

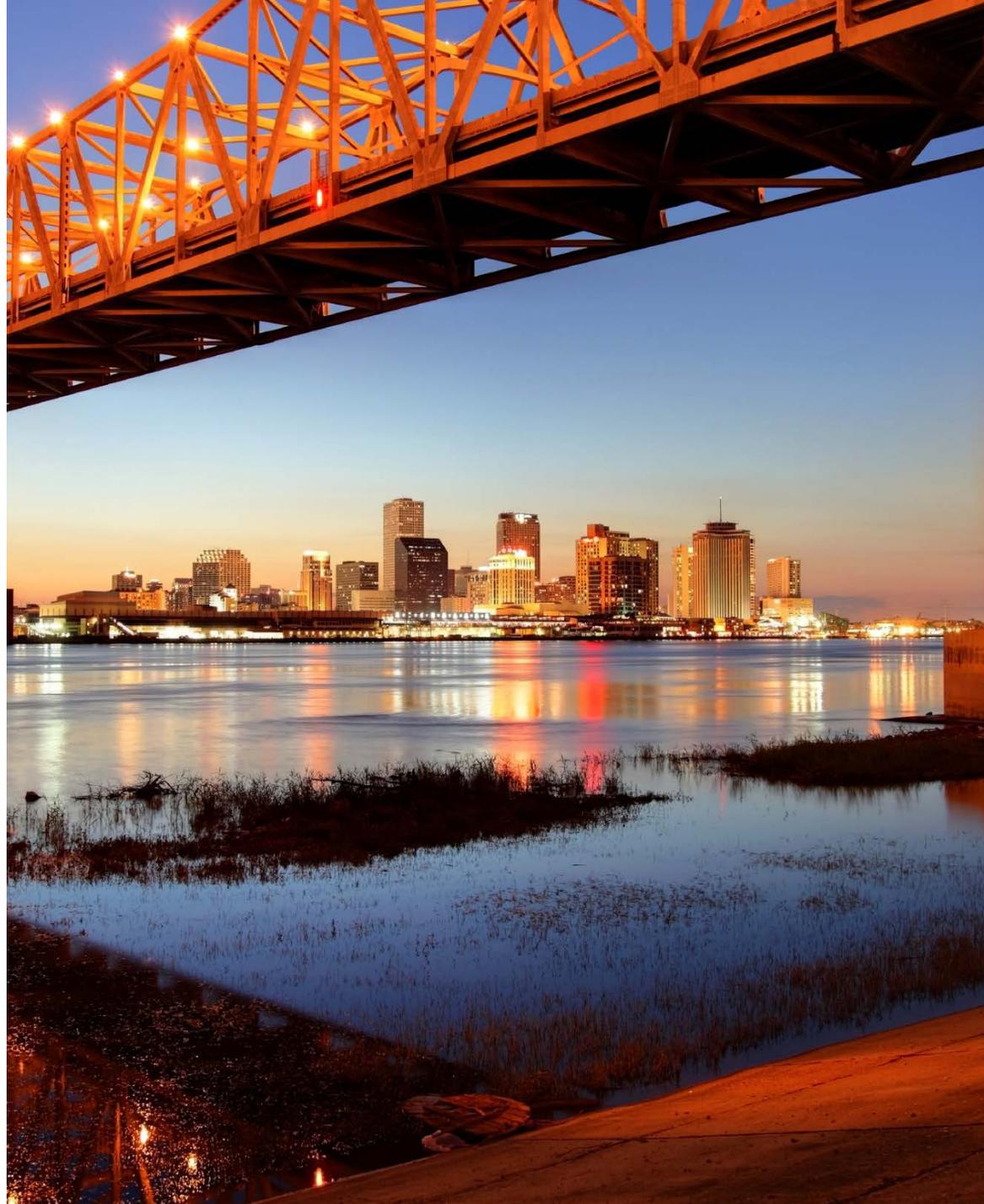


2015 Engineering & Construction Conference

Disruptive Technologies & Their Impact on E&C

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June 18, 2015





Mark J. Cotteleer
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Services, LP

Emerging technologies at the digital/physical interface are impacting businesses, across industries, in profound ways

MATERIALS & MFG.



Advanced materials

Materials innovation has evolved from natural materials to synthetics and then custom materials. Now, materials are designed as end-to-end functional solution.

Additive manufacturing

Additive Manufacturing could be used to achieve supply chain transformation, product performance enhancements, or both.

Robotics

Industrial robots are becoming more user-friendly and can now be programmed to easily switch between tasks and interact in close proximity to / with humans and in extended digital landscapes.

Distributed generation

Alternative energy is making performance gains, but is limited by storage solutions. Advances in storage and micro grid management technologies enable improvements

Modular operations

Products, processes, and operations are being designed in pieces that are flexible and can easily be repurposed to match customer demand, meet product design requirements,

CONNECTIVITY



Advanced sensors

Advanced sensors are smarter and more proactive and predictive in monitoring, as a result of advances in technology and companies are integrating sensors in product design and operations.

Remote-controlled operations

Centralized hubs allow for manufacturing and operations centers to be supervised by fewer people with the assistance of analytics.

Facebook of assets

Combined with advances in sensors, the Facebook of assets could improve asset management capabilities by providing a database of assets with real-time statuses.

Smart machines

Machines – equipped with sensors integrated with software – assess the environment and the machine's performance in order to predict issues.

COMPUTING & BIG DATA



Advanced analytics & visualization

Companies are using new analytic techniques and technologies to extract value out of existing data. The application of data science is finding patterns to predict future outcomes and trends.

Advanced computing

Increases in power and Artificial Intelligence, such as cognitive analytics, machine learning, and natural language processing have enhanced capabilities to analyze data more effectively

Virtual industrialization

Before opening a new facility or repurposing a shop floor, manufacturers can run detailed simulations, determining the most efficient and cost effective setups limiting trial and error.

Digital infrastructure

Advances from fiber optics to storage capabilities are handling more data, faster, and with more energy efficiency.

Cloud computing

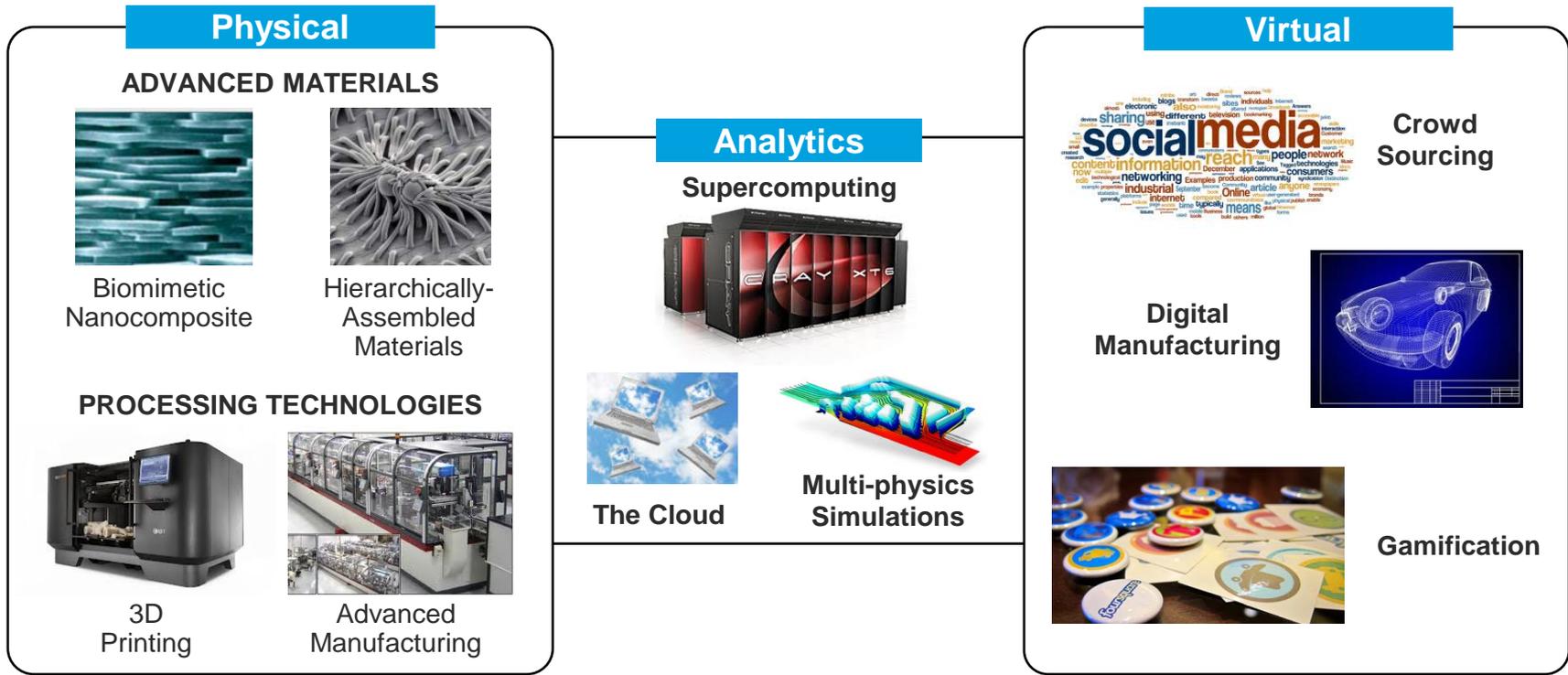
In combination with other digital advances, cloud storage will provide the storage enabling intensive data capture and analysis that integral part to Industry 4.0.

Exponential Technologies Industry 4.0 Disruptive Technologies

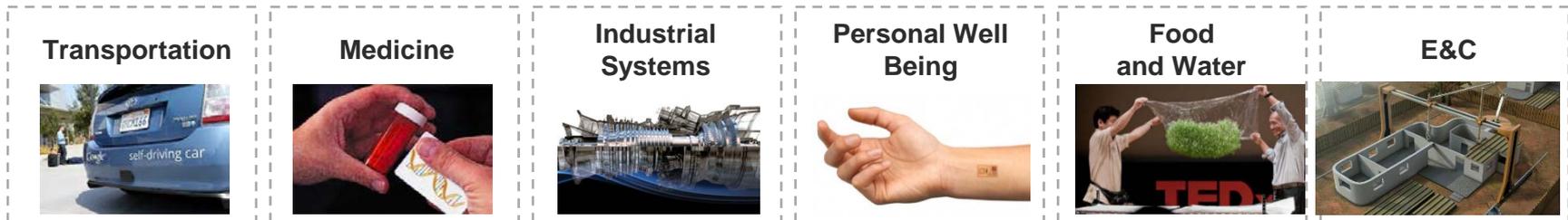
Manufacturing has undergone eras of transformational change from the first industrial revolution (mechanical production) to the second (electricity and mass production) and the third (information technology).

