you frustrated with your company's current data capabilities?

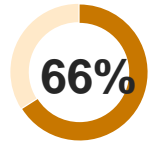


Most of the companies we interviewed feel frustrated!

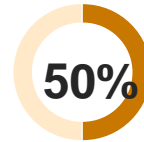
- Organizations must have the capability to *extract value* from information
- The challenge these companies face is difficulty in *demonstrating value* of investing in data systems
- Perception that these are expensive
- Business needs to see return on investment
 - E.g., “We can save X percent if we have this information, and it will only cost Y dollars”

The first step is knowing what data you actually want and why you want it

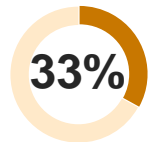
Perceived Roadblocks to Digitalization



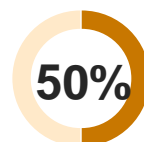
“We have tried IT solutions in the past that work, but not very well. Management is disappointed.”



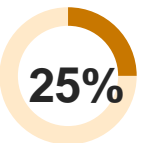
“Legacy systems are perceived as very expensive to change.”



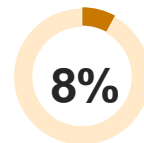
“We can’t get the kind of data we want from EPC contractors.”



“We don’t have data people.”



“No standard breakdown structure for cost and schedule.”



“What would we do with the data?”

Percentages of survey respondents who viewed issue as roadblock

- **For project data digitalization to work, owners need a better way of receiving and managing data**
 - **Contractors sometimes resist providing detailed information**
 - **Most project systems do not have data infrastructure (e.g., databases or data management)**
 - **Data collection is manual (spreadsheets) and inconsistent**
- **The effort to remedy these issues is perceived as significant**
 - **You can get more detail from contractors, but it takes discipline**
 - **Automation tools are not comprehensive and can be expensive**
 - **Data functions add to your already scrutinized head count**

- **The most valuable project data for business are data that reduce the project costs**
- **What do cost saving data look like?**

