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The Digital Revolution in Construction

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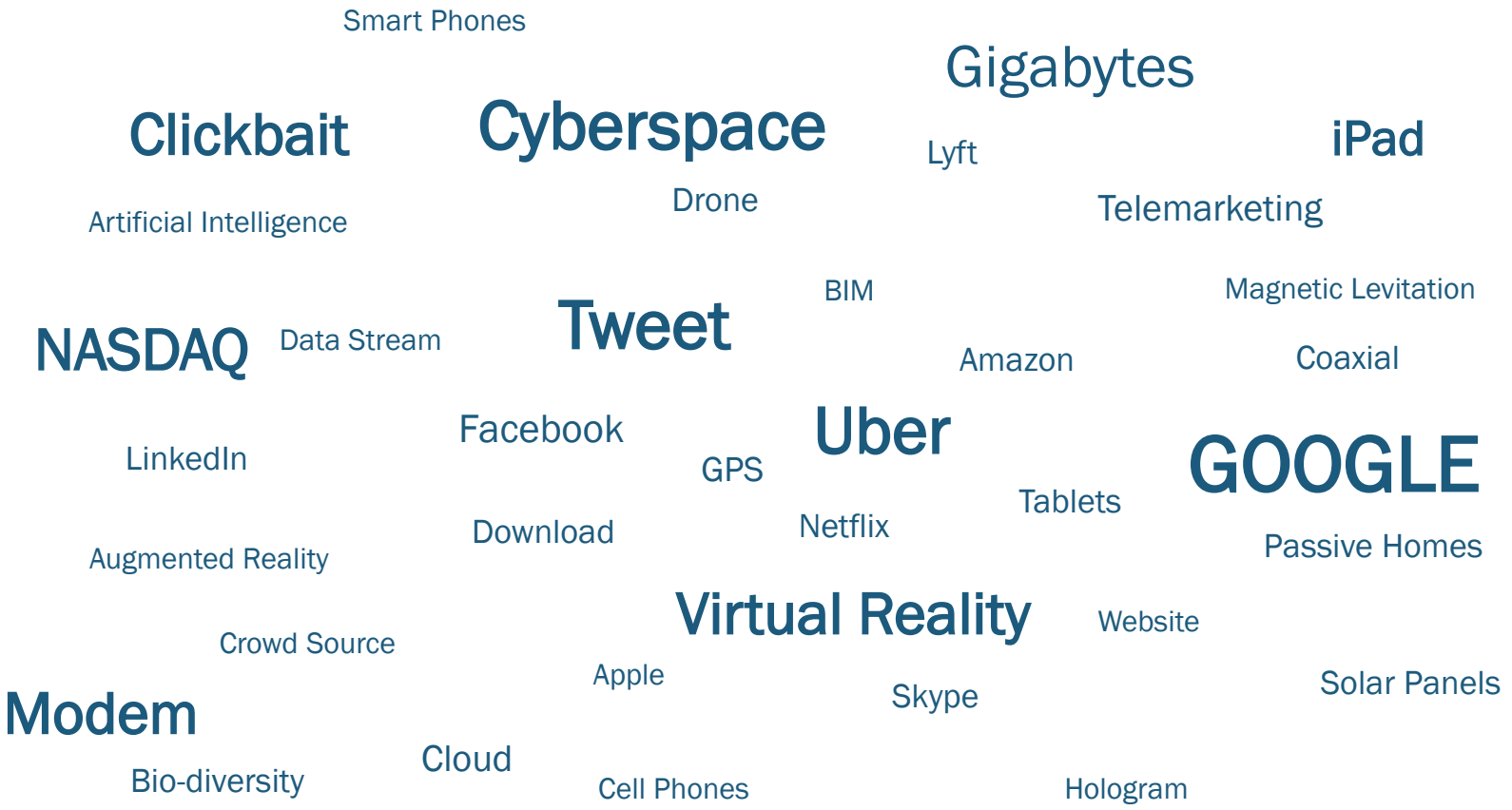


Words or terms that weren't around, or had quite different meanings, when I was a lad ...

Latest buzzwords carrying the most heft in construction:

- Drones;
- Robotics;
- Autonomous vehicles;
- 3-D scanners;
- 3-D printers;
- Wearable devices;
- Virtual reality (VR) & augmented reality (AR);
- 360-degree photos/videos;
- Advanced materials;
- Pre-fabrication/modularization;
- Internet of things;
- Energy storage;
- ‘Big data’ and the ‘cloud’;

Key metrics of success:

- Profit margin;
- Sales volume;
- Client retention;
- Top notch and loyal employees;
- Gaining a step up on the competition.