These technologies will continue to evolve over time. We need a way to organize and understand them for our clients!

Advanced Technologies: connecting atoms-to-bits



A convergence of technologies will enable new solutions

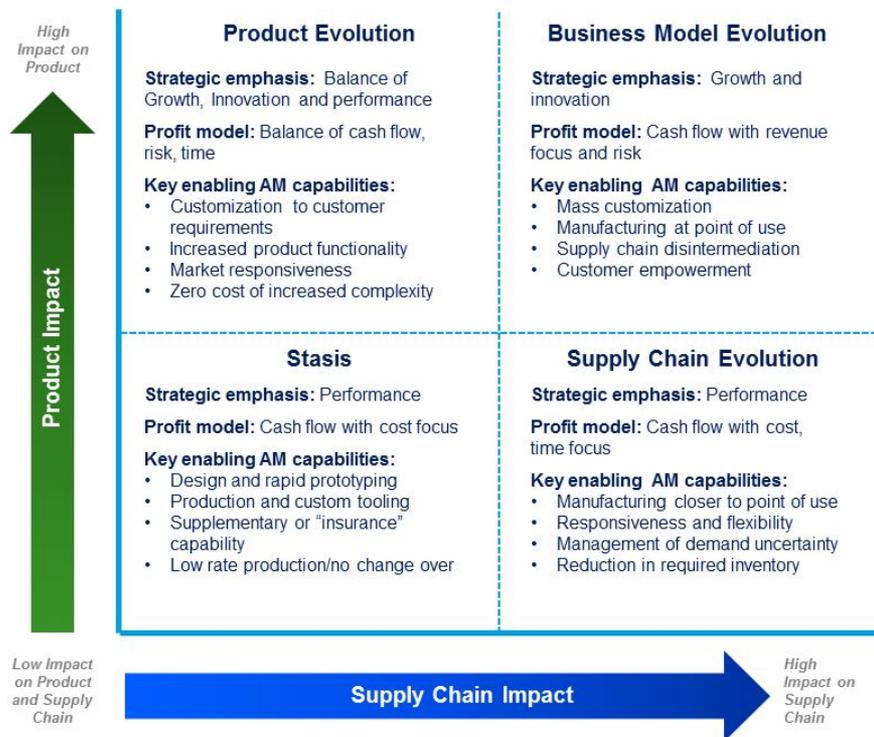


Deloitte is working to develop tools and services that enable each of these areas

Amidst all the hype, we like to deploy simple frameworks to help us think through the issues.

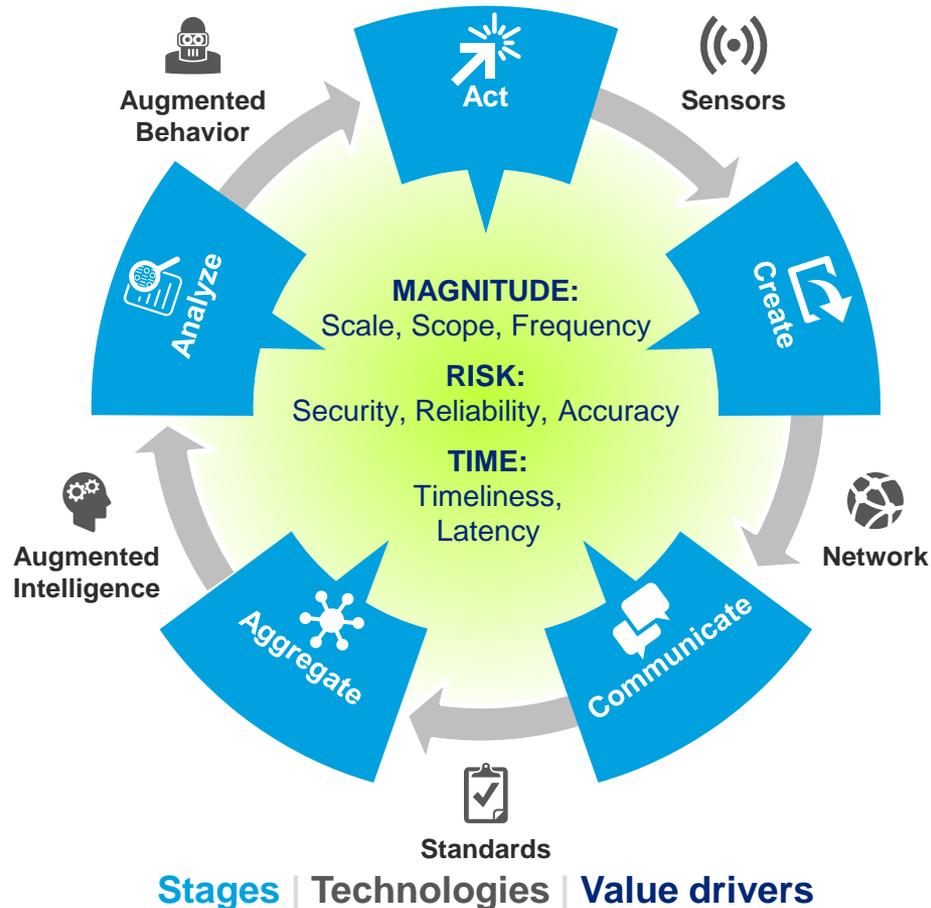
Additive Manufacturing Framework

Additive manufacturing is a process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies.



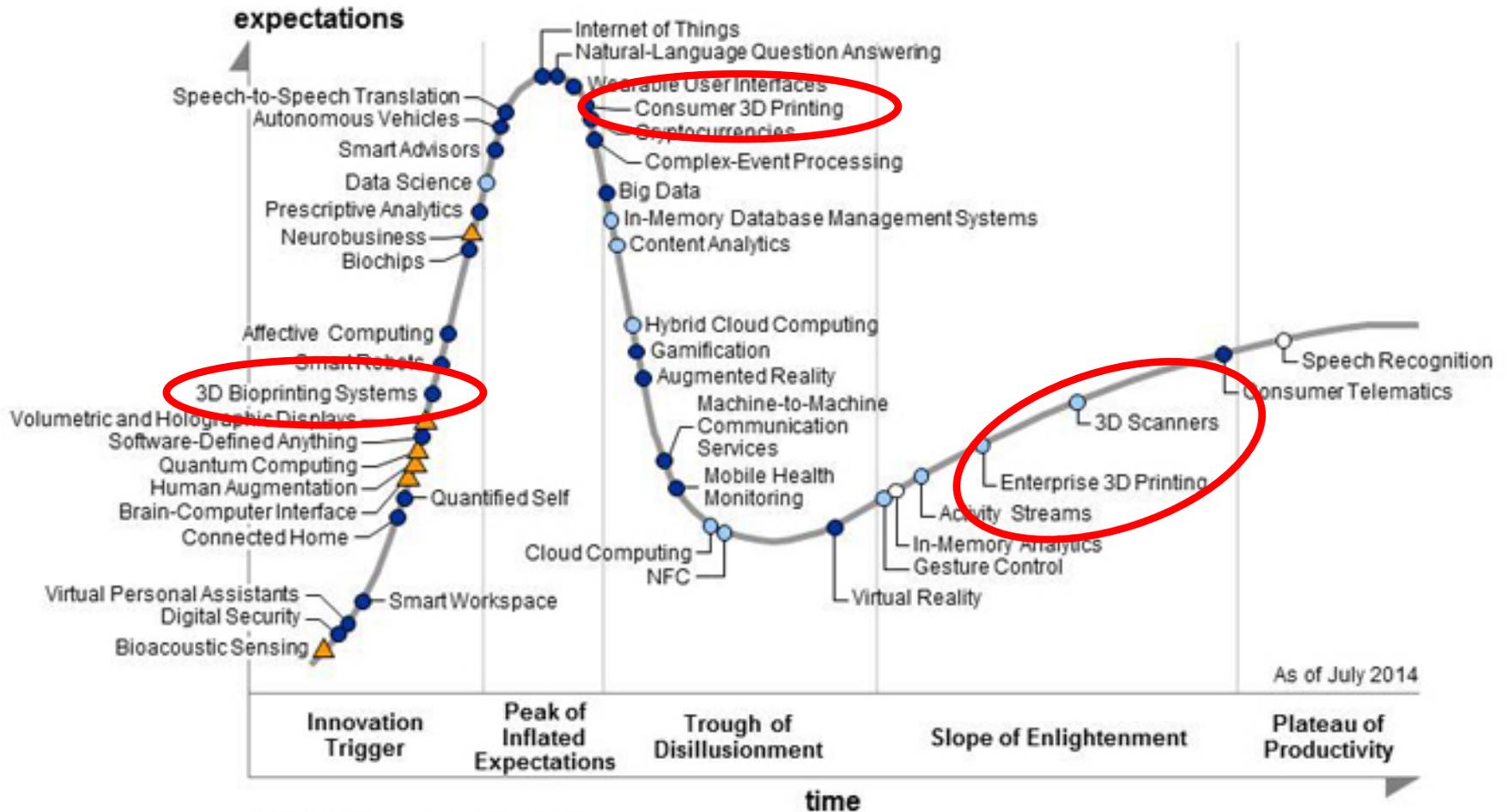
Internet of Things Framework

"IoT includes network-connected objects, systems, and devices which may be monitored or controlled through an application via the Internet."



