Technology Infusion with E&C

2017 Engineering and Construction Conference
## Agenda

<table>
<thead>
<tr>
<th>Module/Topic</th>
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<tr>
<td>Growing the business using technology</td>
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<tr>
<td>Latest in technology</td>
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<tr>
<td>Cushman &amp; Wakefield Services – Virtual Reality and AI</td>
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<tr>
<td>Suffolk Construction – Virtual Design Construction</td>
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<tr>
<td>Geisler – Impact of Driverless Cars on Real Estate</td>
</tr>
<tr>
<td>Q&amp;A</td>
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Growing the business

Industry investment in technology
Argument for growing your technology spend

Investment in technology is likely to have positive effects on profit margins by reducing SG&A. Technology allows companies to deliver larger revenue projects with the same or reduced support team. Use of technology and integration may result in higher initial costs but bigger margins in the long run.

Industry Trends

- Digital transformation
- The shifting role of ERP to Cloud and Digital
- BIM, Augmented Reality, Cognitive and Robotics
- The “field tech”, the end of the back-office investment
- Tech savvy and millennial focused workforce
- Labor shortage
- IoT coming on line everywhere
The state of technology spend in E&C

IT Spending Percent Change, by Industry, 2016. Up 0.6% from 2015, expected 2.5% jump in 2017.

IT Spending Percent of Revenue, by Industry, 2016. Same as 2015.

*SOURCE: GARTNER IT KEY METRICS DATABASE, March 2017*
The state of technology spend in E&C (cont.)


<table>
<thead>
<tr>
<th>Industry</th>
<th>IT Spending per Employee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-Industry Average</td>
<td>$13,365</td>
</tr>
<tr>
<td>Insurance</td>
<td>$29,424</td>
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<tr>
<td>Banking and Financial Services</td>
<td>$25,696</td>
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<tr>
<td>Government - National/International</td>
<td>$21,594</td>
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<tr>
<td>Utilities</td>
<td>$20,783</td>
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<tr>
<td>Software Publishing and Internet Services</td>
<td>$20,501</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>$18,925</td>
</tr>
<tr>
<td>Energy</td>
<td>$18,016</td>
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<tr>
<td>Media and Entertainment</td>
<td>$16,124</td>
</tr>
<tr>
<td>Pharmaceuticals, Life Sciences and Medical Products</td>
<td>$12,441</td>
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<tr>
<td>Professional Services</td>
<td>$10,465</td>
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<tr>
<td>Government - State/Local</td>
<td>$8,977</td>
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<tr>
<td>Transportation</td>
<td>$8,350</td>
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<tr>
<td>Education</td>
<td>$8,016</td>
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<tr>
<td>Chemicals</td>
<td>$7,509</td>
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<tr>
<td>Consumer Products</td>
<td>$7,494</td>
</tr>
<tr>
<td>Healthcare Providers</td>
<td>$6,820</td>
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<tr>
<td>Industrial Electronics and Electrical Equipment</td>
<td>$6,393</td>
</tr>
<tr>
<td>Retail and Wholesale</td>
<td>$5,871</td>
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<tr>
<td>Food and Beverage Processing</td>
<td>$5,549</td>
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<tr>
<td>Industrial Manufacturing</td>
<td>$5,325</td>
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<tr>
<td>Construction, Materials and Natural Resources</td>
<td>$4,535</td>
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</table>

IT Spending Percent of Operating Expense, by Industry, 2016. Same as 2015

<table>
<thead>
<tr>
<th>Industry</th>
<th>IT Spending Percent of Operating Expense</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-Industry Average</td>
<td>4.6%</td>
</tr>
<tr>
<td>Government - National/International</td>
<td>9.4%</td>
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<tr>
<td>Banking and Financial Services</td>
<td>8.8%</td>
</tr>
<tr>
<td>Software Publishing and Internet Services</td>
<td>8.3%</td>
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<tr>
<td>Media and Entertainment</td>
<td>6.1%</td>
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<tr>
<td>Education</td>
<td>5.8%</td>
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<tr>
<td>Professional Services</td>
<td>5.2%</td>
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<tr>
<td>Telecommunications</td>
<td>5.2%</td>
</tr>
<tr>
<td>Healthcare Providers</td>
<td>4.5%</td>
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<tr>
<td>Pharmaceuticals, Life Sciences and Medical Products</td>
<td>4.3%</td>
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<tr>
<td>Government - State/Local</td>
<td>4.0%</td>
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<tr>
<td>Utilities</td>
<td>3.9%</td>
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<tr>
<td>Transportation</td>
<td>3.6%</td>
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<tr>
<td>Insurance</td>
<td>3.5%</td>
</tr>
<tr>
<td>Industrial Electronics and Electrical Equipment</td>
<td>2.6%</td>
</tr>
<tr>
<td>Consumer Products</td>
<td>2.5%</td>
</tr>
<tr>
<td>Industrial Manufacturing</td>
<td>2.0%</td>
</tr>
<tr>
<td>Retail and Wholesale</td>
<td>1.8%</td>
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<tr>
<td>Food and Beverage Processing</td>
<td>1.5%</td>
</tr>
<tr>
<td>Chemicals</td>
<td>1.5%</td>
</tr>
<tr>
<td>Energy</td>
<td>1.5%</td>
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*SOURCE: GARTNER IT KEY METRICS DATABASE, March 2017
The state of technology spend in E&C (cont.)

