Forum

A Futurist View: What is on the Horizon

Panelists:
Dean Jorge Vanegas
and
Professor Rodney Hill
Texas A&M University

Francis Rabuck
Technology Manager
Bentley Systems
Forum

Is the Capital Projects Industry observant...?
Is it prepared...?

Panelist:

Jorge Vanegas, Dean

Texas A&M University
College of Architecture
HOWDY!
The world is changing fast...
Reducing the history of the earth into 365 days

(4.6 billion years compressed into one year)
January 1st
The earth is a boiling forming ball of fire!
April 1\textsuperscript{st}

First life forms! Oxygen begins to appear!
October 31st

Oxygen level reaches 20%!
First sexual response in life forms!
November 3rd
Fish appear on the scene!
November 13th
Insects appear on the scene!
December 15th
Dinosaurs appeared!
December 26th
Dinosaurs Disappeared!
December 31st
3 minutes before midnight
human beings appeared!
December 31st
One minute before midnight
farming appears!
December 31st

One second before midnight
the steam engine is invented!
Your life span is approximately $\frac{2}{3}$ of a second!
... And in addition, we are living in an age of transition...
In the history of human civilization, there have been only three waves of Transformation!

1. Tribal hunting and gathering to agrarian society
2. Agrarian society to the industrial revolution
3. The industrial revolution to the information/knowledge age
We are now moving to the fourth wave:

4. The information/knowledge age to the Intelligence/Innovation Age!
So, what is in the horizon for the Capital Projects Industry?
So, what is on the horizon?

Prognostications

Predictions

Forecasts

Guesses
“It is said that the present is pregnant with the future.”

Voltaire
... And the Future arrives every second to “Play” as today’s reality, and it does not have “Mute,” “Pause,” “Stop,” “Rewind,” “Fast Forward,” “Eject,” or “Reset” buttons....
So, will YOU be able to ride the wave of the future...?
Or be dragged under by it...?
YOU have four choices:

- Are YOU going to contribute to make the Future YOU want happen…?
- Are YOU going to just wait and see what Future will happen…?
- Or, when whatever Future arrives:
  - Are YOU going to ask “what happened…?”
  - Or, are YOU just going to say “huh, something happened…?”
To face the future, we need to be...
(1) Observant...
The Future
Particularly, of the serious and complex challenges we face...
Millennium Development Goals...
Source: United Nations
http://www.un.org/millenniumgoals/
15 Global Challenges for Humanity...
The Grand Challenges for Engineering...
Make solar energy economical

Manage the nitrogen cycle

Place energy from fusion

Advance health informatics

Develop carbon sequestration methods

Provide access to clean water

Reverse-engineer the brain

Engineer better medicines

Secure cyberspace

Prevent nuclear terror

Advance personalized learning

Engineer the tools of scientific discovery

Source: National Academy of Engineering
http://www.engineeringchallenges.org/
The 2030 Challenge to the Architecture and Building Community...
All new buildings, developments and major renovations shall be designed to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50% of the regional (or country) average for that building type.

At a minimum, an equal amount of existing building area shall be renovated annually to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50% of the regional (or country) average for that building type.

Carbon-neutral in 2030
(using no fossil fuel GHG emitting energy to operate).

The fossil fuel reduction standard for all new buildings and major renovations shall be increased to 60% in 2010, 70% in 2015, 80% in 2020, and 90% in 2025.

Source: 2030 Challenge
Doomsday Scenarios...
Stark Realities...
Source: http://www.infrastructurereportcard.org/

2009 Grades

- Aviation: D
- Bridges: C
- Dams: D
- Drinking Water: D+
- Energy: D
- Hazardous Waste: D- 
- Inland Waterways: D-
- Levees: D
- Public Parks and Recreation: C-
- Rail: C-
- Roads: D-
- Schools: C+
- Solid Waste: C
- Transit: D-
- Wastewater: D

America's Infrastructure GPA: D

Estimated 5 Year Investment

Need: $2.2 Trillion
And many more...
To face the future, we also need to be...
(2) Prepared...

The Future
“It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change.”

Charles Darwin
“If you don’t like change, you’re going to like irrelevance even less.”

General Eric Shinseki, Chief of Staff. U. S. Army
Change is hardest on those caught by surprise!
We live in a surplus society...
“The ‘surplus society’ has a surplus of similar companies, employing similar people, with similar educational backgrounds, coming up with similar ideas, producing similar things, with similar prices and similar quality.”

Kjell Nordström and Jonas Ridderstråle, Funky Business
“The short road to ruin is to emulate the methods of your adversary.”