Additive Manufacturing (AM) – aka 3D Printing – is (slowly) going mainstream

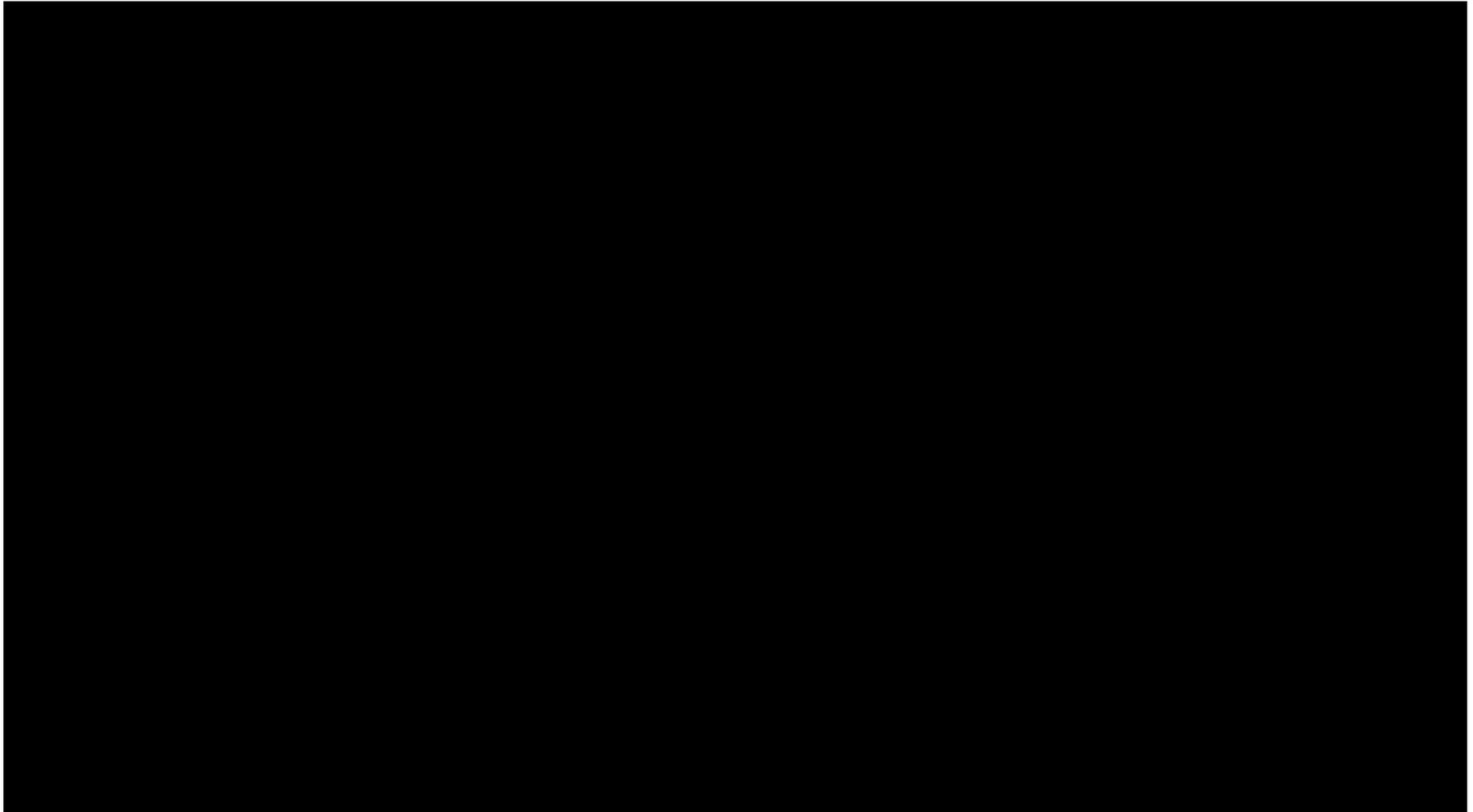
3D Printing in the Gartner Hype Cycle ©



Plateau will be reached in:

- less than 2 years
- 2 to 5 years
- 5 to 10 years
- ▲ more than 10 years
- ⊗ obsolete before plateau

Demonstration project we just did a couple weeks ago.... BMW



And another demonstration project from the Netherlands



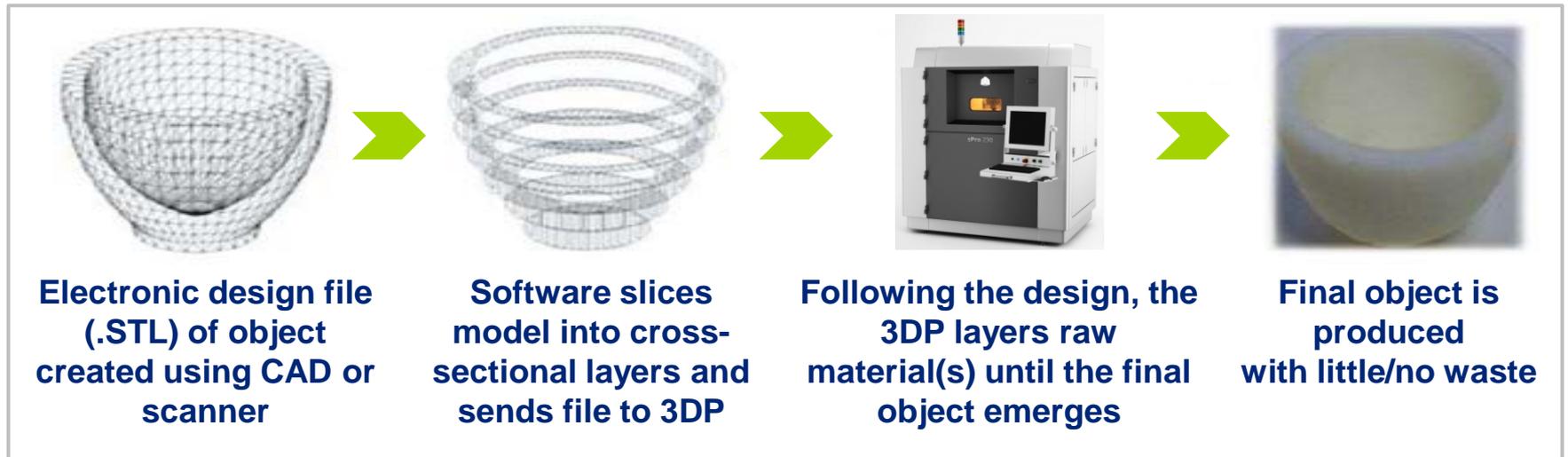
Additive manufacturing (aka 3D Printing): Agenda and definition

Agenda

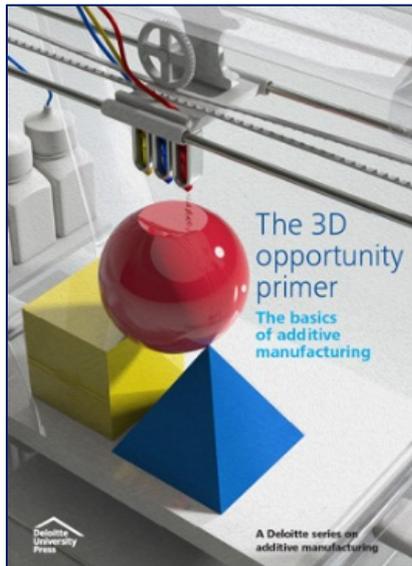
- Briefly discuss “what” AM is.
- Briefly discuss “how” AM might be applied by business (in general).
- Briefly discuss/speculate on implications of AM for E&C.

Definition

Additive manufacturing is a process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies



AM is not one thing; it is many technologies



Vat photopolymerization

- Stereolithography (SLA)
- Digital light processing (DLP)

Material jetting

- Multi-jet modeling (MJM)

Material extrusion

- Fused deposition modeling (FDM)

Powder bed fusion

- Electron beam melting (EBM)
- Selective laser sintering (SLS)
- Selective heat sintering (SHS)
- Direct metal laser sintering (DMLS)

Binder jetting

- Powder bed and inkjet head 3D printing (PBIH)
- Plaster-based 3D printing (PP)

Sheet lamination

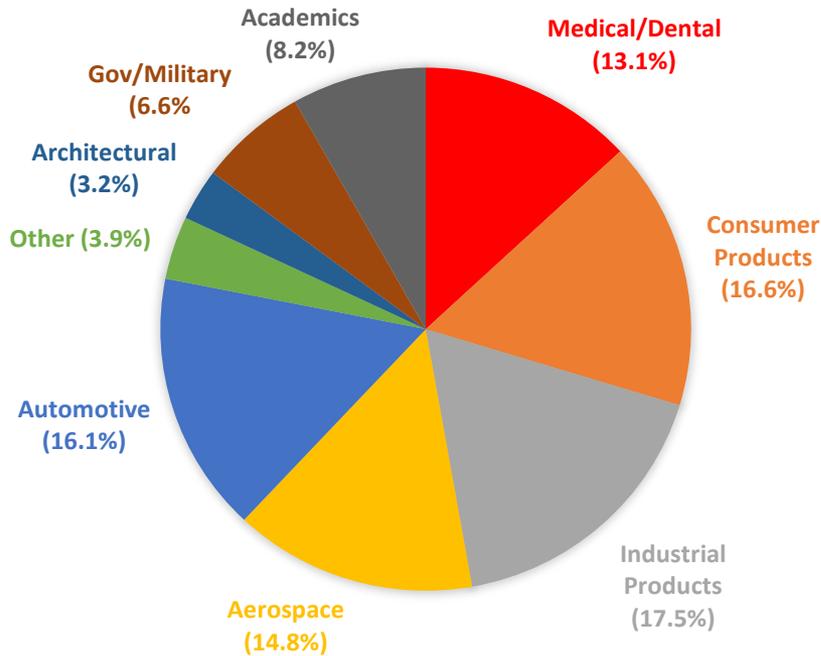
- Laminated object manufacturing (LOM)
- Ultrasonic consolidation (UC)

Directed energy deposition

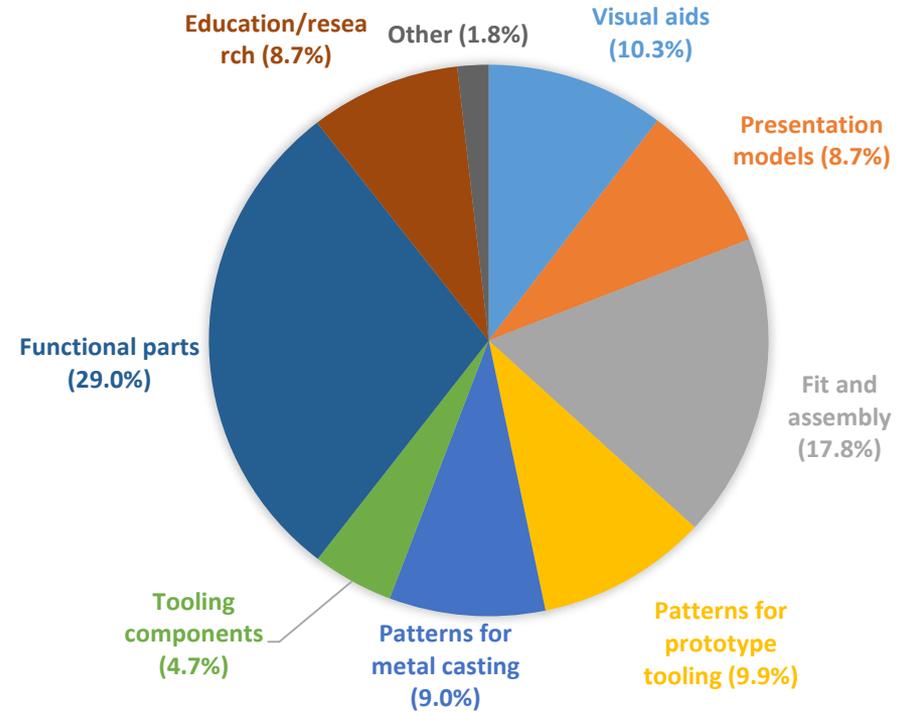
- Laser metal deposition (LMD)

AM impacts across industries and application domains.

