

## Notes from a Decade of Travels in a World Without Walls

Joel L. Cuello

Between 2000 and 2010 my academic and research activities frequently drew me out of the confines of the university campus and outside of the United States, sending me into orbit over a good part of our planet -- covering six continents, 22 countries and 59 cities, with at least one return trip made to two-thirds of those countries within the same time period.

I always traveled alone, which made meeting colleagues and new friends on the other side of my long journeys all the more welcoming and gracious. Traveling solo also certainly heightened the sense of adventure at times, such as what was occasioned by my very first trip into the West Bank in 2006 when I was met at the airport in Tel-Aviv by an elderly Palestinian, who could not speak a word of English, but who had been entrusted with fetching me and whisking me away into the Palestinian territories in the middle of the night. Or that time in 2007 when I spent the night sleeping on the floor at London Heathrow waiting for my disrupted flight to India to be rescheduled as a result of the U.K. liquid terrorist plot which had just been thwarted a day earlier. Most of the time though, traveling alone afforded me with auspicious moments to make quiet, unhurried personal observations and to engage in intellectually honest reflections about our changing world while on the move -- as an engineer, as a professor, and as a fellow citizen of the planet.

With the last decade dramatically book-ended by two worldwide economic recessions as well as by such watershed events as the 9/11 terrorist attacks on the United States and by China's ascension in 2010 as the world's second largest economy, our planet has truly been re-ordered and realigned during the first 10 years of the 21st century. From a decade's worth of memorable travels crisscrossing our world of porous boundaries, here are 8 of my notes on trends that will reshape our globally interconnected world this century.

**1. Hello World.** Riding a taxicab in Mumbai (population 20.1 million), visiting the bustling bazaars of Cairo (12.5 million), or walking through the pulsating streets of Manila (11.7 million) or Shanghai (15.8 million), one simply could not escape that palpable sense of being surrounded, not just by people, but by throngs of people.

Global population last year marked a new milestone of reaching 7 billion people occupying the planet. While it took 150 years for the world population to rise from 1 billion to 3 billion in 1960, it has taken merely 5 decades for the number of people since then

to more than double to 7 billion. In the last 50 years, Europe grew by 21 percent, the U.S. by 72 percent, China by 111 percent, while India added the largest single contribution to world population by gaining 782 million people (more than twice the U.S. population today).

The main impact of the world's population, however, lies less in its absolute number -- which the United Nations Population Division is projecting to stabilize to about 9.2 billion by 2050 -- than in how the world population is distributed on the planet. It has been reported in *Foreign Affairs* that by the eve of World War I in 1913, Europe had more people than China and the proportion of the global population living in Europe, Canada and the U.S. was over 33 percent. By 2003, however, the combined population of Europe, Canada and the U.S. accounted for just 17 percent of the world population. In 2050, this figure is expected to decline further to 12 percent, far less than it was in 1700.

Today roughly 9 out of 10 children under the age of 15 live in developing countries. Indeed, over 70 percent of the world's population growth between now and 2050 will occur in 24 countries, all located in the developing world. Further, the world's six most populous Muslim-majority countries of Bangladesh, Egypt, Indonesia, Nigeria, Pakistan and Turkey had a combined population of 886 million in 2009, which is expected to increase by another 475 million in the next four decades. By comparison, the six most populous developed countries are projected to gain only 44 million people during the same time period.

The increasingly skewed shift in the center of gravity of the world's population from the developed world to the developing world, and in general from West to East, has been reshaping the global economic, scientific, political and military landscapes and will only persist in the coming decades.

**2. The Ascent of Cities.** The ancient city of Hebron in the Judean hills (population 170,000), home to the biblical patriarchs Abraham, Isaac and Jacob and home to Palestine Polytechnic University, my host University in the West Bank, never fails to evoke within me that heightened feeling of visiting a place that is simpler, more serene, and of another time. The Israeli occupation has virtually isolated Hebron in many respects from the rest of the world and has unwittingly helped preserve many of the ancient city's traditions and rhythms of life. Visiting Hebron provides a glimpse of how people in ancient times, through living and working together in cities, not only gained efficiencies

in their lives and economy, but also hastened the weaving of the tapestry of their collective ideas and narratives toward a realized and shared civilization.

In 2010, for the first time in the history of the world, the proportion of the world's population living in cities exceeded 50 percent, despite the world's cities occupying only 3 to 4 percent of the planet's land area. Indeed, the number of countries with multiple cities with more than 1 million residents each continues to grow. Pakistan has 8, Mexico 12, and China more than 100. By 2030 India will have 68 such cities, while China will have 221. By 2030, China will add 400 million city dwellers (more than the U.S. population) while India will add 215 million (more than the population of Brazil).