Winston Churchill
“To grow, companies need to break out of a vicious cycle of competitive benchmarking and imitation.”

W. Chan Kim & Renée Mauborgne
“Think for Yourself —Stop Copying a Rival”
Financial Times/08.11.03
“Beware of the tyranny of making Small Changes to Small Things. Rather, make Big Changes to Big Things.”

Roger Enrico, former Chairman, PepsiCo
So, what big changes lie in the future for the capital projects industry?
There is a Perfect Storm brewing within the Capital Projects Industry...
Are ALL being challenged and WILL CONTINUE to be challenged even more in the future...
In other words...

What we do...

...how we do it...

Contextual Envelope of a Specific Capital Project

Compatibility

Processes for the Delivery and Use of a Specific Capital Project

Resources for the Delivery and Use of a Specific Capital Project

Compatibility

...and with what...

(Inspired by M. Vorster)
Are challenged as a result of current unsustainable paradigms and dysfunctional behaviors...

In other words...

Characteristics and Requirements of a Specific Capital Project

Processes for the Delivery and Use of a Specific Capital Project

Contextual Envelope of a Specific Capital Project

Resources for the Delivery and Use of a Specific Capital Project

(Inspired by M. Vorster)
So we will see more advances in ...

Sustainability (in WHAT we do...)

Lean Project Delivery (in HOW we do what we do...)

Fully Integrated and Automated Technologies (in WITH WHAT we do what we do...)

Characteristics of Specific Capital Projects

Processes for the Delivery and Use of Specific Capital Projects

Resources for the Delivery and Use of Specific Capital Projects

So we will see more advances in ...
Sustainability...
Lean Project Delivery...

SOURCE: Lean Construction Institute; http://www.leanconstruction.org
Fully Integrated and Automated Technologies...
But, these developments pale in comparison with the Super Storm brewing outside the Capital Projects Industry...
Transdisciplinary, Transinstitutional, and Transnational: Eliminating the artificial boundaries among disciplines and knowledge domains, institutions (public and private), and nations, in the pursuit of solutions.
Ubiquitous Computing: Making many computers available to a user throughout the physical environment, while making them effectively invisible to the user, enabling the user to remotely interact with people and the natural, built, and virtual environments; remotely monitor, collect, and access data, information, knowledge, experience, and wisdom; and remotely control devices.
Cloud Computing: A style of computing in which capabilities related to Information Technologies (IT) are provided to users “as a service” allowing them to access technology-enabled services from the Internet ("in the cloud") without requiring knowledge of, expertise with, or control over the technology infrastructure that supports the services.

http://www.vardhamantech.com/cloud.html
Augmented Reality: A term for a live direct or indirect view of a physical real-world environment whose elements are merged with, or augmented by virtual computer-generated imagery, creating a mixed reality.

http://www.thefutureisawesome.com/category/augmented-reality/
Collective Intelligence: A shared or group intelligence that emerges through collaboration, innovation, and competition, from the capacity of human communities to evolve towards higher order complexity and integration, which (1) appears in a wide variety of forms of consensus decision making in bacteria, animals, humans, and computer networks; and (2) is studied as a subfield of sociology, of business, of computer science, of mass communications, and of mass behavior – from the level of quarks to the level of bacterial, plant, animal, and human societies.

In other words...

Collective Intelligence internal flow

Intention

Reflection

Competence

Support

Trust, social capital

© Pierre Lévy, CRC, Université d’Ottawa

Automation and Robotics: The application of science, engineering, and technology (particularly electronics, mechanics, control systems, computer-aided technologies, hardware and software, and artificial intelligence), in the design, manufacture, and application of autonomous devices and robots for industrial, consumer, or entertainment use, which reduce the need for human sensory and mental requirements, and which perform tasks that are too dirty, dangerous, repetitive, or dull for humans.

http://www.acceleratingfuture.com/michael/blog/2007/03/357/
And finally, (7) NBIC…

Nano-Bio-Info-Cogno Convergence: The synergistic combination of four major provinces of science and technology, each of which is currently progressing at a rapid rate: (1) nanoscience and nanotechnology; (2) biotechnology and biomedicine, including genetic engineering; (3) information technology, including advanced computing and communications; and (4) cognitive science, including cognitive neuroscience.

In other words...

In closing, let me leave you with two thoughts...
With respect to the future, is the Capital Projects Industry OBSERVANT...?
Or, is it a “boiling frog”…?
Is the Capital Projects Industry PREPARED...?
Or, will it be caught by surprise...?
Your call...
Thank you...

jvanegas@tamu.edu
And now, Professor Rodney Hill...
Forum

The Present and Future Perfect Storm

Panelist:
Rodney Hill, Professor
What is the future for the construction Industry?
The future belongs to people who see possibilities before they become obvious.