AM system sales revenue to various sectors: 2014



AM application areas: 2014



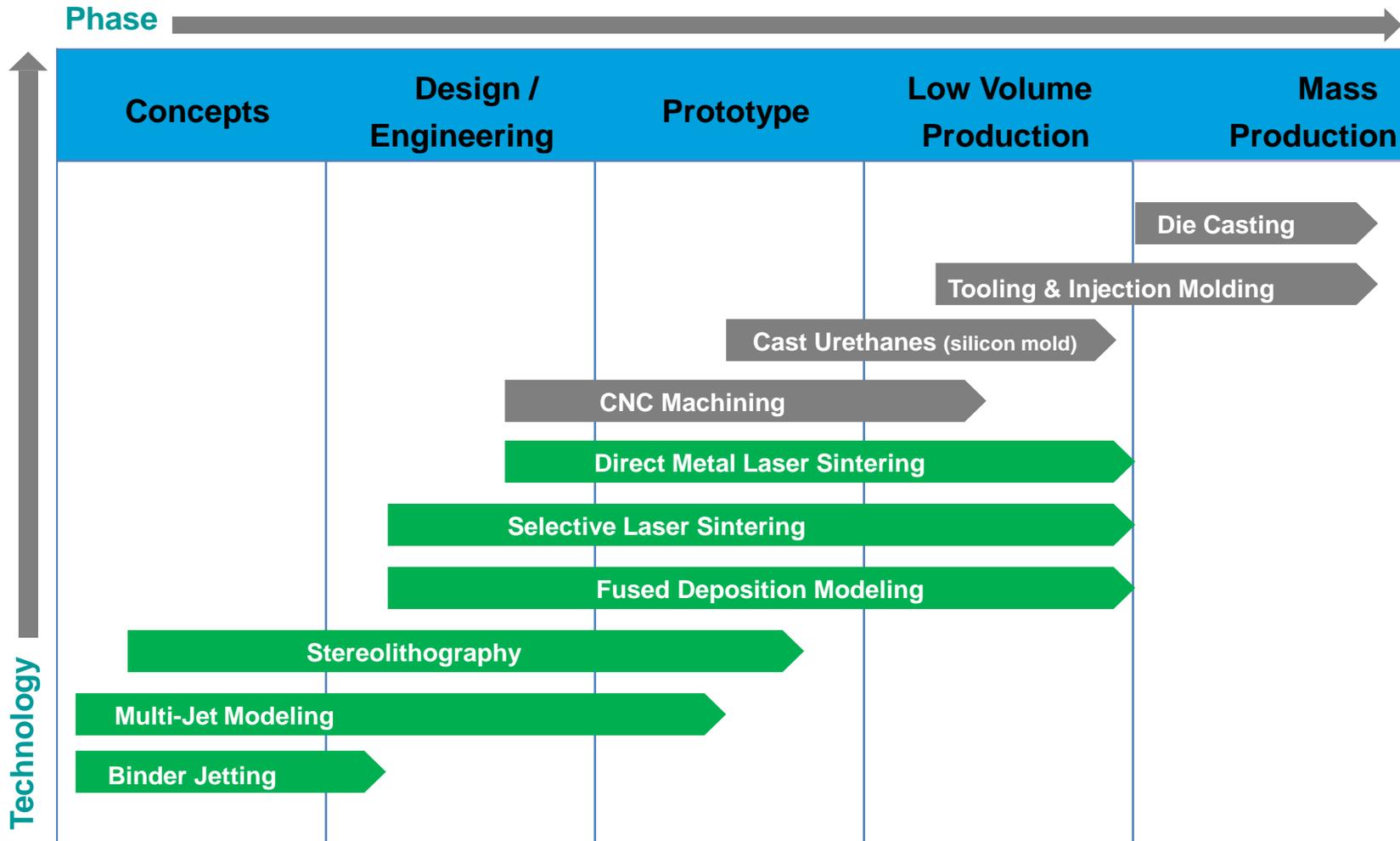
General Industry Notes

- 2014 global AM market revenue was \$4.1 billion
- 25 year CAGR of 27.3 percent; 33.8 percent in the last three years.
- Market forecast of \$21 billion by 2020.

Industries & Applications

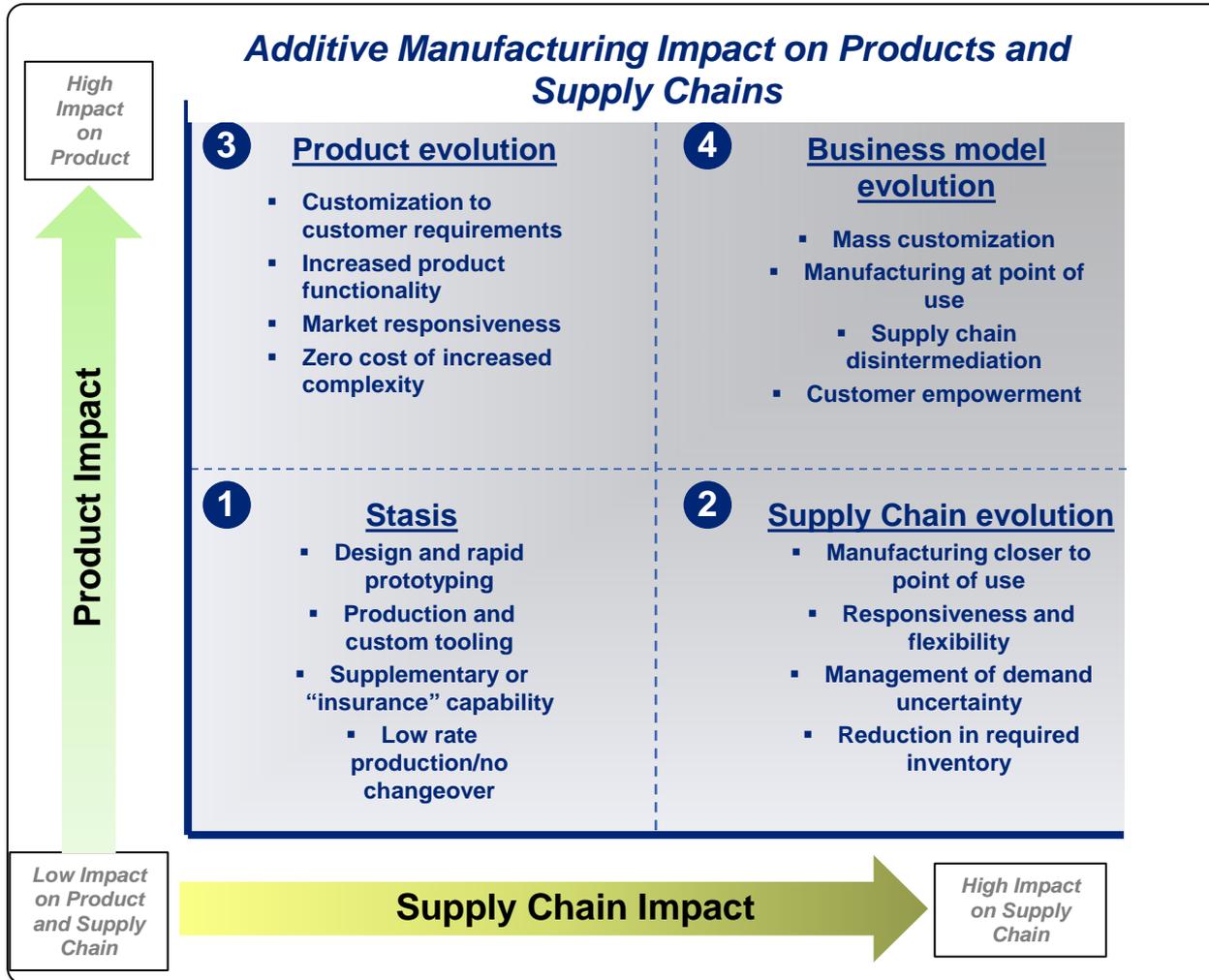
- Consumer & industrial products lead; Medical & A&D are the hot spots.
- Functional part growth rate exceeds general growth rate (19% in 2011).

Manufacturing technologies and the application spectrum



How will additive manufacturing will impact industry: Paths for performance, innovation & growth.

Our Point of View: Additive Manufacturing is an innovative technology that can significantly impact products and the ways that they are distributed



Benefits of AM Exist Across the Value Chain

Design:

- Minimal constraints
- Faster product development

Production:

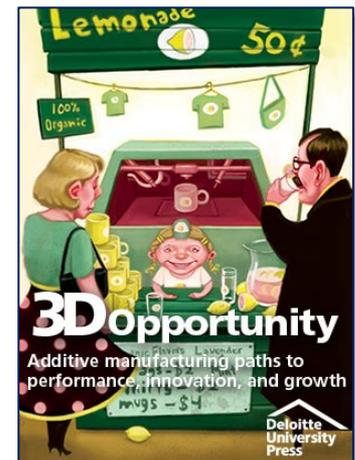
- Minimal barriers to entry
 - Minimal tooling
 - Less material waste
- Reduced manufacturing steps
 - Print on demand

Transportation & Distribution:

- Localized production

Maintenance Support:

- Store designs electronically



Some E&C specific applications of additive manufacturing

Contour crafting full-sized structures

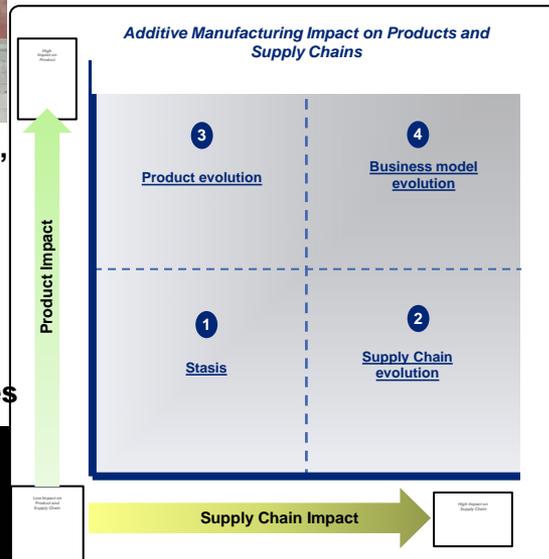


Consider: Low cost, rapid delivery, unique structural approaches. Experimenting with material compositions.