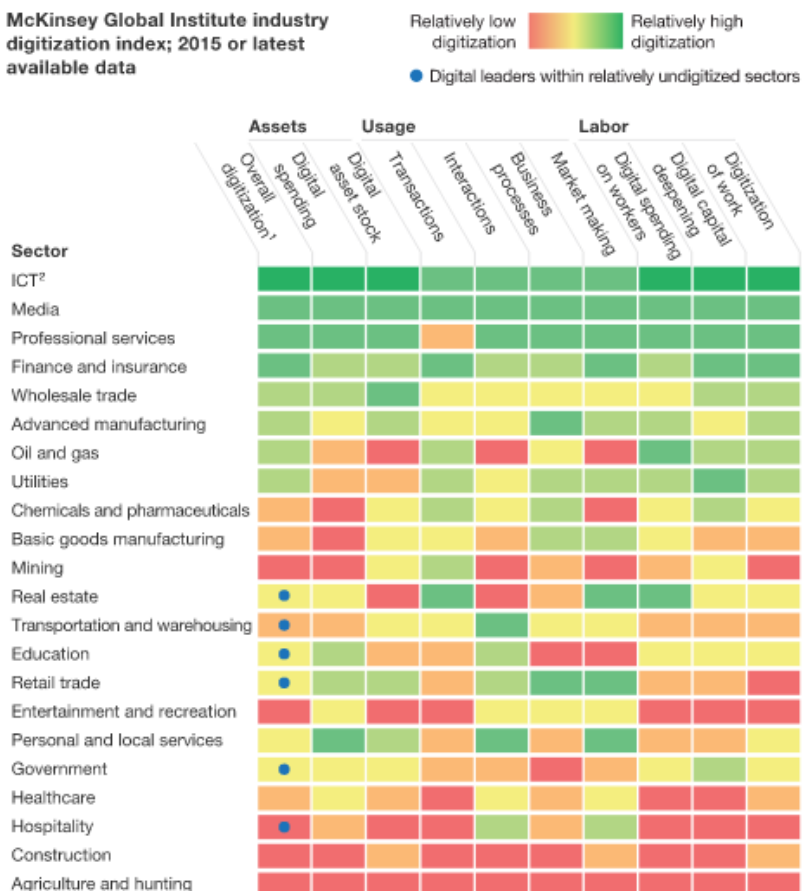
Personal Products	Personal Practices
Business Products	Business Practices

But steering the best path requires constant re-calibration to benefit from technological advances …

Something to think about…

The adoption of high-tech in construction will receive a big boost from the millennial generation moving into management.

The construction industry is among the least digitized.



Source: McKinsey & Company; *Imagining construction's digital future*, 2016

Construction is among least digitized

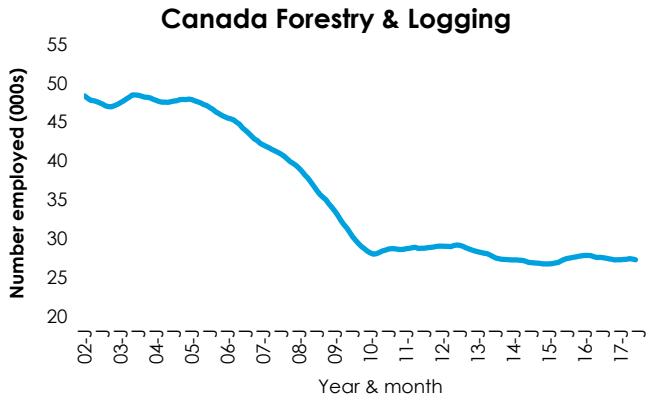
Construction is notoriously risk averse.

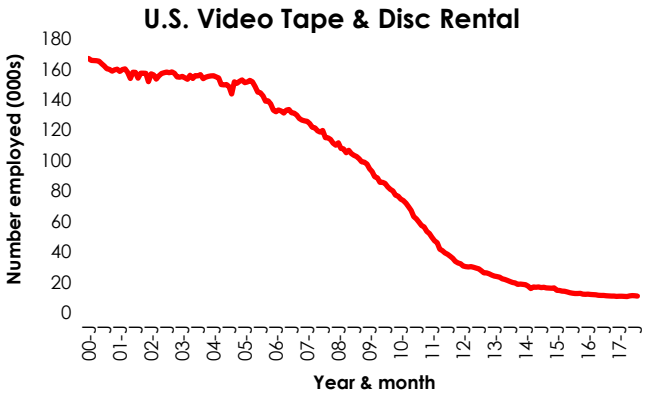
Quick Primer on Digital Disruption from Other Industries

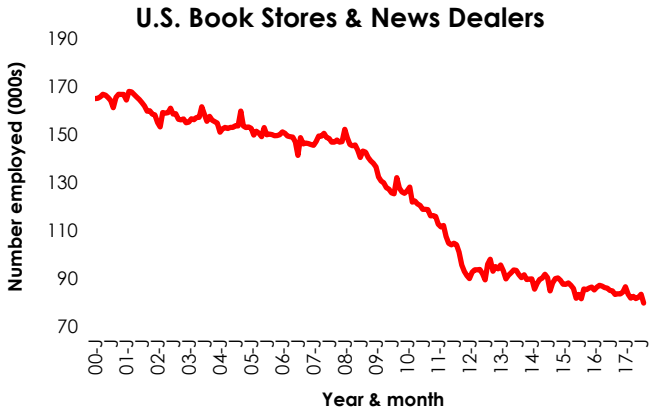
- Digital disruption refers to change that occurs when new digital technologies and business models affect value proposition of existing goods and services
- Disruption can be major (e.g. changing your entire business model) or minor (e.g. using online techniques to shorten the sales cycle)
- You either disrupt yourself or your competitors will do so