India, which is less than 30 percent urbanized today, is expected to be 55 percent urbanized by 2050. China, which is about 40 percent urbanized today, is expected to be 73 percent urbanized by 2050. The world's urban population is projected to go up to 4.7 billion by 2030. At that time Asia will be home to 55 percent of the world's urban population. China and India alone will account for 30 percent of the world's urban dwellers.

A heavily urbanized century demands the design of city-centered engineered systems for all types of basic needs – sustainable dwelling, food production and distribution, water reuse and delivery, as well as energy generation and conservation.

**3. A Common Rise.** On my recurring visits to the United Kingdom, I keep returning back on my available time to the British Museum which, through its vast collection of historical objects and artifacts, provides a kaleidoscopic survey of human history through the seemingly inevitable ebb and flow of kingdoms and civilizations – the Assyrians, the Babylonians, the Egyptians, the Greeks and the Romans. Even in the ensuing Dark Ages when Europe descended into political turmoil and cultural backwardness until the genesis of the Italian Renaissance in the early 1400s, the civilizations of China's Tang Dynasty, the Islamic Empire and the Maya in Mesoamerica took their turn to rise and reach their peak. Indeed, the successive waxing and waning of kingdoms and civilizations across millennia have become the basic plot line of mankind's history.

But traveling the world in the first decade of the 21<sup>st</sup> century, one finds that man's history is getting a significant rewrite. With the globalization of trade, information, labor, investment and capital, our history no longer follows the moribund script of successive rise and fall of kingdoms and civilizations, but one that portrays the common and simultaneous rise of states and civilizations across the globe – a development that is unique and truly unprecedented in human history.

The economic numbers attest to the trend. It has been reported, for instance, in *Foreign Affairs* that the proportion of global GDP

produced by Europe, the U.S. and Canada fell from 68 percent in 1950 to 47 percent in 2003 and, by 2050, will decline further to only 30 percent -- smaller than it was in 1820. Conversely, an overwhelming proportion of the world's GDP growth between 2003 and 2050, about 70 percent, will occur outside of Europe, the U.S. and Canada.

The World Bank has predicted that by 2030 the number of middle-class people in the developing world – those capable to purchasing durable consumer products, such as cars, appliances and electronics – will be 1.2 billion (greater than the combined population of Europe, the U.S. and Canada), a rise of 200 percent since 2005. Thus, there is consensus that the main driver of global economic expansion from now on will be the economic growth of newly industrialized countries, such as China, India, Brazil, Indonesia, etc. The rise of these countries does not mean that Europe, the U.S. and Canada are declining in absolute economic terms. It just means that a host of other countries are now rising together toward parity over the long term with today's already developed countries.

**4. A Hungry Planet.** I get to enjoy my predilection for authentic Chinese cuisine when I am actually visiting China. With my host Prof. Yong He and his colleagues and graduate students at Zhejiang University taking me to dine at restaurants in Hangzhou, and mostly on my own in Shanghai and Beijing, the seemingly infinite variety of Chinese gastronomy never ceases to amaze me. But what truly astonishes me and gives me great pause is the simple fact that China has to feed its 1.3 billion citizens three times a day. How does China actually manage to feed 1.3 billion people every day? To put this in perspective, McDonald's, the ubiquitous and colossal global fast-food chain, has reportedly been selling 4.2 million hamburgers a day in the U.S. Assuming that each burger went to a unique individual, that would be equivalent to feeding only 1.4 percent of the U.S. population just once a day. Applied to China, that would be equivalent to feeding a truly miniscule 0.32 percent of China's population just once a day.

The question for us is how do we make our planet continuously feed its 7 billion inhabitants three times a day? This year the U.K. charity Oxfam reported that demand for food in 2050 will be 70 percent higher than it is now, and that today 925 million people already go hungry every day. Oxfam further forecasts that food prices are expected to increase by 70 to 90 percent by 2030 – before taking into account the effects of climate change, which would roughly double price increases again. Between 2000 and 2011, the price of soy per ton increased 260 percent, while the price of corn, wheat and rice per ton each rose roughly 300 percent.