Ted Levitt
World population is expected to peak at 9 Billion by 2050.

The United Nations estimates a 50% increase in population within 4 decades. We are approaching the limit of our food and water supply.
If you began building 40 cities of 2 million people a year for the next 40 years, you would meet the needs of the population increase by 2050.
This is an unprecedented era of accelerating change in human existence where the past will no longer predict the future.
Currently, there exists no system that can feasibly plan & create the infrastructure for those cities or a construction system to build cities at that speed.
“The hypercompetitive business environment demands new emphasis on rewarding speed, creativity, and innovation within the workforce.”

Cetron and Davies
You can’t do today’s job with yesterday’s methods and be in business tomorrow!
The **twentieth century** alone features more turning points in the history of mankind than the previous **five centuries** put together!
When people think of a future period, they intuitively assume that the current rate of progress will continue for future periods.

We assume that progress changes at the rate that we have experienced recently.
At the 2009 rate of change, the entire 20th Century would take place in 25 years.
Twentieth-century solutions executed with twentieth-century speed will not solve twenty-first-century problems.
Presently there are over a billion people living in shadow cities around the world and another billion will be living in shadow cities in 10-15 years.
There is no more fresh water in the world today than 2000 years ago when the population was 3% of the present!
Water will become a more pressing problem than oil, and the quantity, quality and distribution of water will pose significant scientific, technological and ecological difficulties as well as serious political and economic challenges.
As of last year, for the first time in history, there was no world food surplus.
Oil supplies are expected to peak in the next 10-15 years & raw materials will be sought after and in demand more than anytime in the history of mankind.
Thus.................
The Perfect Storm
Water
The link between water, food and energy is strong!
The average human drinks 4 liters of water per day while 500 times as much water is required to produce our daily food totals.
Governments have failed to limit pumping to the sustainable yield of aquifers and water tables are now falling in countries that contain more than half the world’s people, including the big three grain producers: China, India, and the US.
If the vast aquifers in Saudi or the arid southwestern US are depleted, the loss of irrigation water means the end of agriculture.
The World Bank foresees “Catastrophic consequences for future generations” unless water use and supply can quickly be brought back into balance.
“Two out of every three people in the world will be facing water shortages by 2025... global conflict will inevitably result...”
United Nations
It takes 1,000 tons of water to make a ton of wheat worth $200 and only 14 tons of water to make a ton of steel worth $560. Countries concerned with expanding the economy and creating jobs have chosen industry.
Major cities are taking water from agriculture to meet the needs of growing cities. 

Mexico City, Cairo, Beijing, San Diego, Los Angeles, Las Vegas, Denver and El Paso.
Farmers surrounding the major cities have found that the price of water far exceeds the value of the crops they can produce.

**Cities are buying water rights from farmers and ranchers.**

The highly productive land owned by these farmers will become wasteland.
Slowly but surely, fast-growing cities are siphoning water from the world’s farmers even as they try to feed some 70 million more people each year.
Because of falling water tables, conversion of cropland to non-farm uses and industrialization, China’s grain harvest is falling.
175 million Indians are fed with grain produced with water from irrigation wells that will soon go dry!
By 2010, half of India’s population will have to survive on just five gallons of water per person per day for all uses.
The over-pumped aquifers in Iran which have gone dry has created a flow of water refugees.
The accelerating depletion of aquifers means the day may come soon, creating potentially unmanageable food scarcity.
Many smaller rivers in the world have disappeared and major rivers are on the endangered list. The Colorado in the US southwest, the Yellow in China, Indus in Pakistan, the Nile in Egypt and the Ganges in India. How about the Rio Grande in Texas?
The Nile Valley is one of the most fertile lands in the world but because of the shortage of water, Egypt now imports over half of the wheat it needs.
Egypt, Ethiopia and Sudan are entirely dependent for its water on the Nile River, which is reduced to a trickle as it enters the Mediterranean. **Population in these three countries is projected to climb to 264 million in 2025 from 167 million today.**
The European Parliament estimates that 70% of the Continent’s drinking water contains dangerous concentrations of nitrate pollution.
Contaminated water is implicated in 80% of the world’s health problems. An estimated 40,000 people around the world die each day of diseases directly caused by contaminated water.
Contaminated water results in the occupancy of 50% of all hospital beds in developing countries.
By 2040, at least 3.5 billion people will run short of water.