Creating form/fit/function prototypes



Consider: Visualization, communication, engagement. Reviewing various configurations of prototypes. Interior feature, fitting, and décor.



Collaborative Design/Production



Consider: Customer collaboration & experimentation. Differentiation/brand-enhancement through unique design. Tailoring to accommodate individual ergonomics.

Routine Maintenance and Support



Consider: Scan and replace low value, wear items. Reverse engineer hard to find/acquire items. Accelerate repair/replace cycle time.

Some E&C specific applications of additive manufacturing

Contour crafting full-sized structures

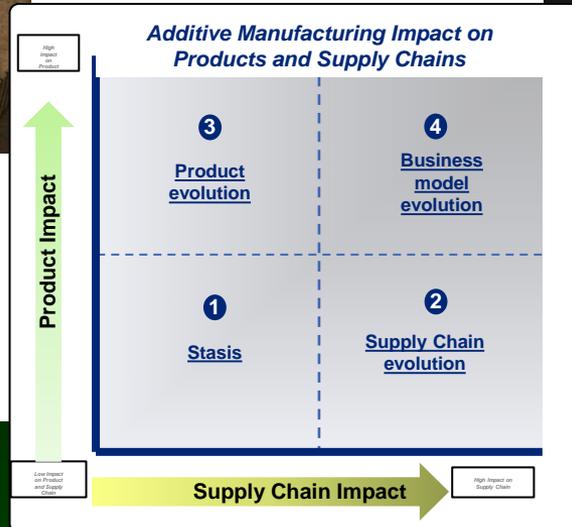


Consider: Low cost, rapid delivery, unique structural approaches, landscape and other decorative approaches.

Collaborative Design/Production



Consider: Customer collaboration & experimentation. Differentiation/brand-enhancement through unique design. Tailoring to accommodate space constraints.

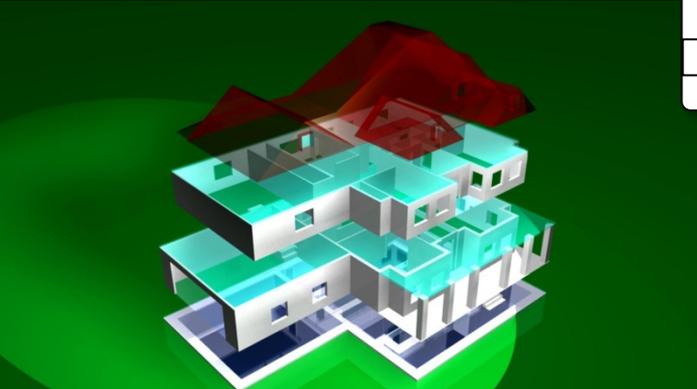


Routine Maintenance and Support



Consider: Scan and replace low value, wear items. Reverse engineer hard to find/acquire items. Accelerate repair/replace cycle time.

Creating physical 3D model of building design



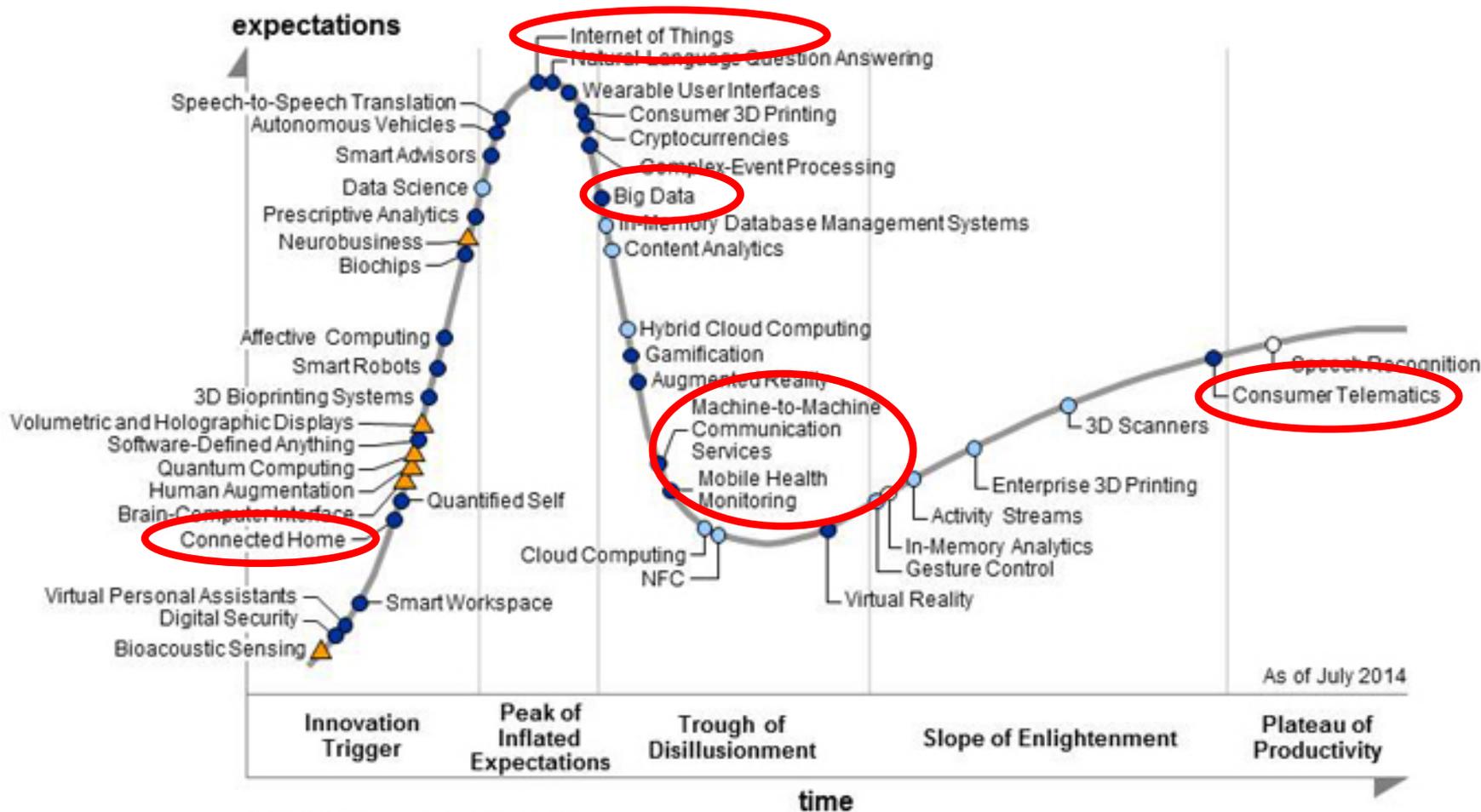
Consider: Visualization, communication, engagement. Testing orientation on plot (features, sun). Interior feature, flow & décor.



David Brown
Specialist Leader – Deloitte
Consulting

Internet of Things (IoT) is also garnering HUGE attention depending on how you look at it.

Internet of Things in the Gartner Hype Cycle ©

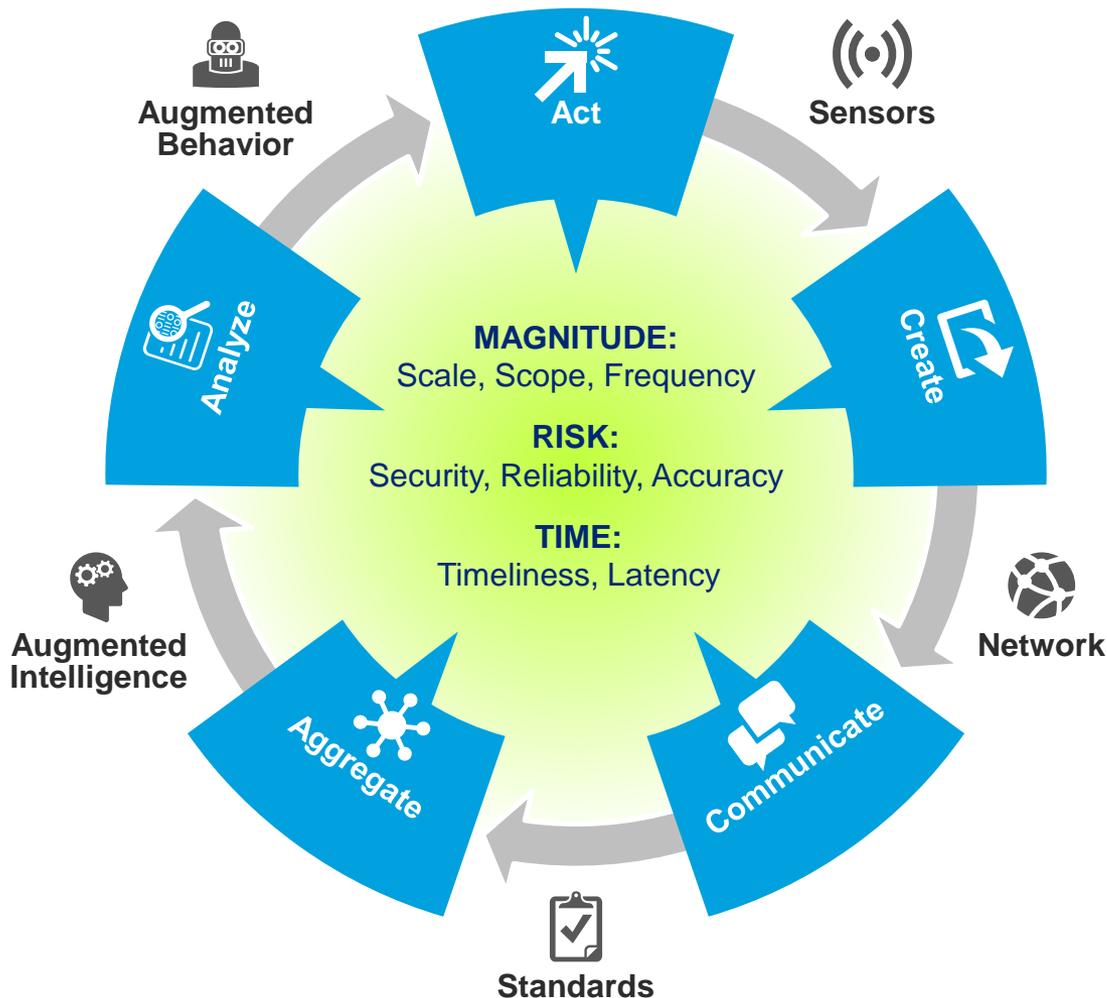


Plateau will be reached in:

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- ▲ more than 10 years
- ⊗ obsolete before plateau

IoT Analytical Framework

The Information Value Loop offers a standard analytical framework for thinking about value generation and, importantly, capture related to IoT/Industry 4.0



Stages | Technologies | Value drivers

Advances in a number of related technologies, including sensors, networks, cloud, security and machine-to-machine (M2M) management platforms, are allowing companies across industries to illuminate their dark assets.