On my visit to Oslo in 2010, my host Dr. Roald Flo took me to the Norwegian Nobel Institute where we were shown the stately conference room where the five-member Norwegian Nobel

Committee gathers every year to select the recipient of the Nobel Peace Prize. On the walls of the conference room hang the pictures of all individual Peace Prize laureates, including those for Martin Luther King, Jr. (1964), Henry Kissinger (1973), Mother Theresa (1979), Nelson Mandela (1993) and Jimmy Carter (2002). But the picture that really caught my eye was that for the American Norman Borlaug who was awarded the Peace Prize in 1970 for “his leadership of the Green Revolution in developing countries and helping to reduce world hunger.” Toward the innovative design of sustainable food production systems for a more secure and peaceful world, we certainly need more Norman Borlaugs today.

**5. A Thirsty World.** I would see them every morning as I was driven from my hotel to the Biofuels Research Center in Coimbatore in tropical Southern India – scores of Indian women walking on the roadside, quiet and stoic in their brightly-colored saris, balancing on their heads equally brightly-colored plastic jugs containing water they had collected from a source clearly at a considerable distance away from where they lived.

Women in developing countries walk an average of 3.7 miles to collect water, and one out of eight people in the world today lacks access to clean water. With current urbanization trends, some 993 million city dwellers by 2050 will each live with less than 26 gallons of water each day, considered the daily minimum. Today around 150 million people fall below the 26-gallon threshold for daily water use (the average American uses 98 gallons of water each day). India’s six biggest cities, including Mumbai and Delhi, are among those most affected by water shortages today. And as many as 119 million people in the Ganges River Delta alone are projected to face water shortages by 2050.

The use of water for agriculture accounts for 32 percent of all water use in Europe, 39 percent in North America, 71 percent in Latin America, 72 percent in Australia and Oceania, 81 percent in Asia, and 86 percent in Africa. Driving from Israel’s border to Jordan’s capital Amman, I would see numerous fruit and vegetable stands by the roadside where local farmers sold their fresh harvests, belying Jordan’s serious problem, not just with food security, but more so with water security. According to official figures, Jordan every year uses 600 million cubic meters of water more than it can replace, and the Kingdom still uses less water per capita than any other country in the Middle East. What is more, majority of Jordan’s water is used for agriculture, though agriculture does not contribute even 4 percent to the country’s GDP.

It both surprises and perplexes that we have arrived in the 21st century while someone has yet to design both a low-cost and water-efficient irrigation system that farmers in the developing world, especially those in the semi-arid regions, could readily adopt and use.

**6. Climate Insecurity.** I visited Punta Arenas located in the extreme South of Chile near the bottom of the world as a Fulbright Senior Specialist in 2010 on the invitation of the Antarctic Research Program at the University of Magellan. With its renown as the southernmost city in the continental land mass of South America, Punta Arenas is also part of the storied Patagonian region, a vast cathedral of nature in all of its epic grandeur and majesty. Over a weekend, my host Prof. Pedro Cid took me on a hiking trip, providing me with my first encounter with the region’s immense landscapes, picturesque mountains, lakes, icebergs, glaciers and ice fields. Even as its tranquil splendor reassures how ravishingly beautiful our planet is, Patagonia has now, unfortunately, also become a quiet testament to our planet’s growing climate insecurity – with 270 of the largest glaciers in the region between Chile and Argentina losing volume 10 to 100 times faster in the last 30 years over the last 300 years.

At the top of the world, as much as 40 percent of the Arctic ice cap’s area during summer has disappeared also in the last 30 years.

Meanwhile, the past decade happened to be the hottest ever measured, with 2005 and 2010 tied as the hottest years measured since systematic measurements began in the 1880s. Indeed, nine of the 10 hottest years in history occurred in the last 13 years.

While diversity is generally good, it is not so when it comes to diversity in weather disasters, which is precisely what today’s warmer, moister atmosphere is primed to offer across the globe -- from catastrophic flooding to blizzards, heat waves, droughts, wildfires and windstorms. In the United States alone, a significant rise has been observed in the incidence each decade of billion-dollar disasters, representing the upper tier of the worst natural disasters. Adjusted for inflation, the 1980s had an average of one billion-dollar disaster a year, the 1990s with four annually, and the first decade of the new millennium with four to five per year. The average for 2010 and 2011 is a staggering 7.5 a year. Over the last 30 years, 99 billion-dollar disasters have struck the United States, with Hurricane Katrina setting the record in 2005 at \$134 billion in damages.

In the Philippines, 5 of the wettest tropical cyclones in history occurred in the past decade, with their highest recorded total precipitation ranging from 26.97 inches to 42.45 inches.

