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Urban Development and Water Infrastructure: Modifying Our Institutional DNA

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I am very honored to have been asked to deliver the keynote at tonight's dinner. It is a privilege to address a distinguished group of representatives from the academic community; and it's especially gratifying to have Dr. Patel joining us this evening. Thank you so much for hosting us this evening, and thank you even more for your visionary commitment to sustainable development, particularly in developing countries. Personally, I am motivated by your vision of the Patel College as a "DO Tank – Not a THINK Tank."

Redefining Relationships

You are an especially influential audience, when it comes to the simple message I want to leave you with tonight. We have an urgent need to redefine the relationships among those of us in the water industry and those of us who are the thought-leaders and drivers in the broader sphere of urban planning and development. We may all agree that because water is so central to the health, wellbeing, and sustainability of urban populations and their economies, the ways in which we manage it must be a primary consideration in urbanization and land-use planning. And yet, this is rarely the case.

We have an urgent need to redefine the relationship between water professionals and urban development if we are going to be successful in achieving sustainable urban growth.

Often our role as water planners and civil engineers is explicitly subordinated to the demands created by land-use, urban planning, and city design decisions. Like plumbers, we're called upon to provide a reliable supply of potable water, take it away once it's been used, keep property dry, and protect it from flooding. And the way we do it hasn't changed much in the last 150 years. I will tell you that the propagation of this time-honored approach cannot keep up with the current pace of global urbanization. If you believe the industry's self-assessment of our U.S. water infrastructure, we aren't keeping up with the repair and replacement needs of the systems we already have.

Reinvention within the Water Sector

I came to the Patel College following a 37-year career at one of the world's largest and most successful civil engineering companies. When I stepped down as Executive Vice President earlier this year the firm's total revenue or turnover was about $1.2 billion US dollars. I was smack in the middle of a complex institutional process that generally delivers water infrastructure designed according to 19th and early 20th century templates of what should be done and how it should function.

Within the water industry we are going through a complete rethinking of the purpose and function of the infrastructure we create.

And if you asked "why?" – I would tell you that's what you expect us to do. It's built into the standards of professional practice, local ordinances and building codes, augmented by state and federal regulatory requirements that all together make it difficult to do anything else.

It's worth taking a moment to reflect on how we got here. You can tell the story in four chapters leading to the present.[1]

Chapter one begins before the Common Era with the opportunistic use of easily accessed surface water and shallow groundwater. Streets were used as the primary means for directing stormwater flows that periodically swept away of every kind of human, animal, and vegetable waste imaginable. This situation persisted in many cities well into the seventeenth and eighteenth centuries, and can still be found as the norm in many developing countries, particularly in informal settlements – life-threatening water quality, haphazard drainage, regular flooding, and no sanitation.

Chapter two introduces the engineered construction of water storage facilities, aqueducts, and drainage facilities – all of which were well-developed technologies in Roman times and earlier – reflecting the ingenuity to build linear conveyance able to divert and transfer water from pristine sources of supply to local cisterns for storage.

Chapter three tells the story of the degradation of water quality and its public health consequences resulting from the growth of industrial cities in the nineteenth and twentieth centuries. We added water treatment and disinfection both at the source of potable supplies and at the point of disposal to receiving waters, dramatically improving human health, water quality, and the natural habitat of fish and wildlife.

By chapter four, which is still in progress, our attention shifts to reducing and controlling the pollutants from stormwater runoff, which can affect water bodies from sources that arrive either through pipes or flow directly into rivers and streams — adding additional

[1] (Novotny, Ahern and Brown 2010)

pollution abatement measures to the end-of-pipe, command and control, fast-conveyance systems approach that has evolved over four thousand years.

So, over time, we have successfully designed urban water systems that keep land relatively dry and provide a reliable supply of potable water for human and commercial needs. And then, as a matter of convenience, we use potable water as a means of carrying away human and industrial wastes for subsequent treatment and disposal. For the last hundred years, these systems have always been integrated into the built environment of buildings and streets – relying on properly designed streets as one of the means of providing adequate drainage.

Our approaches to water management have traditionally looked at water as either an abundant resource to be utilized for potable, commercial, and waste disposal purposes, or a nuisance and threat to be protected against.

Centuries of engineered systems have been designed to move water rapidly from where it is to where it's needed, and from where it's not wanted to someplace else – a linear, rapid conveyance, piped process that attaches no real value to the resource and as a business model recovers its fixed and variable costs by charging customers based on how much they use, not how much they conserve.

But today, at the Patel College we are helping to write a fifth chapter – a fundamental rethinking regarding the purpose and functions that we expect our water utilities to perform.