"Digital Disruption And Disintermediation – Key Drivers For B2B Companies." Christopher Ryan. **Business 2 Community**. August 9, 2015. http://bit.ly/2pfwDhy

Where Tech Change has Caused Job Losses

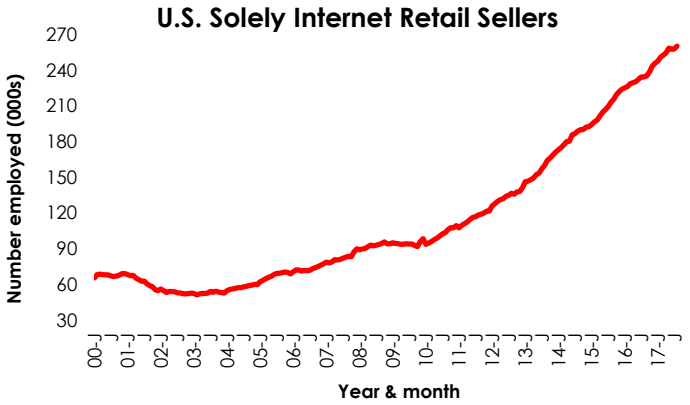


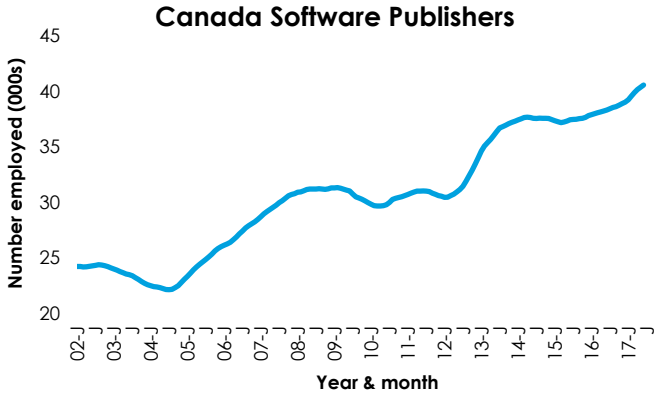


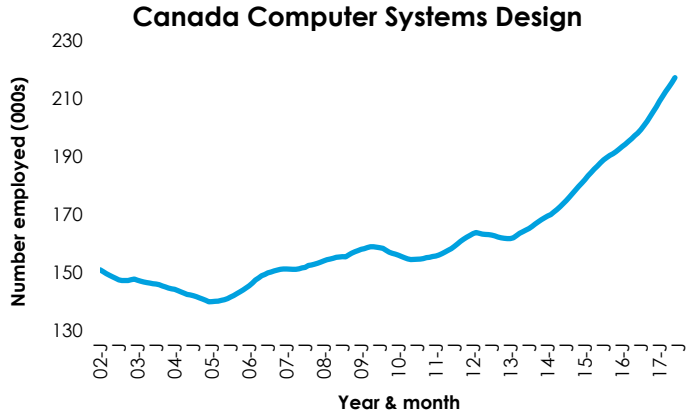


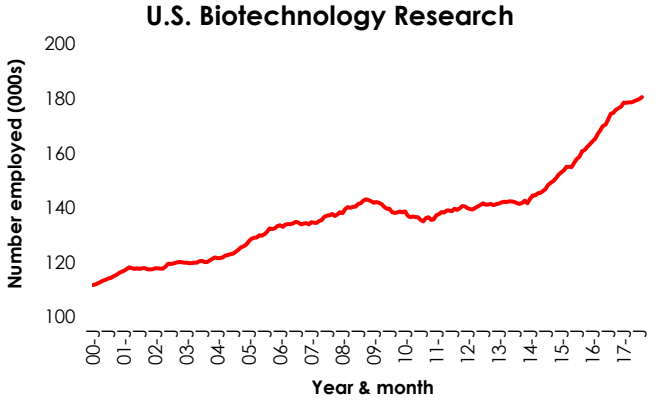
Data sources: Statistics Canada & Bureau of Labor Statistics (BLS).

Where Tech Change has Caused Job Gains









Data sources: Statistics Canada & Bureau of Labor Statistics (BLS).

Individual use of technology:

How to use a smartphone?

E-mail
Text message
Visit websites
Use apps
Watch videos
Visit social media sites

How to use the Internet?

Research brands and models
Research specs
Read reviews of models
Find a dealer
Read reviews on forums
Find a lender

Changes:
Personal Practices …

- A convergence of the ‘personal-you’, the ‘public-you and the ‘business-you’; they are separate and yet they converge;
- Your ‘social media platform’ can lead to job happiness;
- Everybody needs a ‘platform’ … Donald Trump has a platform … It helped him become President;
- Internet connects everybody around the world (at least as long as there is ‘net neutrality’);
- A key positive by-product has been transparency; has also helped promote compliance courses (re. ethics);
- How important is social media? … There are companies with their own video studios in their corporate offices.