Human vulnerability to extreme weather disasters is expected to increase in the coming decades. A rising global population, rapid urbanization and the growth of megacities will lead to the emergence of highly vulnerable urban communities especially in the developing world and along coastal areas. There are currently about 25 million people who are environmental refugees. Climate refugees, for instance, account for more than a third of recent migrants to the city of Dhaka in Bangladesh, a low-lying

country that has been seeing more frequent flooding as glacial melt in the Himalaya has accelerated. By 2050, the number of environmental refugees globally is projected to rise to 150 million.

**7. Resource Wars.** I still find it wondrous to leave one world in a winged tube and, in just about 10 to 15 hours, arrive at the end of the journey into an altogether different world. This was how it felt for me when I left Los Angeles and arrived for the first time in Beijing, China in 2000. Beijing then felt to me like another world in many ways, but it was the people -- or how they were -- that looked most foreign to me. The majority still dressed in drab-colored Mao jackets, and the faces I saw in the streets appeared mostly grave, unsmiling and even pensive. But fast forward 10 years, and the contrast cannot be strikingly clearer. The city itself, of course, underwent physical transformations many times over in the last decade, and the people of Beijing themselves look transformed -- many fashionably dressed mostly in the Western style, and the majority radiating a mix of optimism, confidence and ambition. Arriving in Beijing today feels just like arriving in Tokyo, Seoul, Singapore, Manila, Sydney, Mumbai, Tel-Aviv, Riyadh, Paris, London or Sao Paolo -- that is, arriving in a global city that is vitally a part of the globalized economy.

And while some in academic and policy circles are still debating whether the world of the 21st century is one where all nation states would democratize or one where people would align themselves along civilizational lines and subsequently engage in a "clash of civilizations," what is clear is that the world has already decided to live by another system that is neither ideological nor cultural. In the world of the 21st century, capitalism serves, not only as an economic system, but a new shared "global civilization," with its language, principles and practices embraced universally.

In addition to lifting millions of people out of poverty into the middle class across the world and enabling global corporations to post record profits worldwide, global capitalism has had the added bonus of also making the world a more stable and peaceful place. Indeed, despite the highly visible wars in Afghanistan and Iraq in the last decade, the number of countries experiencing some form of major political violence -- which had increased continuously through the Cold War period from 1946 until 1992 when the Soviet Union collapsed -- declined progressively, dropping from a peak of about 30 percent of all countries in 1992 to only 13 percent of all countries in 2010. An integrated global economy certainly makes nation states more disinclined to wage war against one another given that it would prove ruinous for all.

In an era of greater peace, however, a new brand of conflict is emerging in a world with an integrated economy, that is, the competition between nation states for the acquisition of all types of resource assets across the planet -- from oil fields to natural

gas reserves, mines and even biomass. Time was when only Western firms gained control of foreign energy and other resource assets. Today, Brazil, Russia, India and especially China have been scouring the planet to lock down resource supplies to sustain their burgeoning economies. With China overtaking the U.S. as the world's largest energy user in 2010, and with China projected to be the world's top oil consumer by 2027, China has aggressively been securing foreign resource reserves in Central Asia, Africa, the Middle East and Latin America. In 2009 and 2010, two Chinese state-controlled banks, the China Development Bank and the China Export Import Bank, provided loans totaling at least \$110 billion to governments and firms in developing countries to facilitate the supply of raw materials or land for China's economy -- an amount that exceeded the total loans issued by the World Bank to developing countries in the same time period. Meanwhile, Saudi Arabia recently announced that it had sold more oil to China in 2011 than to the United States, which had previously been its largest customer.

But perhaps nowhere is the competition for resources more emblematic of the current globalized economy than at the top of the world where, as a result of a warmer atmosphere, the polar ice cap is shrinking and the permafrost layer is receding, providing opportunity for access and exploitation for the first time in millennia of the region's abundant resources -- including up to 90 billion barrels of undiscovered but recoverable oil, up to about one-third of the world's natural gas, plus a wide array of minerals. Not surprisingly, the Arctic countries of the United States, Russia, Canada, Norway, Denmark, Iceland, Sweden and Finland are fiercely contesting which countries have the right to which polar territories to access the riches of the Arctic. In 2007 a Russian expedition planted a flag at the bottom of the polar sea floor, 14,000 feet below the surface, staking its claim on a contested portion of the Arctic. Subsequently, the United States and other Arctic nations have begun rebuilding their military presence in the region.