Are you positioning your company into a competitive disadvantage? The tide is changing and more companies are understanding the power of digital transformation.

- Construction industry is last or near last in IT spending compared to 21 other industries
- The smaller revenue companies in E&C actually spend more on technology by Revenue, by Operating Cost, and by Employee than the larger companies
- Underspending on IT may be a short sighted strategy
- 70% of US productivity growth comes from technology
- Technology investment is one of the key drivers in attracting and retaining young talent, >70,000 construction jobs will be filled with millennials this year
Latest in Technology
Cushman & Wakefield Services
Terry Vergon
The coming crisis ... data flood
It started with vibration analysis...

Evolution:
• Taking readings (monthly or ??)
• Wired monitoring (using alarm set pts, manual review)
• Wireless monitoring (using alarm set pts, manual review)
• Wireless monitoring (profile comparison, manual review)
• Wireless monitoring (AI and ML, multi-variable, EIB)
The coming crisis ... data flood

IOT and ... (what’s next)

With IOT – gigabits per minute

Different inputs and perspectives

Not enough qualified engineers

Must find a way to handle the analysis (smart decisions with course of action, manual or auto)
A simple end-to-end IoT based Predictive Maintenance system

**Connect**
- Vibration Mote
- Temperature
- Petasense Transmitter - Retrofit 3rd Party sensors

**Collect**
- Petasense Transmitter

**Predict**
- Asset reliability
- Asset performance
- Energy efficiency

- **3rd Party**
  - Existing sensor data (e.g. PLC, PI)

**Simplify connectivity to “things that matter”**

**Data with high quality, high volume, high speed**

**Insights for important industrial problems**
Health Score

1. Class of Algorithms: Anomaly Detection

2. Types of machines: Rotating Machines (Motors, Pumps, etc.)

3. Data Sources
   1. Field Data (18 Billion Readings available)
   2. Simulated Data & Test Lab Data (have a test lab)

4. Phased Approach for Health Score Analysis Process
   1. Phase 1 – Target Simple Machines – Fixed Speed or Little variations in Load
   2. Phase 2 – Target Variable Speed machines - Get Current/Load Input alongside vibration

5. Overall Process

Collect Vibration Data → Select “n-dimensional” feature baseline → ML Algorithms measure “deviation” from baseline → Reliability engineers visualize results of ML Algorithms
Latest in Technology
Deloitte Consulting
Allan Cook
It’s a digital world out there

Organizations are always looking for the next competitive advantage. By innovating technological capabilities through Next Generation (Next-Gen) Offerings, companies are able to compete and win against competitors in...
Need to focus on Reality Disruption

"AR" is the real world with interactive digital elements locked contextually in the environment around the user
  - Partially rendered, transparent environment
  - Nascent solution ecosystem
  - Aware of surroundings and self

Augmented Reality
OVERLAYING THE REAL WORLD

Virtual Reality
AN IMMERSIVE EXPERIENCE

"VR" is an entirely digital world that immerses the user, who is unaware of the environment around them
  - Fully rendered, enclosed environment
  - Consumer & enterprise maturity
  - Robust behavioral analytics

Mixed Reality
PUTTING OBJECTS INTO THE REAL WORLD

"MR" is merging real & virtual worlds to produce new environments & visualizations where physical & digital objects co-exist & interact in real time
  - Partially rendered, transparent environment
  - Fully rendered VR objects
... because it’s about to happen...