Changes:
Business Products …

- Drones, robots and autonomous vehicles
- 3-D scanners (no longer limits to design-feature flourishes, plus significant reductions in material waste);
- 3-D additive printers (large machines can now ‘print’ houses);
- Specially-cured concrete (e.g., for ultra-tall skyscrapers);
- Microbes added to concrete (for self-healing);
- Extending the height limits of ‘tall timber’ buildings;
- Clear-to-opaque windows (at touch of a button or voice command);

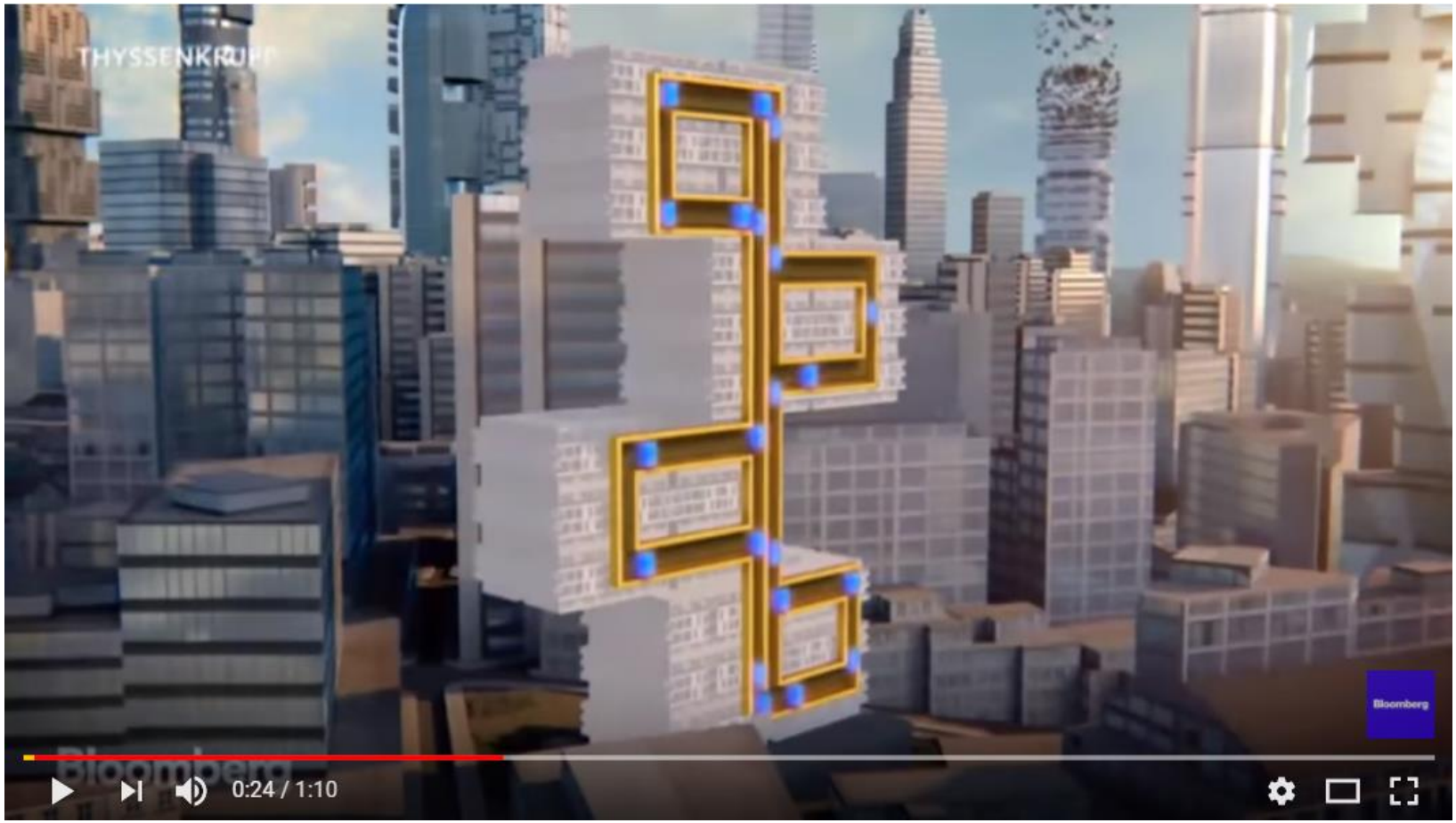
Changes:
Business Products Cont'd ...

One of the most promising uses of VR consoles is in hospitals to help patients with boredom and to provide a distraction from pain.