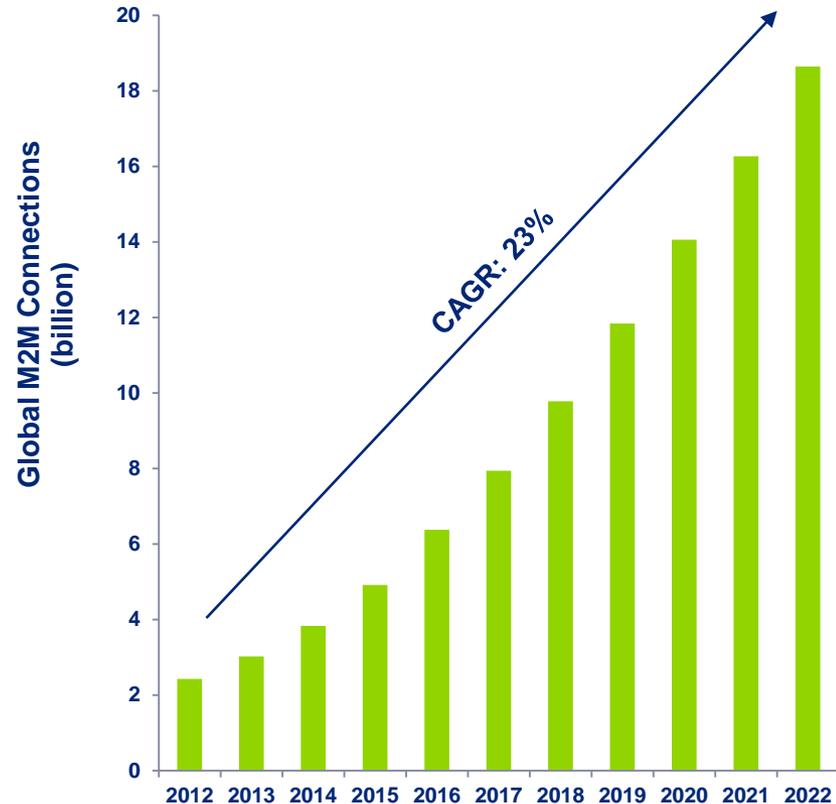
They can create, communicate, aggregate, analyze, and act on data to drive operational efficiencies or new growth models in totally new ways.

Information value is created with the magnitude and timeliness of information flows is increased, or when the risks to those flows are decreased.

The Global IoT Market is expected to reach a size of \$19 trillion by 2020

- **26 billion** embedded devices and intelligent systems by 2020
- **\$19 trillion** global economic value creation by 2020
- **\$9 trillion** in annual sales by 2020
- **4 billion** connected people
- **50 trillion** GBs of data
- **25+ million** apps
- **75%** of executives exploring/adopting IoT

Global M2M Connections 2012-2022



Six industry verticals are expected to drive the majority of this growth over the next decade

Category	M2M Applications	Examples
Consumer & Commercial Telematics 	<ul style="list-style-type: none"> Fleet management – GPS, vehicle diagnostics, fuel monitoring, driver performance Accident assistance, concierge services, navigation, remote vehicle access, infotainment 	<ul style="list-style-type: none"> OnStar Agero Hughes (Verizon) Wireless Car QNX KORE
Home Automation 	<ul style="list-style-type: none"> Security – Alarm system monitoring, video surveillance, intrusion detection Smart appliances – Energy consumption control, inter-appliance communication 	<ul style="list-style-type: none"> Control4 Schlage uBlox Alarm.com Securitas GE ADT Lok8u
Insurance 	<ul style="list-style-type: none"> Usage-based insurance (UBI) – Mileage monitoring, driver behavior diagnostics, accident data, driver feedback, environmental impact monitoring 	<ul style="list-style-type: none"> Driver Factor DriveWay Scope StateFarm Travelers Hartford Allstate

Category	M2M Applications	Examples
Health Monitoring 	<ul style="list-style-type: none"> Hospital/clinic asset management, supply chain optimization Patient location and condition tracking, medication administration EKG body sensors, diabetes monitoring 	<ul style="list-style-type: none"> J&J Siemens Medtronic CardioNet Vitality Ideal Life Reflection
Retail & Vending 	<ul style="list-style-type: none"> Retail: cashless payment, mobile point of sale, checkout line optimization, on-shelf availability, mobile customer promotions, supply chain Vending: Real time stock information, monitoring cash collection, remotely diagnose/ repair issues 	<ul style="list-style-type: none"> VeriFone Diebold Hypercom USA Tech Axeda MEI Raco Crane
Smart Grid & Utilities 	<ul style="list-style-type: none"> Smart grid networks – import/export electricity, monitor loads, control production/ infrastructure, bidirectional grid control Smart meters – measure energy consumption, adjust operations 	<ul style="list-style-type: none"> ABB GE Schneider Echelon Siemens Grid Net Itron Ecobee

Source: Forrester (2011), Deloitte analysis. Other categories not listed here include Manufacturing Automation, Education, Wholesale Trade and Government

A number of market forces are driving this rapid growth in IoT adoption, both in terms of demand as well as supply

Today and going forward, businesses must increasingly...

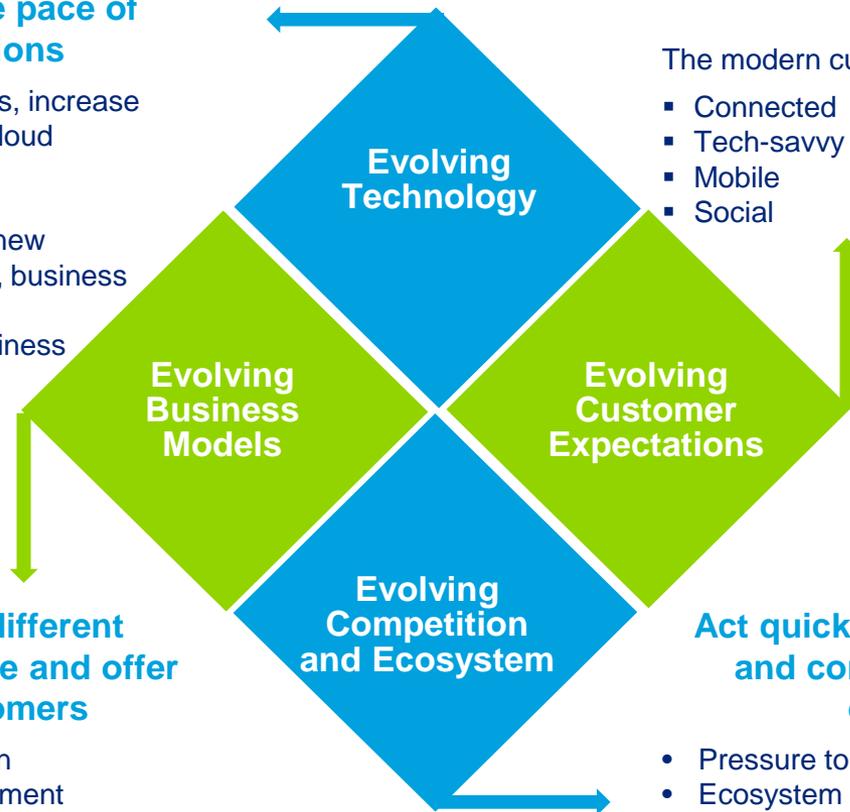
Accelerate product development to stay current given the pace of technology innovations

- Decrease in technology costs, increase in big data capabilities and cloud computing enabling IoT implementations
- Tech innovations spawning new features, services, platforms, business models
- Increasing complexity in business operations and systems
- Technology innovation as a differentiator

Cater to an increasingly sophisticated set of customer needs

The modern customer is more:

- Connected
- Tech-savvy
- Mobile
- Social



Look for new and different approaches to package and offer services to customers

- Mechanisms for monetization
- Customer 'lifecycle' management
- Models of product/asset ownership

Act quickly to keep up with competition and contend with rapidly changing ecosystem dynamics

- Pressure to innovate
- Ecosystem movements (new players, acquisitions) mean that competition is coming from new quarters
- Increasing trend of partnerships to improve product offering and time-to-market

Technology innovation is spawning new features, services, platforms and business models

There are 5 key areas where technology innovation is taking place, that are together causing the Internet of Things market to take off

Smart Devices



- Examples: Smart home devices, wearable tech
- Devices are becoming miniaturized and more affordable
- The trend is away from “all-in-one” devices to those that meet specific needs
- The focus is now on more ‘personal’ applications

Mobility



- More devices are enabled with both portability and connectivity
- The mobile device is finding application as the controller of other devices
- With ‘Bring-Your-Own-Device’ (BYOD) trends, the focus is on device management to app management

Cloud Computing



- Over 50% of IT spending over next 2 years is on cloud
- Cloud is being used to help drive business agility and speed to market
- Cloud provides a common innovation platform for Mobile, Social and Big Data
- Cloud enables the analysis/dissemination of data for IoT

Analytics



- Data visualization and dashboards is making analytics more accessible and driving adoption
- Data from smart devices is now being collected and monetized
- Predictive analytics is helping businesses be more proactive in driving decision-making

Data Security



- Significant requirements given the number and types of devices, companies
- Dramatic increase in investment given increased regulation and focus on privacy and controls
- Security-as-a-Service is driven by more users accessing cloud services from mobile
- Hybrid cloud model helps meet more stringent SLAs

Technology Solutions Influencing IoT: Analytics

What are the Trends

- Equipment telematics
- Use of Tablets in the field
- “Yard Club” Caterpillar connects contractors to idle equipment

Capabilities to Look For

- Statistical modeling
- Handle huge amounts of data
- Leverage information around cost codes and change orders
- Automate hours and location tracking
- Predictive Analytics

What Defines Success?

