Construction Productivity and Convergence of BIM, GIS, and 3D Gaming

Geoff Zeiss
Director Utility Industry Program
Autodesk
The world economy is expanding at an unprecedented rate
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International focus: Energy intensity

- Energy intensity graph
  - Toe per thousand $2010 GDP
  - US, China, World, India

- Shares of world primary energy graph
  - Oil, Coal, Gas, Hydro, Nuclear, Renewables*
  - Includes biofuels

IEA Energy Outlook

Energy Outlook 2030

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Greening the building/infrastructure market

Globally $6-7 trillion annually

Today 6% qualifies as “green”

In 2020 75% will be “green”

Green buildings and infrastructure driven by regulation, owner and investor demands, resource cost, security concerns, and third party standards.

Source: Global Insight
Worldwide Infrastructure Expenditure 2005-2030

$24 trillion to $41 trillion

Source: Booz Allen Hamilton, Global Infrastructure Partners, World Energy Outlook, Organisation for Economic Co-operation and Development (OECD), Boeing, Drewry Shipping Consultants, U.S. Department of Transportation

http://www.strategy-business.com/article/07104?pg=all
Governments don’t have this kind of money
Québec Plan Nord

The Plan Nord will be carried out over a period of 25 years. It will lead to over $80 billion in investments during that time and create or consolidate, on average, 20 000 jobs a year, equivalent to 500 000 man-years. The Plan Nord will be to the coming decades what La Manicouagan and James Bay were to the 1960s and 1970s.

Target 70% private funding

http://www.plannord.gouv.qc.ca/english/overview/index.asp
The National Infrastructure Plan brings together the first ever comprehensive cross-sectoral analysis of the UK’s infrastructure networks and sets out a clear pipeline of over 500 infrastructure projects, worth over £250 billion over the next 5 years.

The Government will use all the tools at its disposal to facilitate the private investment that will finance the majority of the UK’s infrastructure.

Est £400 billion over next decade

Target 70% private funding
Who is going to do all this?
Historical Productivity in Construction

Construction productivity
GVA per hour worked in 2007 PPP $

SOURCE: EUKLEMS; Associated General Contractors of America, 2011; U.S. Bureau of Labor Statistics

McKinsey & Company
European economies face steep labor declines

Shrinking labor forces will be the norm throughout Europe with only a few exceptions.

Working-Age Population; 2005=1.0

Note: Working age = 15-64
Source: United Nations 2004 medium variant forecast

Adele Hayutin, Labor Force Implications and Pension Vulnerabilities, Briefing to the Senate Special Committee on Aging, May 21, 2007
Aging utility workforce in Europe

Source: Stuart Ravens, Ovum
Germany

- Needs 400,000 engineers, master craftsmen and skilled workers.

- 80,000 unfilled positions for engineers
  (Association of German Engineers)

- GDP growth reduced by one percent by the labour shortage and problem is growing worse
  (German Chamber of Industry and Commerce)

- Could be faced with a labor shortage of five million people within the next 15 years. (The Economist)

http://www.economist.com/node/18621769
http://taxguru.in/chartered-accountant/germany-relaxes-immigration-laws-professionals.html
Productivity gains could reduce cost of infrastructure

McKinsey & Company

1 Estimates from CGLA for 2010-2030 global investments, adjusted for an assumed 15% investment in telecom
2 ROCCS estimates for roads, assumed for all transport classes; EU-KLEMS data for U.S. in 2007 as proxy for water, energy, and telecom

SOURCE: McKinsey Global Institute
Technology is rapidly evolving to meet these challenges
New geospatial data sources

Radar-derived
High-resolution digital terrain models
New geospatial data sources

High resolution aerial photogrammetry

Oblique aerial photogrammetry

“Streetview”
New geospatial data sources: laser scanning
Transportation Planning
Laser Scanning to Models for ROW, Planning, Design, Construction and O&M
Evolution of CAD to Model Based Design or BIM

**CAD**
- Graphics only
- Lacks intelligence
- Lacks domain knowledge

**Model based design or BIM**
- Integrates geospatial and engineering design data
- Enforces business and engineering rules
- Automates clash detection
- Automates change propagation
- Reduces data redundancy
- Improves collaboration among design teams
- Automates bill of materials and job costing
- 3D visualization involves non-technical stakeholders in design process

**Benefits**
- Increases productivity
- Reduces risk
- Reduces costs
- Improves design quality

Deliverable is paper

Deliverable is an intelligent digital model

Intelligent models
Gaming and 3D visualization

Now used by engineers
Gaming and 3D visualization
Lighting Design & Analysis

SF Presidio Parkway Project
5D for financial control
Analysis and simulation

- Building performance simulation
  Visualize environmental performance

- Visualization of building performance and environmental characteristics

- Visualize environmental factors
  Solar, Shading, Daylighting, Weather

- Conceptual design analysis such as basic form and building orientation, internal layout, and external materials.
Technology is changing many domains
Advanced wastewater treatment plant design
Rail project coordination

Primavera integration for design & construction coordination
Substation design
Key Benefits

- **Improves efficiency**
  - Estimate 50% productivity improvement
  - Estimate 27000 person-hrs saved per year

- **Improves quality**
  - Integrates with other enterprise systems including GIS to reduce data redundancy

- **Facilitates knowledge transfer**
  - Critical to address the challenge of an aging workforce

- **Estimated ROI ~ Just over one year**
Immediate business benefit of these technologies are efficiencies in the $6.1 trillion construction industry
Convergence breaks down silos
Vision for sustainable city design
Reality Capture → Energy Modeling → Mapping

City 3D Model

BIM models

Conceptual design – integrate architectural and engineering designs and city 3D model

Environmental impact
Modeling urban underground infrastructure
Communication
Planning, Design, Visualization, Collaboration, Public Outreach, Agency Approvals
Some takeaways

- We are facing global challenges: increasing urbanization means increasing energy demand, water stress, and environmental impact
  - more to do, fewer people to do it

- Technology is changing how we design and build
  - BIM, smart design, convergence

- Convergence of BIM, geospatial, 3D visualization enables
  - intelligent models of entire cities
Designing for a sustainable future