- Wearable devices (to monitor fatigue or stress of workers);
- Virtual reality (VR) and augmented reality (AR) devices (for design-feature problem solving);
- Super fast roller bay doors (for security and to reduce energy loss);
- 360-degree photo/video equipment (for security and to help property managers promote sales);
- Super fast elevators;
- Magnetic levitation (maglev) ropeless elevators (sideways as well as vertical; someday perhaps diagonal as well);

There will be no height restrictions for maglev elevators.

Multi – The First Preview of the ThyssenKrupp Magnetic Elevator



https://www.youtube.com/watch?v=Peyq0Zp-HbI&t=11s

With today's emphasis on reducing GHG emissions and saving energy, HVAC firms have been in the forefront of high-tech product introductions:

- Closed-loop systems to capture, purify and re-cycle/re-purpose rainwater and greywater;
- Cleaner-burning furnaces and alternative (e.g., tankless) water heating systems;
- Air venting, blowing and filtration systems that greatly reduce the discrepancy between being outdoors versus indoors (i.e., in aid of a healthier work environment).

Changes:

Business Practices ...

Surveying and locating projects

- Geological surprises can be a huge source of project delays, cost overruns and post-construction litigation/lawsuits;
- Light-detection-and-ranging (lidar) systems are the next-stage evolution in surveying;
- Lidar, used together with ground-penetrating radar & magnetometers, can generate above- and below-ground 3-D images of project sites;
- Especially important with respect to high density and/or environmentally sensitive and/or historically significant locations;
- 58-storey Millennium Tower in San Francisco (opened 2008) is the ‘poster boy’ for what can go wrong.

Pre-fabrication and modular:

- Modular construction – all the bathrooms in Toronto's Humber Valley Hospital were first built off-site in what was essentially a manufacturing facility;
- Modular as an answer to labour shortages;
- Modular/manufacturing plants as a means to attract more female workers;
- Ultra-large module structures in the energy field are often imported from Asia – due to what is said to be a domestic expertise gap.

30-Story Building Built in 15 Days

https://www.youtube.com/watch?v=rwvmru5JmXk&t=10s

Some of the features claimed:

- Unique diagonal steel bracing;
- 5 times more earthquake resistant than conventional buildings;
- 5 time more energy efficient
- 15 cm glass curtain wall insulation;
- External solar shading;
- 3-stage air filtration;
- Indoor air is 20 times cleaner than outdoor air;
- Air quality monitoring in every room.

Drones and Advanced Robotics:

- Construction sector ranks low in productivity advances;
- 'Momentum Machines' in California is a company making robots that can flip burgers;
- Drones and other unmanned aerial vehicles (UAVs) present opportunities in land surveying; construction site security; equipment deployment; and environmental damage assessment (i.e., their planned usage will become essential for oil and gas pipeline approvals; will be viewed as part of the 'social contract').

High-tech is now going hand-in-hand with 'GREEN' building.

Masonry Construction Robot on the Job

https://www.youtube.com/watch?v=fpD5H1EH0go&t=1s

The Internet of things (IoT) refers to:

- Embedding miniature computers and sensors in appliances, entertainment devices, machinery and equipment.
- Connecting those ‘things’ to the Internet wirelessly;
- Gathering and processing data from the connections;
- Taking action and making decisions to better manage and synchronize the connected objects to improve efficiency, accelerate innovation and cut costs.

Drive cost savings/efficiencies

4 ways to save with IoT

- Reduce equipment loss;
- Lower fuel consumption;
- Extend asset life;
- Optimize fleet size.

"Using The Internet Of Things To Drive Cost Savings In Construction." **BSM Technologies**. Accessed online April 25, 2017. http://bit.ly/2qcNPkK

Power and fuel savings

- Using IoT, construction sites can send back information on the amount of electrical power in use;
- After-hours lighting can be adjusted for energy-savings;
- Machines can forward data on idling times;
- On and off periods can be altered to save fuel.

"How "The Internet of Things" is Affecting the Construction Industry." Rachel Burger. **The Balance**. October 7, 2016. http://bit.ly/2pZ8ABt

Changes (High-tech & otherwise) that promote power and fuel savings:

- Heat recovery units;
- Fuller and better adoption of insulation;
- Improved sealing between work and/or housing modules;
- Automatic door closers;
- Motion or presence detectors;
- Water-saving taps;
- Switching to energy-saving light sources – e.g., compact fluorescents, light emitting diodes (LED), halogen.

Remote operation

- Ever-improving GPS technology allows growing numbers of operators to control their machines from outside the cab;
- Development of wireless safe remote controllers with look and feel of Xbox and PlayStation accessories is accelerating;
- Operators can control construction machines with gamepad-like controllers and view their work from widescreen displays miles away;
- Opens up the world of equipment operations to a younger generation that is familiar with and enjoys using gaming consoles;
- Allows equipment operation in areas that might be hazardous to humans (e.g. pollution, contamination).