- Ability to overcome “insufficient detail”
- From Reactive to Predictive maintenance
- Capture data to reduce breakdowns
- Getting away from MS Excel

Shortlist for E&C

- Acumen 360
- Primavera Risk Analysis
- Vico Software
- Zonar
- Uptake (Caterpillar Inc.)

Technology Solutions Influencing IoT: Social and Cloud

What are the Trends

- Collaborative software
- Cloud vs. in house
- 3D printing

Capabilities to Look For

- Simply and effective
- Facebook like interaction

What Defines Success?

- Cross functional collaboration
- Real time access to everything

Shortlist for E&C

- Oracle Cloud PPM
- Microsoft Sharepoint

Technology Solutions Influencing IoT: Wearables, UAVs & Augmented Reality (AR)

What are the Trends

- Proliferation of niche players
- Locked box charging stations
- FAA shows favorable rules for commercial use of UAVs
- Kick the tires on new technologies, have some fun

Capabilities to Look For

- Industry standards
- Ability to support BYOD
- Privacy

What Defines Success?

- Wearables bridge to AR and IoT
- Develop internal best practices
- Better safety records
- Adequate insurance for UAV
- Adopt to gain competitive advantage

Shortlist for E&C

- Autodesk
- BIM 360
- Inglobal Technologies
- Google SketchUp

How the Internet of Things is impacting business in the Construction & Engineering industry

The Internet of Things is transforming the construction industry. IOT is a force multiplier, allowing the opportunity to integrate disparate but related functions in a way that creates additional value-added services

- Equipment monitoring and repair
- Better control of costly, high-value assets
- Tagging and tracking
- Equipment inspection
- Inventory management and ordering
- More control over resources
- Energy conservation
- Electronic time logging
- Safety
- Wearables

- Forrester: **53%** of information workers use **3 or more devices** for work
- IDC: **328,000 smartphones** will be **on the job by 2017**

The Internet of Things increases the complexity of the environment and requires unprecedented coordination, collaboration and connectivity to be successful. Devices must work together and be integrated – they must communicate and interact seamlessly with other systems and devices connect to the network – from point solutions to comprehensive platforms

Hardhat of the Future?



Manufactured by DAQRI (hardware.daqri.com/smarthelmet), the hardhat uses google-glass-like technology, features 360 degrees of camera vision and works effectively in low light. It allows users to share the data with others in real time, supports HD video recording, photography, 3D mapping and alphanumeric capture, allowing the Smart Helmet to read and understand signage and instrument data. It uses its own software IntelliTrack to work with the device, allowing for full 4D capability.

Unmanned Ariel Vehicles (aka, UAVs or Drones)

UAVs can provide an unparalleled way of recording onsite activity and progress quickly and reliably. They can improve jobsite communication and be used in hazardous and hard-to-reach environments to reduce human risk and lower cost.



Some potential jobs for UAVs

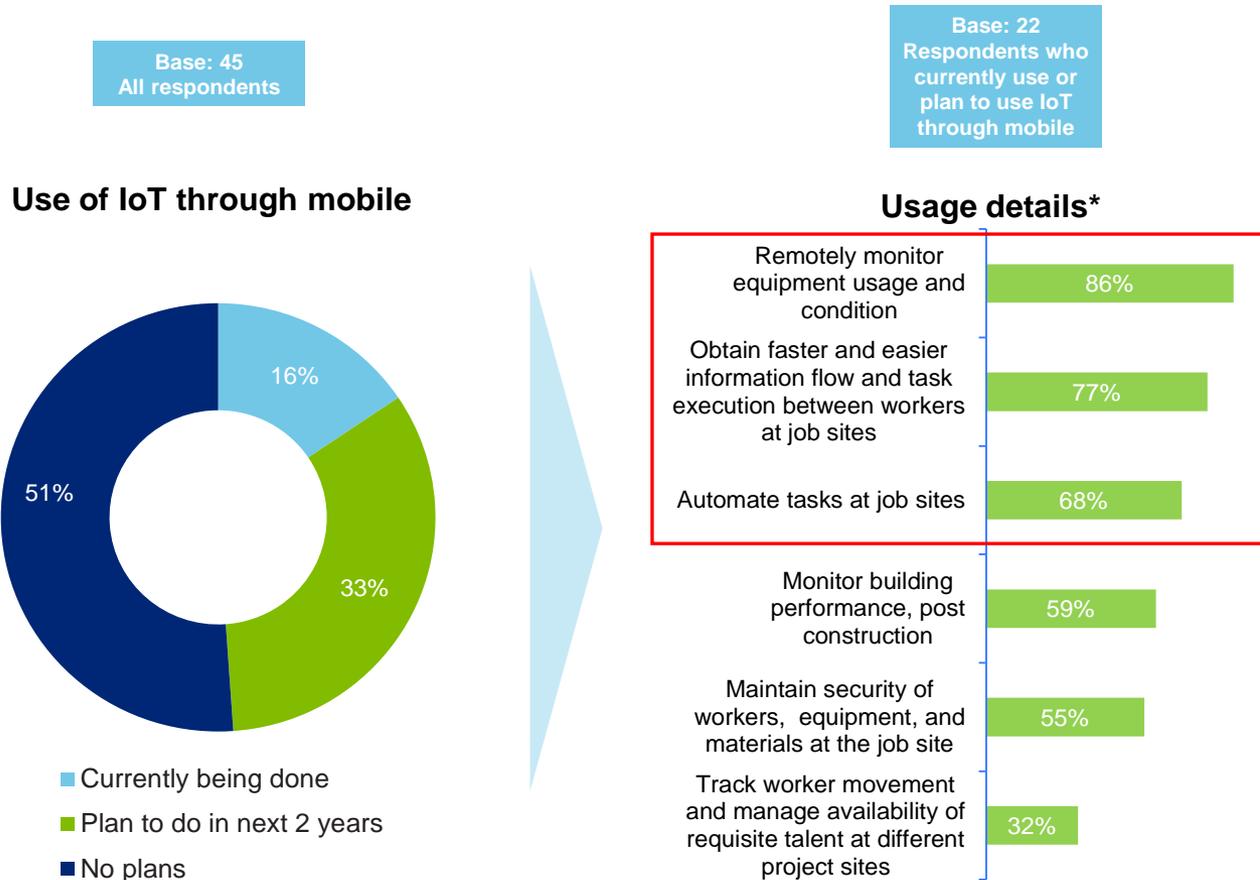
- Area or asset inspection (buildings, bridges)
- Surveying
- Monitoring safety at remote job sites
- Presales/marketing of potential jobs
- Observing progress on current jobs
- In combination with other IOT devices (e.g., augmented reality) to provide seamless presentation of information

Factors that are influencing the use of drones include:

- Limitations on commercial use of drones by governmental agencies (e.g., FAA)
- Technology maturation
- Industry adoption of new technology

Internet of Things (IoT) through Mobility

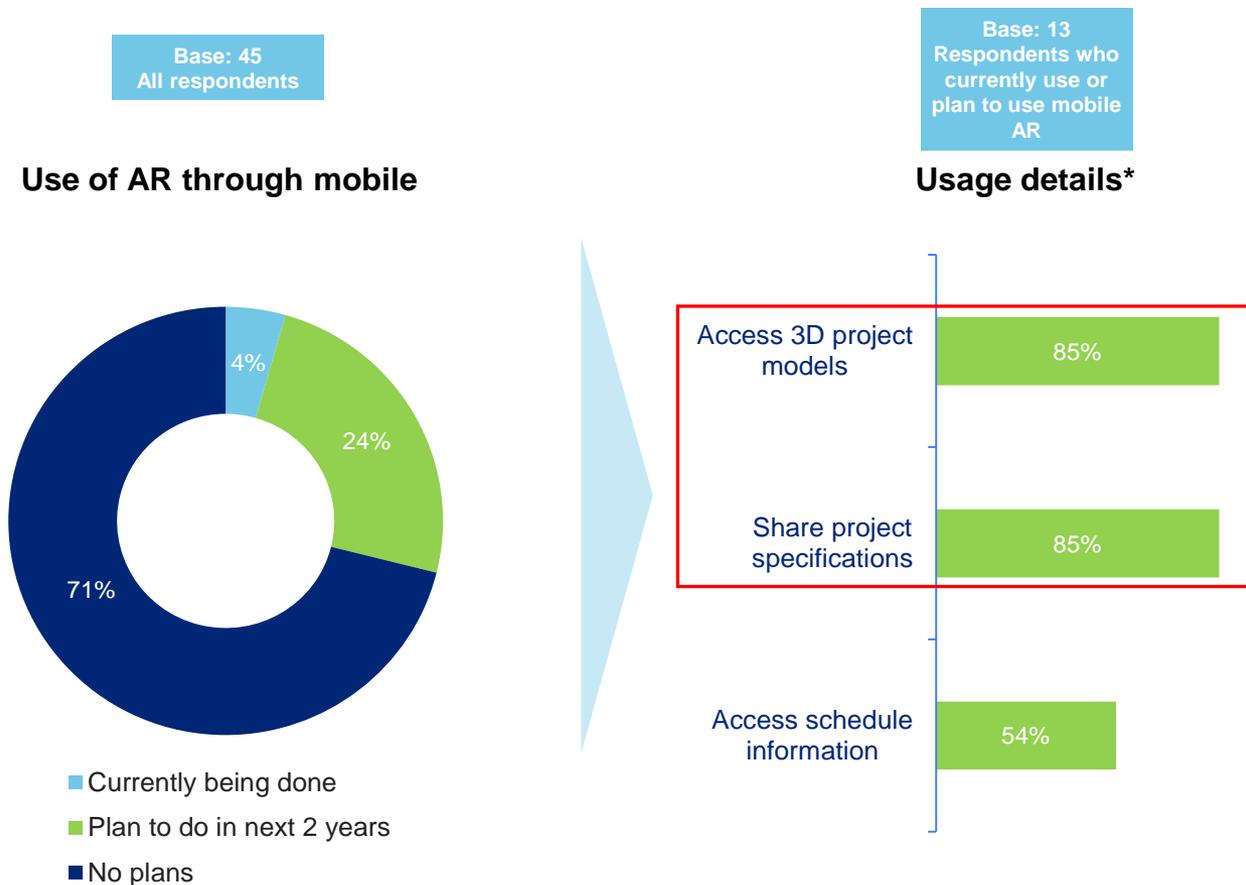
49 percent respondents currently use or plan to use IoT through mobile, primarily to remotely monitor equipment, drive efficiency in information flow, and automate tasks at job sites