Cost Data

Drive competitive targets

Control Data

Cost & schedule data for execution control

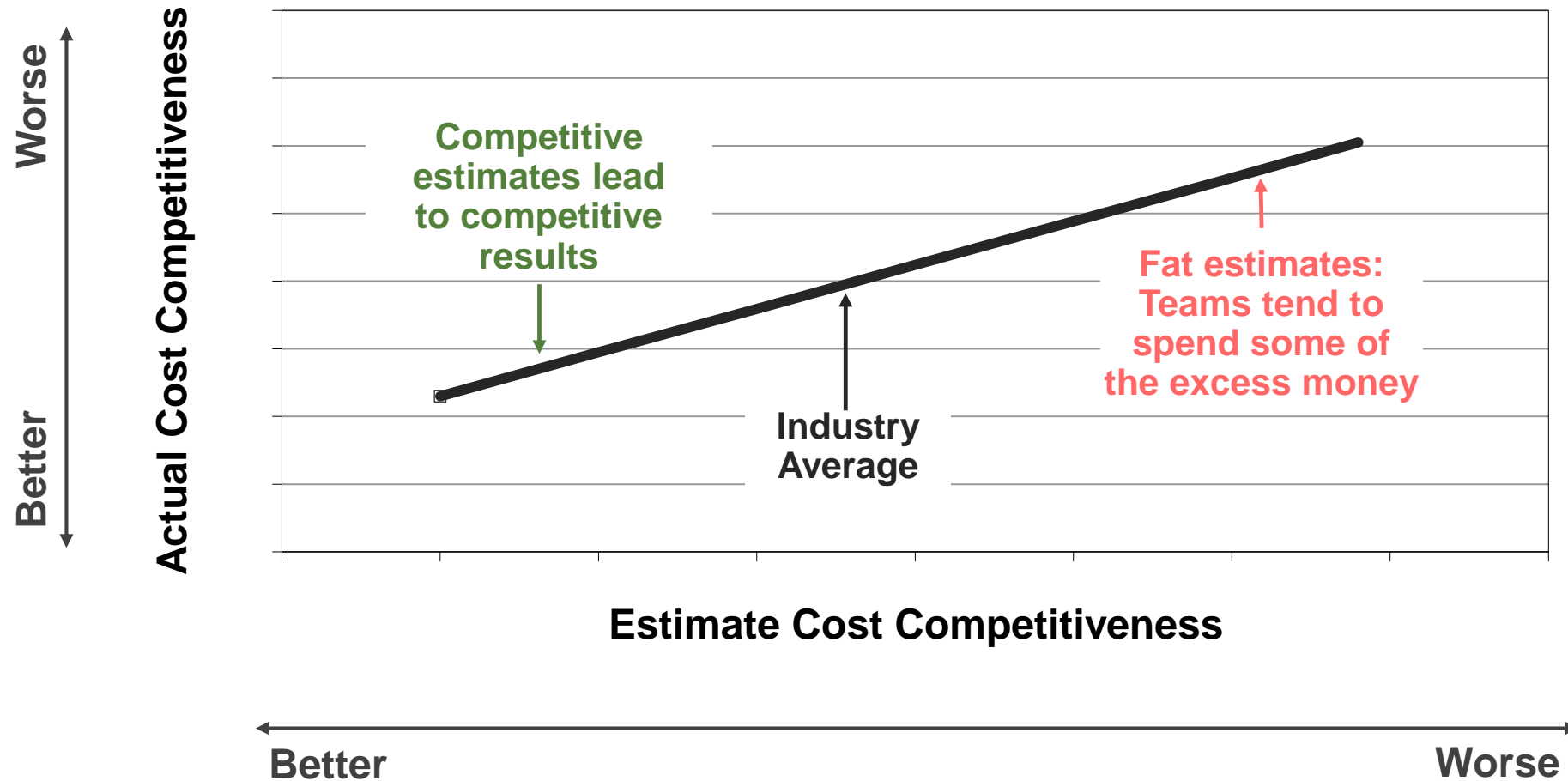
Design Data

Promote standardization

Team Data

For team optimization

Having a Good Idea of “Should Cost” Is Correlated With Better Actual Cost Performance



Cost Estimating

- **Bottoms-up estimating methods are reliant on:**
 - Detailed quantities
 - Detailed material pricing
 - Detailed labor rates
 - Detailed rate of placement
 - Detailed indirects



Companies preparing their own detailed cost estimates need detailed data to drive competitive estimates

Cost Validation

- Analogues
- Capacity curves
- Discipline-level quantities and rates (e.g., “piping labor hours/foot of pipe”)
- Location factors
- Project-level escalation



Companies using cost data for validation—surprisingly—need almost as much data!

Like Engineering, Data Analytics Requires Specialization

Do you just need help organizing the data?



Database Administrator (DBA) 

- Knowledge of database design and theory
- Knowledge of database software, SQL Server, MySQL, PostgreSQL, etc.
- Capable of database server installation
- Capable of ensuring security and generating backups

Are you overwhelmed with the data, and looking to make predictions?



Data Scientist 

- Typically masters or PhD in computer science, math, or statistics
- Skilled with statistical computer languages
- Experience creating data structures
- Knowledge of statistics and machine learning
- Experience with data visualization techniques

Do you want to study cause and effect in a structured experiment?



Statistician 

- Masters or PhD in statistics
- Skilled in the theory and application of statistics
- Designs research plans and experiments
- Skilled in statistical computer languages

Spreadsheets are limited in capacity, flat files, time consuming to update, and prone to error



* Excel is a registered trademark of Microsoft

- **Design Standardization**
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- **Conclusion**

Innovative Construction Management Strategies

Use Drones to Monitor Physical Progressing (1)