"Xbox-like remote control could make operating construction equipment as easy as playing video games." Wayne Grayson. **Equipment World**. June 5, 2014. http://bit.ly/2pZafXq

Supply replenishment

- Using RFID (radio frequency identification) tags which use electromagnetic fields to automatically identify and track objects, units of supply can be automatically counted and continuously monitored;
- When the count drops below a given level, the system can trigger a request from a central system to order more;
- When stocks run low, supplies are automatically ordered and delivered to the job site;
- Costs are also contained because the construction company does not need to bring in significantly more supplies than it is likely to use at any one time;
- Just-in-time provision becomes possible automatically.

IoT will take just-in-time inventory management to the next level …

www.cribmaster.com

"How "The Internet of Things" is Affecting the Construction Industry." Rachel Burger. **The Balance**. October 7, 2016. http://bit.ly/2pZ8ABt

Equipment servicing and repair

- Using telematics data, condition monitoring is proactive process of evaluating equipment health;
- Goal is to provide recommendations for maintenance, repair and component replacement that will lower owning and operating costs and improve availability;
- Sensors in machines allow transmission of information about their status and any need for service or repairs;
- Fixing machines before they break makes more sense than waiting for failure, which by Murphy's Law is all too likely to happen just at the wrong time.

IoT will take traditional preventative maintenance to the next level …

"How "The Internet of Things" is Affecting the Construction Industry." Rachel Burger. **The Balance**. October 7, 2016. http://bit.ly/2pZ8ABt

Usage of 'Big Data' in design-build-operate lifecycles:

- 'Big data' from weather and traffic, plus community and business activity can be used to determine optimal scheduling of construction work;
- Sensor input from machines on site can show active and idle times to help with buying versus leasing decisions; and with determining how to use fuel best to lower costs and reduce carbon footprint;
- Sensors built into buildings, bridges and many other types of construction can help with monitoring many key performance metrics;
- Traffic stress information can help with future planning; anxiety over bridge safety can be eased or exacerbated with 'big data' on 'flexing'.

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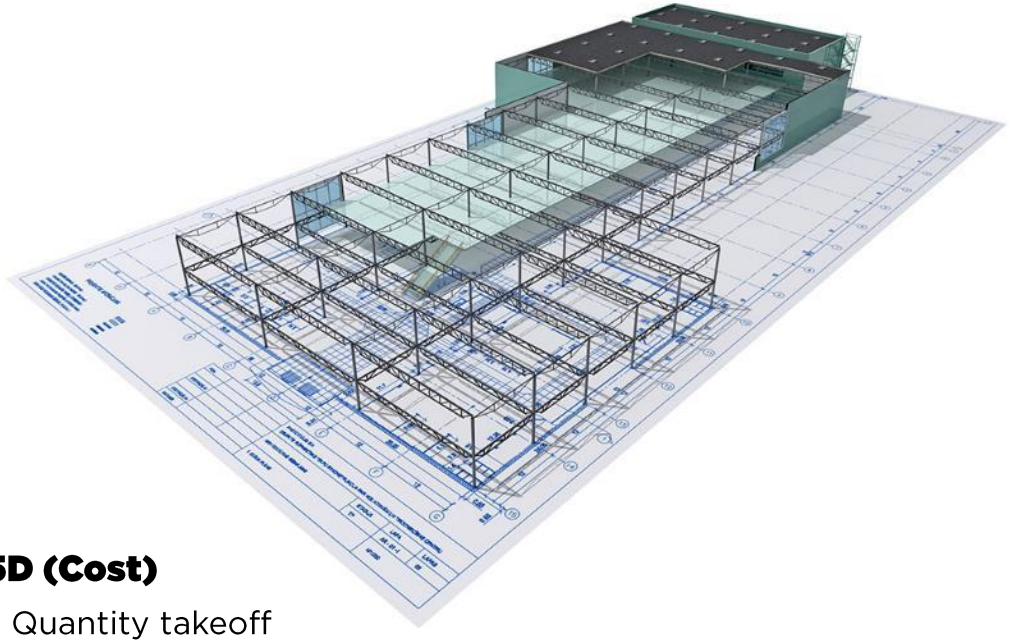
Closer Look at BIM



3D (Shape)

- Renderings
- Walkthroughs
- Clash detection
- Design
- Assemblies
- Specifications
- Sustainability studies

4D (Time)

- Virtual construction
- Scheduling
- Project phasing
- Equipment deliveries
- Visual validation
- Pre-fabrication
- Life-cycle simulation

5D (Cost)

- Quantity takeoff
- Detailed bill of quantities
- Fees comparison
- Trade selection
- Logistics
- Comparative cost studies
- Life-cycle cost