By 2050, fully 2/3’s of the world’s population could be living in regions with chronic shortages of water.
Can engineers and contractors take the lead in rain water harvesting, cisterns and conservation? 

What opportunities can this present?
How can you reinvent your company and role in an accelerating future?
Global Food Supply
Importing grain has become the most efficient way to import water. In effect, countries are using grain to balance their water books. Similarly, trading in grain futures is in a sense trading in water futures.
The countries that are financially the strongest will fare best in the grain markets/water markets.
Many of the Middle Eastern countries are buying rich farm land in areas of the world where the rainfall is plentiful. All of the food produced will go back to the Middle East.
South Korea just leased 125,000 acres of fertile land from Russia to meet their food needs!
To adequately meet human nutritional need over the next 40 years, global agriculture will have to supply the same amount of food that was previously produced throughout the entire history of humanity.
There has been no growth in the world grain harvest or world fish catch since 1990. In a two year period from 1994 to 1996, China shifted from being a net grain exporter of 8 million tons to being a net importer of 16 million tons - a 24 million ton swing.

Almost the entire world surplus of grain.
China is reducing rice production to redirect the water to its growing population.

2 weeks ago rice prices increased by 30%.

Last year average food prices went up by 50%
To alter the diet of China and have China consume seafood at the level of Japan, it would need 100 million tons a year: the current world catch.
China, Egypt, Cambodia and India have banned exporting grain.

Restrictions in Kazakhstan, Russia, Ukraine and Argentina have closed a third of the global wheat market.
The potential benefits of GM food should be dead obvious to all. It is possible to grow bountiful crops on marginal lands.
Designer plants could make deserts bloom, detoxify ruined soils, return scarce rangeland to nature, eliminate malnutrition, and abolish hunger for a future population of 10 billion or so.
For the first time in decades there was no surplus food in the world markets.

Look for food prices to increase by 3 to 5 times the present prices in the coming years.

The Arlington Institute
Three separate factors are converging to drive food prices up.

**Over the next forty years, population will grow by 3 billion.**

Within 10 years the developing countries will be eating 40% more meat and more grain will be shifted to animals. **Grain prices will go up and the global poor will starve.**
It is predicted that temperatures will rise 3.6F this century and that means a twelve to twenty percent fall in global food production.
The price of food relative to average income is heading for levels that have not been seen since the early 19th century, and it will not come down again in our lifetimes.

Gwynne Dyer, Ph.D, Global Business Network
The average US household spends 10% of annual income on food.

The World Bank forecasts the average US household will spend 25% of annual income on food within ten years.
Energy & Building Materials
If China consumes oil at the rate of the US by 2030, they would use 99 million barrels of oil a day.

The world currently is producing 84 million barrels a day.

The Futurist, July 2006
As of August of 2009, China is consuming $\frac{1}{2}$ of the oil production of Saudi!
The International Energy Agency said that oil supply was falling faster than expected and will force up prices to record levels and increase the west’s dependence on oil cartel Opec within five years.

**Gas will reach the same shortage within ten years.**

Financial Times, July 10, 2007
At the International World Economic Summit in Davos in 2008, oil was predicted to reach $500 a barrel by 2020.
China was one of the largest exporters of coal until last year when it imported 16 million tons of coal. It created six storage facilities to stockpile existing domestic coal production. China has enough stockpiled for 4 decades.
China is buying up coal mines around the world and investing in oil and energy companies in every continent in the world.

Wall Street Journal, August 21, 2009
The demand for metals are predicted to double in demand over the next ten years.

The global supply chain will be altered dramatically in an accelerating future for materials and energy.
China has 95% of the world’s rare earths.

Rare earths are used in green & high technology products. China announced on Sept. 4, 2009, that they were restricting the export of rare earths.
China has been the fastest growing economy in the world since 1980.
In less than 10 years India’s economy will surpass that of the UK!
India is projected to have an 8% growth rate this year!

Financial Times, July 10, 2009
Growth forecasts for 2009
China-9.8%
France-1.9%
Japan-2.0%
US-2.7%
Germany-1.9%
UK-2.0%
Financial Times, Jan. 28, 2009
Among the five basic food, energy and industrial commodities-grain, meat, oil, coal, and steel consumption in China has eclipsed that of the US in all but oil.

The Futurist, July 2006
Chinas consumption of steel is two and a half times that of the United States.
China’s highway system will be larger than America’s by 2020!
Many countries are just now facing up to the state of declining infrastructure in their countries as massive new construction projects are competing for attention.
China is planning to build 20 new major cities each year for the next 14 years. The ones it already has are growing by 13 million to 15 million people annually. 300 million farmers will move from the countryside in the next 20 years.