Collectively, we humans on the planet currently use about 50 billion tonnes of resources per year which, without restrictions, could jump up to 140 billion tonnes per year by 2050. This would be equivalent to collectively consuming resources by 2050 of a total weight roughly equal to that of Mount Everest! How we produce or manage and use our resources -- food, water, energy, fuels, minerals -- constitutes the biggest challenge of the globalized world of the 21st century. This also happens to be the biggest engineering challenge of the 21st century.

**8. Universities Without Walls.** Especially in a global economy that consumes an alarmingly prodigious amount of natural resources, knowledge remains the most precious resource on the planet. And while the economic ascent of nations has always been historically founded on the creation of knowledge and the subsequent translation of knowledge into value, this fact has never been more manifestly clear and more urgently desired and

coveted than it is in today's competitive and interconnected global economy. Thus, as the walls between countries fall as demanded by globalization, so do the walls of the world's preeminent centers of knowledge -- the world's universities.

While universities in Medieval times were hermetically cloistered ivory towers whose main purpose was the preservation and conservation of knowledge from antiquity, today's universities are by design without walls and, through public and private partnerships globally, create abundant new knowledge that becomes fuel to the fire of the economic dynamos of nations.

Each time I have the opportunity to visit universities in other parts of the world, I never cease feeling grateful for the prized privilege of gaining a front seat for seeing our shared and diverse planetray challenges -- food security; water, energy and environmental sustainability; public health; poverty eradication; cross-cultural and religious understanding; diplomacy, etc. -- and seeing for myself an entire panoply of knowledge pieces that are being creatively put together to design solutions to such challenges.

Universities which have a global reach, not only have the privilege of engaging in the joint search for solutions for shared global challenges, but also have the best hope today of bringing home the best solutions to their local and national problems.

### **The Places We Go**

Travel takes us to geographical places and at times also takes us to places of understanding. Albert Einstein once wrote that the human mind "always has tried to form for itself a . . . synoptic (or broad-view) image of the surrounding world." Since ancient times people have been traveling with this hope of arriving at a place where the natural, the philosophical, the artistic and even the religious merge, affording them with that longed-for harmonious, synoptic view of the world. We all share that innate human desire to go farther to take a chance at arriving at such a place.

During my travels in the past decade, I harbored the hope of visiting such a place of synoptic understanding, though my hope admittedly was fairly modest. My only goal was to gain a broad-view understanding on a personal level of the most consequential trends and developments that would significantly impact our interconnected world this century.

To travel the world during the first decade of the 21st century was to see the common rise of nations transpiring across the

globe despite numerous present and future obstacles. Obstacles such as political and military threats between nations would be easy enough to identify and -- through global cooperation and diplomatic hard work, made perhaps easier by the reality of a shared global economy -- could be surmounted through agreements and compromises. A disquieting obstacle that is posing a clear and present danger to all nations today, however, is the fast-increasing and unsustainable global use and consumption of the planet's resources. With everyone on the planet heading toward emulating the Western ways of living and consumption, one estimate shows that if everyone on the planet today lived like the typical American, we would need the equivalent of 5.4 Earths to sustain our needs. Rephrasing the biggest engineering challenge of the 21st century, how do we seek worldwide economic growth and development without relying on the increased exploitation of the Earth's resources?

During the first wave of globalization in the 16th century when people were literally circling the globe for the first time, conquering other peoples and plundering their resources, a small group of native tribes in North America were at the same time quietly sowing the seeds of resource sustainability. The Iroquois, architects of the Seven Generation Sustainability enshrined in *The Great Law of the Iroquois*, practiced an ecological concept that requires thinking seven generations ahead to ensure that the decisions made today would benefit their descendants seven generations into the future.

During this second and present wave of globalization in the 21st century, there is a global imperative to redesign the very foundation of globalization if our shared economic civilization in this globally integrated world is to last -- demanding a complete disavowal of the principle of resource plunder and accelerating the universal embrace of the practice of resource sustainability.

Mark Twain, with insights he had gained through his travels, offered that "travel is fatal to prejudice, bigotry and narrow-mindedness." Through my travels in the past decade, it is my ardent hope that, by the middle of the century and certainly by the end of this millennium, we all in the engineering professions can offer, not only that Engineering is fatal to resource depletion, wastage and reckless misuse, but more so that, indeed -- Engineering is fatal to hunger, poverty and unsustainable development. \*\*\*

*Joel L. Cuello is a Professor of Biosystems Engineering at The University of Arizona. [cuelloj@email.arizona.edu](mailto:cuelloj@email.arizona.edu)*