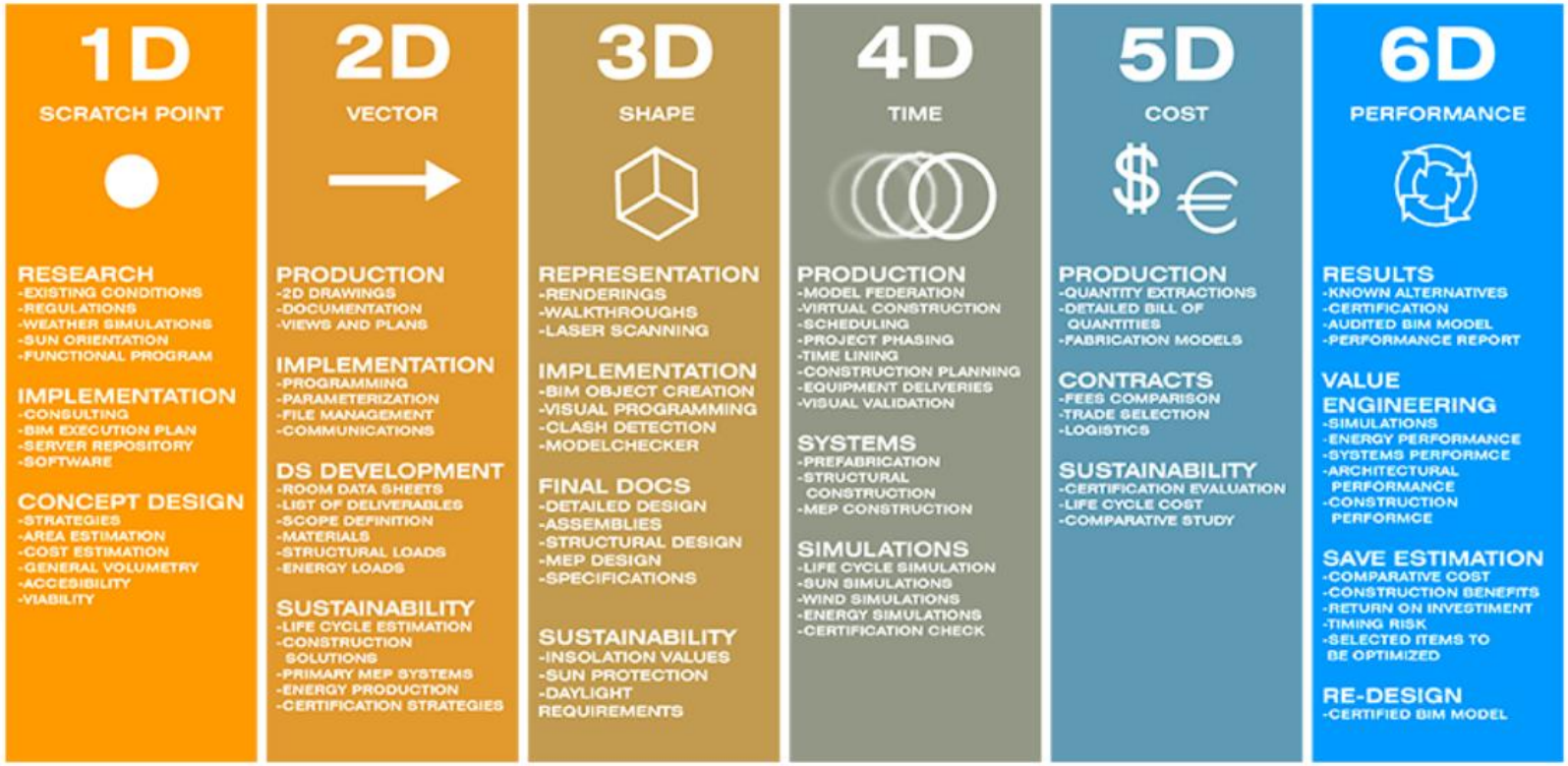
Transitioning from traditional CAD to BIM (1D to 6D):

– 3D BIM features ‘spatial construction modeling’;
– 4D BIM adds project scheduling information;
– 5D BIM adds project cost-estimating information;

- Meaningful collaboration between architects, engineers and quantity surveyors;
- By involving the estimator community earlier, clears the way for valuable advice on costs and takeoff quantities;
- Any change in the design is reflected immediately in the schedule and budget.

– 6D BIM will focus on performance.

BIM6D



Source://bim6d.es/en/scope/

High-tech Aids to Security on Job Sites:

- Drones for surveillance;
- Facial recognition locking systems;
- Mobile phone access codes;
- Super fast doors;
- 360-degree photos & videos.

High-tech has also been important in the evolution of project delivery systems …

The journey along the evolutionary road has encompassed:

- Traditional tri-partite construction (i.e., owner, architect and contractor);
- Fast-tracking;
- Design-build;
- Integrated project delivery (IPD);
- 'Lean' project delivery.

And let's not forget the new forms of payment that are being introduced: PayPal; Apple Pay; Bitcoins; Cyber-currencies.

But what is often overlooked is ...

A Host of Economic Issues ...

A ‘hot top’ issue ripped from the headlines:

The possibility that construction management firm Aecon will soon acquire Chinese ownership:

- Should come as no surprise;
- Potential corporate culture clash;
- Deeply embedded state ownership;
- Huge opportunities from ‘One Road One Belt’ initiative;
  a) China’s plan to reshape global trade;
  b) A Silk Road for the 21st century.

Adopt measures to keep out foreign competition and foreign know-how?

If there are legitimate ‘dumping’ concerns, then the answer is yes.