*The chart highlights the respondents that rated usage for various tasks as 'likely' or 'very likely'

Augmented Reality (AR) through Mobility

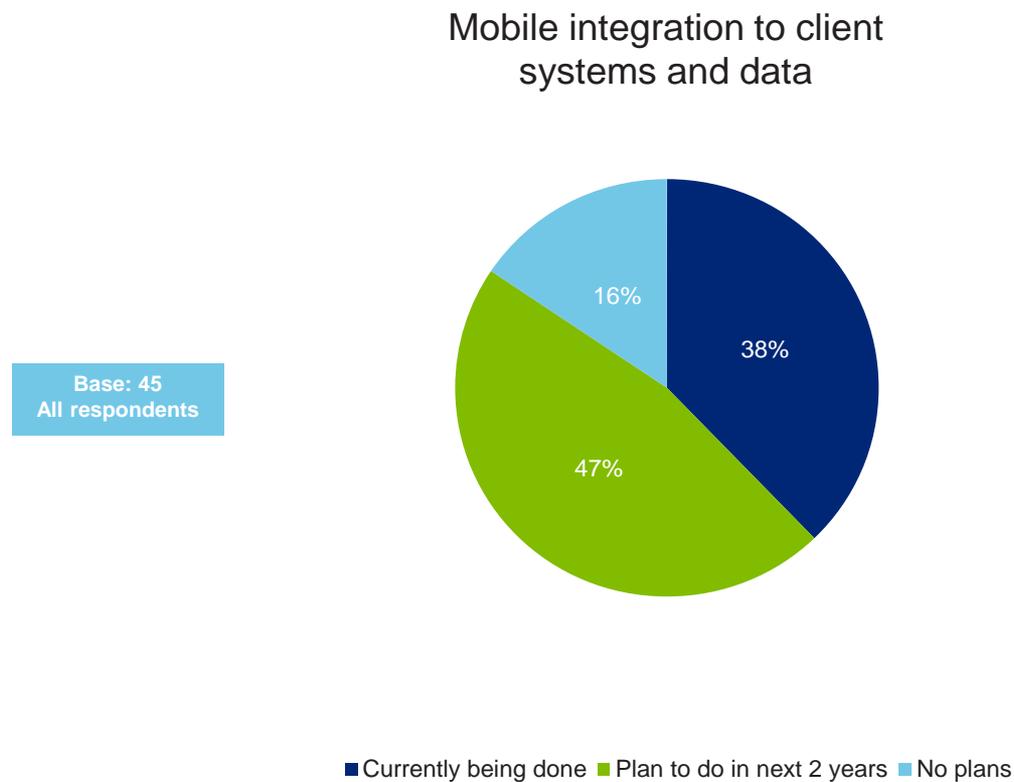
Despite low adoption (4 percent), use of augmented reality (AR) through mobile will increase in the next two years (24 percent). Respondents use or are likely/very likely to use AR through mobile mainly to access 3D models and share project specifications



*The chart highlights the respondents that rated usage for various tasks as 'likely' or 'very likely'

Client System Integration through Mobility

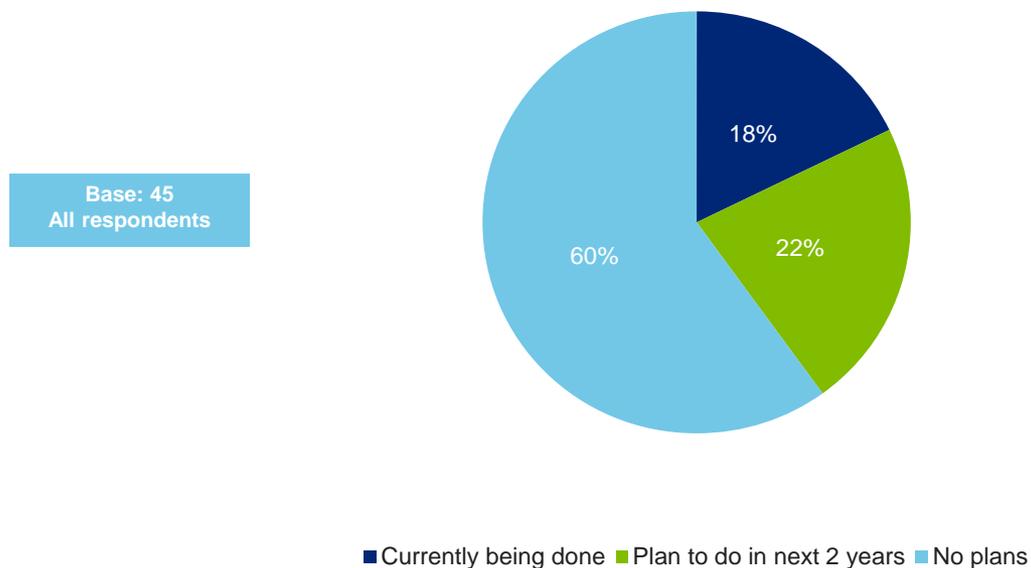
85 percent companies currently have or plan to have mobile integration with client systems and data in the next two years



Social Interaction on Projects through Mobility

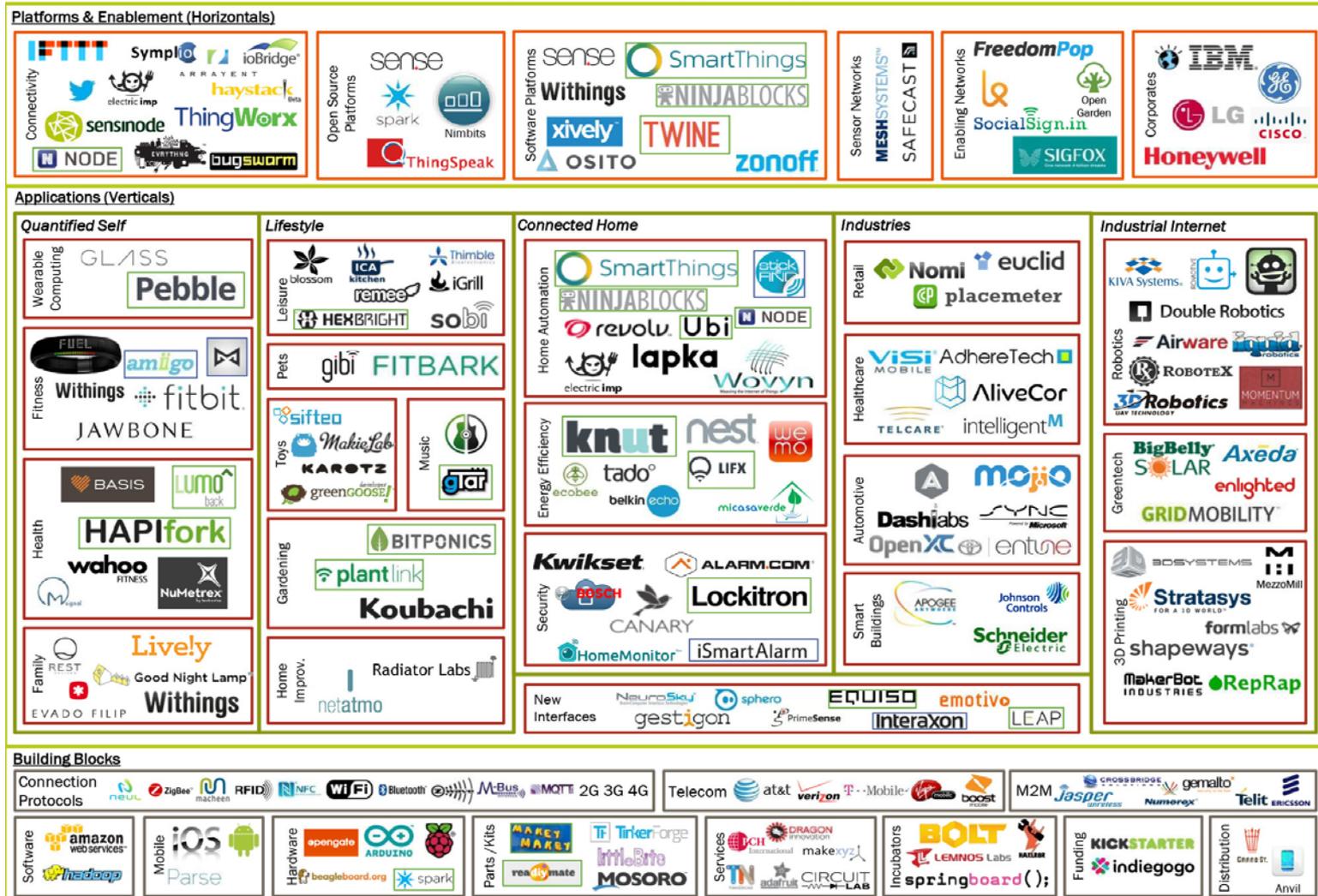
40 percent companies use or plan to use mobile for social interaction on projects within the next two years

Social interaction on joint ventures through mobile



The current IoT landscape is one that is highly fragmented particularly in terms of capabilities and vertical solutions

INTERNET OF THINGS LANDSCAPE



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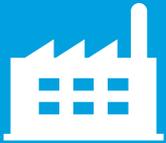
Speed of adoption of IoT technologies and solutions will depend on executives finding ways to monetize on the investments

Economic Value Framework



Focus on Financial Metrics

- Increase in revenues
- Decrease in cost/expenses
- Reduction and improvement in asset utilization



Focus on Operating Metrics

- Improvements in:
 - Facilities/asset lifecycle
 - Product lifecycle
 - Customer lifecycle



Transition from “Transaction” to “Relationship”

- Holistic approach to past and future transactions with an entity with focus on the relationship

As a firm, Deloitte is investing in broad perspectives that inform the discussion

Internet of Things

[www.dupress.com/
internet-of-things](http://www.dupress.com/internet-of-things)

Digital Manufacturing

[www.dupress.com/
3d-opportunity](http://www.dupress.com/3d-opportunity)

Analytics

[www.dupress.com/topics/
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