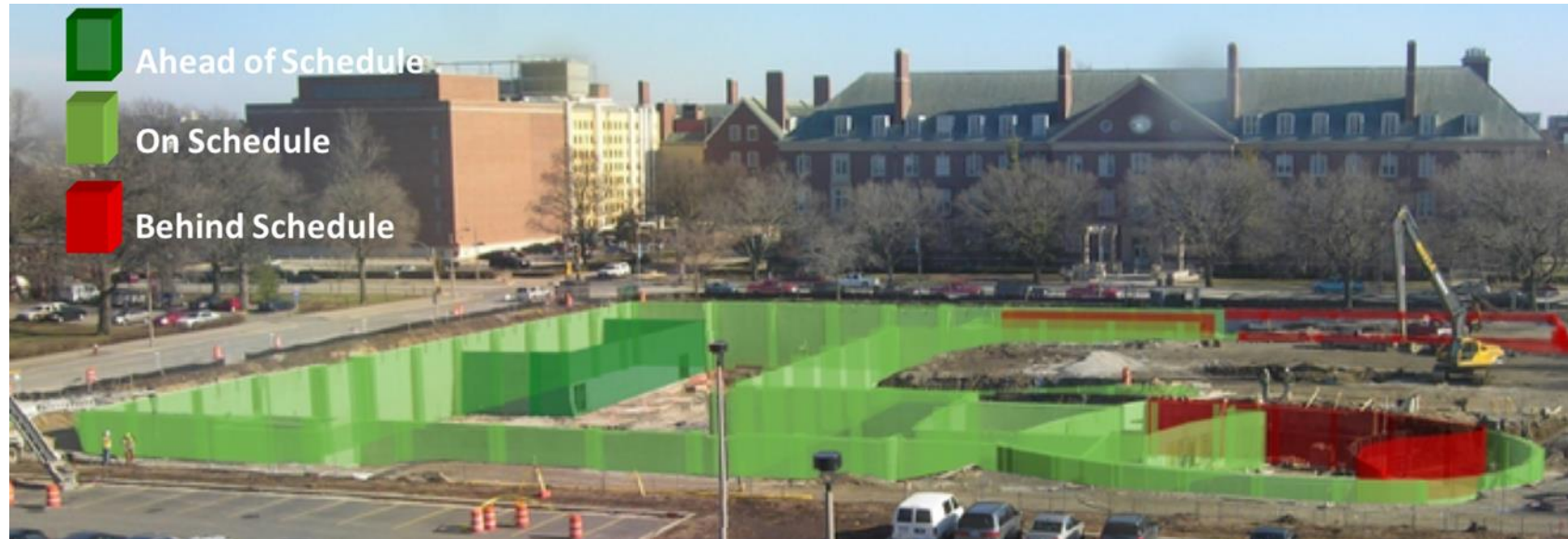
- **Use predictive visual data analytics tools to automate and streamline construction progress monitoring**
- **Utilizes both images and videos taken with camera drones and four-dimensional Building Information Modeling**
 - **Quickly identifies and visually communicates actual and potential performance problems during construction**
 - **Via smartphones and tablets to project participants, on and off site**

<https://informedinfrastructure.com/20656/sacramento-kings-new-arena-incorporates-drone-monitoring-system/>

Innovative Construction Strategies

Use Drones to Monitor Physical Progressing (2)

Provides a comprehensive picture of what's going on and can highlight how a slowdown in one area may affect the entire project



<https://informedinfrastructure.com/20656/sacramento-kings-new-arena-incorporates-drone-monitoring-system/>

- **Innovation has been applied to personal protection equipment (PPE)**
 - **Construction vests with:**
 - **GPS tracking**
 - **Body temperature, blood pressure, and heart rate monitoring**
 - **Hard hats with:**
 - **Cameras, powerful lights, carbon monoxide detection, proximity sensors, etc.**
 - **Smart eye-wear (e.g., Google Glass)**
 - **Exoskeleton and power lift suits**
- **Use of some of these technologies is new and limited, and because incidence of safety incidents does not follow a normal distribution, it may take a long time to statistically prove their effectiveness**

- **Design Standardization**
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- ***Conclusion***

“Ultimately, progress and innovation win”

Travis Kalanick (co-founder, Uber)

- **Companies that continue to innovate in their approach to design, safety, use of data, contracting and execution approaches have a competitive advantage over those that do not**
- **Simply put, companies that are too slow to innovate are marginalized and typically left behind**
- **As you approach your work, consider Thomas Edison’s sentiment:**

There is always a way to do it better. The challenge is simply finding it.



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