Otherwise … There are 2 major problems with protectionism:

(1) Inefficiencies accumulate;

(2) Retaliation escalates.

Owners Contemplating Investments Are Weighing New Square Footage vs Internet and Other High-tech Trends

	VERSUS	
The old standby issue: Bricks & mortar retail	⟷	Online shopping (videos, music, books, travel agencies)
But many more examples now: Single-family residential (high square footage per unit)	⟷	Multi-family residential (low square footage per unit)
Street-corner banking branches	⟷	Transactions over the Internet (PayPal; etc.)
Brokerage houses	⟷	E-trading
Office space	⟷	Working from home / 'hoteling' or sharing of space
Hotels/motels	⟷	The 'sharing economy' (e.g., Airbnb)
University & college campuses	⟷	Proliferation & convenience of lower-cost online courses
Medical office buildings	⟷	Health care Google searches / digital transfer of records
Pulp and paper mills / post offices	⟷	E-mails and instant messaging / comments on Facebook
Prisons	⟷	Ankle bracelets
Cinemas	⟷	Netflix / iTunes store
Concert halls	⟷	Virtual reality
TV stations	⟷	Facebook live
Grocery stores	⟷	AmazonFresh / Instacart / Grocery Gateway

What will be built ? …

- Residences (‘passive’ or increasingly energy-neutral homes);
- Health care facilities (aging population);
- Warehouses (distribution centres a.k.a. ‘drone docking stations’);
- Battery plants (electric and hybrid vehicles, plus energy storage);
- Airports (where ‘bricks & mortar retail’ is still thriving);
- Wind, solar and geothermal power plants;
- Lithium mines;
- Skyscrapers (for emerging nations, symbols of achievement);
- Infrastructure …

Logistics Rule ...

- The goal of improved 'logistics' is to move goods, services and people faster, cheaper, safer and greener.
- The words 'logistics', 'infrastructure' and 'productivity enhancements' have become synonymous.
- The push for both 'hard' (i.e., roads, sewers, pipelines, etc.) and 'soft' (schools and hospitals) infrastructure largely comes down to striving for productivity enhancements.
- 'Soft' infrastructure supplies the brains (through educational facilities) and the healthy workers (medical facilities) to create and maintain the whole super-complicated logistics apparatus.
- The nation that understands and adapts to this new dynamic will prosper best.

Much new infrastructure will have a communications/ Internet of Things (IoT) component.

Dual Impacts of Commodities Pricing

- Price movements of major internationally-traded commodities are vitally important for the construction sector in two ways.

- First, they can be a key determinant of when owners of resource development sites will undertake capital investments. As prices for energy and forestry products and metals and minerals increase, the likelihood of spending on new drilling and refining facilities, sawmills and pulp mills and mining extraction and milling operations increases.

- Furthermore, such resource projects can sometimes assume the shape of truly immense undertakings – i.e., what have come to be termed ‘mega’ projects – and they can drive on-site employment over the course of many years.

- Second, all building products, when stripped to their essentials, have a commodity base (e.g., copper in plumbing and lighting; hydrocarbons in vinyl siding and PVC pipes; etc.). Therefore, commodity pricing plays a significant role in construction material costing.

Resource Sector ...

There are so many petrol-powered cars on the road and they last so much longer than they used to, there will continue to be a strong demand for gasoline for at least a decade or more.

Due to high-tech advances in so many spheres, demand for raw materials is transitioning towards ...

- Aluminum (light weight, contributing to energy-efficiency);
- Copper (3 x greater usage in electric vs gas-powered vehicles);
- Lithium, cobalt, manganese (for batteries);
- Half of the world's known supply of lithium is in Chile;
- More than half the world's supply of cobalt is in the Congo (where not many companies want to do business, due to 'child labour');
- Silver in solar cells.

Breakthroughs …

- Quantum computing …
  a) Dramatic departure from binary 0s and 1s (i.e., no longer current on or current off methodology);
  b) Works on basis of ‘superposition’ theory (i.e., that a photon of electron can be 0 or 1 at same time);
  c) Most famous example is ‘Schrodinger’s cat’ – often mentioned in the TV show, ‘Big Bang Theory’;
  d) Also ties to ‘string theory’ in physics.
- A virtual ‘you’ to keep on tweeting after you’ve left this corporeal realm (i.e., based on your history of social media interaction);
- ‘Spotmini’.

‘Spotmini’ – Boston Dynamics

https://www.youtube.com/watch?v=kga045Sya04

Because we're human beings …

The more things change, the more they stay the same, right?

Maybe not …

Not if we muck around with basic DNA through the use of genomics

Is the volume and rapidity of change stressing you out?

Have no fear, surely there's an altered gene sequence that can fix that problem.

We’re living in science fiction …

Author: Alex Carrick, Chief Economist, ConstructConnect ‘www.constructconnect.com/blog/;
With acknowledgement for major input by Garrett Wasny, MA, CMC, CITP/FIBP, ‘www.garrettwasny.com’.