*VR & AR in the Lead* – Leading the exponentials (e.g. blockchain, cognitive, connected home, IoT, commercial drones, autonomous vehicles, etc.). VR is the only one to have left the “trough of disillusionment” & pushing to “slope of enlightenment”

*Some Disillusionment Today* – Because this is where we are in the hype cycle – need to realize the potential is still there, just the previous wave set expectations too high

*Now is the Opportunity* – If we wait for the “plateau of productivity,” we will be too late—this is the time when we can become the dominant player

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The Fourth Transformation – PC | Web | Mobile | Digital Reality
... across a broad range of applications
Emergent technologies can transform job-site labor

**Data Audit**
Record what was done, by who, at what time, with visual and audio record per action

**Work Instruction**
Allow workers to minimize issue triage by providing instruction specific to the task at hand

**Remote SME**
Allow remote operations to access subject matter experts and enable see-what-I-see
Emergent technologies can transform operations

**Equipment Management**
Access data that is being gathered about a facility to facilitate preemptive maintenance

**Safety**
Deliver contextual awareness to workers through providing thermal, air, and equipment data

**Digital Twin**
Allow workers to identify inconsistencies and enact reconciliation with digital twin processes
Emergent technologies can transform the selling process

**Real Estate**
Allow for previsualization of high cost assets, configuration & user acceptance

**Options & Layouts**
Allow for visualization of multiple options, layouts and finishes

**Staff Training**
Allow customers to onboard with new complex hardware without needing physical sales support
Stores

Solution

Virtual Store Concept
Visualize the flagship store to a level of detail that allowed all departments to clearly preview and understand if the concept would work.

Value

Efficiency - Enabling stakeholders to preview and sign off the concept before costly real world build began.

Training - VR tool became the primary training facility for retail staff to feel confident in how to interact in the space from day one.
Homes

Solution

Bring to life a series of house styles, developed by a specialist residential architect, to allow prospective buyers and developers to literally walk through the new home concept.

Value

Sales - Enabling prospect buyers ‘walk through’ a home before purchase before construction is completed – making sales conversations easier for the developers.

Tools

Google tools

Google cardboard apps Web VR 360
**Mall**

**Solution**

Over a three year period, brought to life refreshed designs from multiple interior design and architecture firms into one holistic view.

**Value**

Alignment - Enabling stakeholders to preview and sign off multiple vendor works in one cohesive vision for the shopping center.

**Tools**

Google tools

Google cardboard apps Web VR 360

500+ 2D images & 50+ 360VR images
But, this can be huge

Augmented/Mixed/Virtual Realities reduce errors and increase worker effectiveness from concept to completion of building projects

**Engineering**

Visualize building parts, models, and progress with Virtual/Mixed Reality

**Construction**

Connect human operators with data systems to enable a data driven workforce

**Customer**

Let buyers experience buildings before they exist and track behaviors to shape design

3D Rends & Fly-Throughs
Generate photorealistic, volumetric visualizations of 3D retail, commercial, and architectural concepts

**Work Instruction**
Connect workers to BIM system information to enable step-by-step adherence to building plans

**Accelerate Sales Cycle**
Allow customers to step into rooms see views in order to facilitate quicker commitment to space

Collaborative Decision-making
Eliminate ambiguity in procurement or entitlement with virtual models of materials, parts, or structures for architects, engineers, and stakeholders

**Inspection**
Apply computer vision to recognize building materials, existing structures, or construction progress while identifying errors for remediation

**Behavioral Analytics**
Track user behavior in navigating new or hypothetical spaces to discover movement patterns and visual cues

Simulation based Analytics
Leverage massively distributed virtual worlds to learn and iterate from simulated foot traffic, parking, or retail behavior

**On-site Visualization**
Enable the ‘digital twin’ by connecting physical construction progress with digital renderings of precast structures to ensure just-in-time fit

**Employee Training**
Open new buildings faster by delivering virtual spatial training while the building is still being constructed

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... and there’s more to think about!

Digital Reality

- Digital Strategy
- Systems Integration
- Content Management Systems
- Workforce Transformation & Training
- Business Model Transformation
- Infrastructure & Connectivity
- Operate – Managed Services
- Advertising & Marketing
- V-commerce & V-tail
- Personalization
- Cloud Services
- Analytics
- M&A
What else is stopping us?

Tipping POINTS

FIVE MAJOR CHALLENGES TO CONQUER FOR MASS ADOPTION

- Extended Battery Life
- Mobile Computing
- App Ecosystem
- Decrease Latency
- Price Point