Andrew Zolli, Fast Company, March 2007
China announced that they are building 79 regional airports in the next five years.
World oil has peaked but population has not. **Between 2040-2050** world population will increase **50%** from today’s population. What will be tomorrow’s energy source?
Population
In the 18th century, we added a few days every year to human longevity. During the nineteenth century we added a couple of weeks each year and now we’re beginning to add 3+ months to each year this century.
People born in the 1990’s can possibly live to be 110-120 years old. With new genetic and nanotechnology discoveries, you could work, stay healthier & live even longer.
With the previous scenario, population on the earth will reach beyond the 50% increase mark predicted for 2050.

Can the earth sustain even a 50% increase?
With the increase in population & the cost of energy, mass transportation will be mandated and supported by governments.
Technology Wild Cards
We used to live in a domino world in which one change logically caused the next. Now we have entered a chain reaction world of exponential shifts. Interconnection means that our problems and opportunities are intimately linked.
Intel’s computer chips in 1965 held a few dozen transistors. Today, Intel’s high-end chip contains more than 1.7 billion transistors. That number is expected to exceed 10 billion by 2012.

Technology Review, July, 2005
Researchers in Israel have fashioned a bio-computer out of DNA that can handle a billion operations per second with 99.8% accuracy.

A trillion of these bio-computers can fit in a test tube.
By 2014, iPod will hold the contents of the Library of Harvard University.
By 2017, iPod will contain the Library of Congress.
The military has funded MIT to develop internet in the brain by 2018!
It is estimated that *all* the technological knowledge that is known today will comprise only 1% of all the technological knowledge available by the year 2030!
Two thirds of the jobs that will be available in the world by 2020 haven’t been invented yet!
Last week, the US said there was a shortage of highly skilled workers who can deal with the new emerging technologies.
Nanotechnology is frequently described as a technology with the potential to capsize the established order.
Nanotechnology
Designing and building machines in which every atom and chemical bond is specified precisely.
“The nanotechnology revolution will enable us to redesign and rebuild-molecule by molecule-our bodies and brains and the world with which we interact, going far beyond the limitations of biology.”

Ray Kurzweil, Futurist, March, 2006
Nanobots injected in our bloodstream will destroy pathogens, correct DNA errors, eliminate toxins and perform many other tasks to enhance our physical well-being.

Ray Kurzweil, Futurist, March, 2006
Biotechnology, nanotechnology and artificial intelligence have become engines of the global economy.
Can you build 50% of the buildings existing on earth in the next 40 years with existing technology?
Can nanofactories be developed in time to build the cities of the future?
What role will artificial intelligence play with robotics to accelerate the construction of new cities?
What could be invented today that will put you out of business tomorrow?
Recently there was a shortage of construction cranes and raw materials. What will be the demand on equipment and materials to build structures for a 50% increase in population in 4 decades?
Possible Wild Card Scenarios
How much will fuel costs escalate in an age of accelerating construction for vessels delivering construction materials to Africa, India, Asia & South America? What have you done to assure a reliable global supply chain?
Producers of items that are heavy and bulky & expensive to transport are cutting back on shipping globally causing a shortage of products abroad.
At what point will countries find importing materials unsustainable in the light of escalating fuel prices?

Example: aggregate for Qatar
The next 4 decades of unprecedented growth will result in chronic raw material shortages.
Will there be an attempt again for a cement cartel to control prices globally?
How will you deal with a lack of standardization of components when the majority of construction work in the world is a mix of global suppliers? What critical and creative skills must your managers possess to solve these problems?
What are the crucial social, cultural and ethical skills needed by your company to practice abroad?
What about adaptive reuse in the US?
3,000 of the 8,000 shopping malls in the US have closed their doors.
What about the mothballed military bases?
Thousands of auto dealership across the country are vacant.
Closed prison facilities across the US?
In addition to building for an increasing population, the possible results of global warming must be addressed now and will take decades to build defenses for vulnerable cities.
150 million people living in coastal areas around the globe could be displaced by 2070. Cities will have to be relocated and built to accommodate that possibility.

13 of the world’s 15 largest cities are on coastal plains and are in peril.
Can you solve the problems of deteriorating infrastructure and maintaining present buildings in the US and the rest of the world while coping with critical new dwellings for an exploding population?
You may have to reinvent your company and take on new roles that include research to innovate/invent the technology & systems demanded for creating the future.

Creativity has become the currency of the new millennium.
The FUTURE will be hardest on those caught by surprise!
And now, Fran Rabuck...