Why the radical change after so many accomplishments and public health successes resulting from this thousand year-old narrative? The answer is it cannot keep up with the world's exponential population growth, the concentration of that growth in cities, and the exhaustion of readily available fresh water that can be abstracted from its sources without threatening the collapse of natural ecosystems. It has many shortcomings:

- It can reach hundreds of kilometers to import water to the city – assuming withdrawals of increasing magnitude will not damage the ecosystems from which they are taken.

- Because of these distances, it consumes large amounts of capital in its construction and large amounts of energy in lifting water over the terrain it crosses.

- It requires large amounts of storage behind dams in order to balance the availability of the water and the timing of demands.

- Once built, it is difficult to increase its capacity when population demands exceed available supplies – the marginal cost of additional supply is enormous.

- It is highly vulnerable to both drought and flooding that can occur in the regions from which water is abstracted.

- It uses potable water as the means of carriage for the human and industrial wastes it exports back to downstream receiving waters or the sea.

- It inevitably competes for and wins the water that would have gone to agriculture and food production.

- It treats all water to potable drinking water standards at massive centralized facilities – in spite of the fact that most water used in cities is not consumed by people.

- It wastes to receiving waters a source of supply (used water) that we now have the technology to treat at any scale, to any quality needed.

- It consumes additional energy in the treatment and recovery of the nutrients and resources flushed into the sanitation system; and finally

- These highly expensive single-purpose systems are an "all-or-nothing" proposition. Both the water distribution network and sewer network either reach you or **do not**. And in many developing countries, they do not – nada.

And so it is that our belief that this age-old approach, with all its obvious flaws, is the only acceptable way of delivering water and sanitation dooms millions in the developing world to life in cities where their basic human needs will never be met.

Incorporation of Natural Systems and Functional Landscape

The next chapter in urban water management, being written here at the Patel College and elsewhere, adopts a radically different, holistic systems approach to the urban watershed. Striving to eliminate the focus on isolated linear components, it aspires to manage all of the elements of water supply, stormwater, and wastewater as an integrated closed loop – one water; and it aspires to address urban water needs at every scale and in every setting.

The approach we are evolving towards involves closed-loop systems and a holistic view of water in urban watersheds.

To accomplish this goal we need an urban landscape that can effectively mimic the processes and structures present in predevelopment natural systems. That relies on the reduction of impervious surfaces, increased infiltration, surface storage and use of plants that retain water,

interconnected green spaces, and storage-oriented drainage with **less** reliance on underground conduits and **more** surface retention, infiltration and flow retardation.

In addition, closing the water loop will benefit from the decentralization of components of the urban water cycle in contrast to the current highly centralized regional systems I have described. Decentralized systems are a fundamental element of urban sustainability – at every scale. The case for this seems highly intuitive to me. If we are going to recycle and reuse water to meet our supply needs, and energy isn't free, then the closer the treatment of used water is to the point of reuse the better.

And we can do all of this because we now have the treatment technologies, green infrastructure designs, and smart sensors and monitoring to make it all happen in an efficient and cost-effective way.

But achieving this vision requires a more fully integrated approach to management of water and land than we have today. Instead of a system that assumes the pre-existing availability of water, sanitation, and drainage to individual parcels for land in cities, we must design an urban landscape that utilizes integrated systems of plumbing and land use to reduce the need for more pipes, pumps, and treatment plants, as well as the imported water to fill them.

The changes that must occur are both physical – in terms of what our systems are intended to do; and institutional – in terms of who manages them, how they are paid for, and how the enabling governance reflected in ordinances, codes and regulations influence their development.

No Longer Just Hooking Up the Pipes

So while we are undertaking a complete overhaul of planning and engineering within the sphere of water management, we must simultaneously reach out to the land use planners, urban designers, architects, and building systems engineers to help us integrate water back into the urban setting, employing ecosystem services and functional landscape to help us do the job.

This cannot be accomplished without collaboration that is fundamentally different from our current working relationships

We cannot do that on our own, and to the extent that we rely solely on architects to do the job for us with new technologies at the building scale, we will no doubt miss the real gains of integrating our activities at a higher level and larger spatial realm.

As those of us in the world of water management rethink what we are trying to accomplish, we must establish a new partnership with the visionary, creative forces of architects and urban designers who have traditionally built upon an existing framework of horizontal infrastructure without much interaction with the planners and civil engineers who designed it.

Aqueducts, large interceptor sewers, and covered drainage canals are the engineering typologies of the past. And the patterns of the future need to go beyond high-performance stand-alone buildings and developments that aspire to be off-the-grid, while resting on top of deteriorating 19th century infrastructure that is not maintained and increasingly starved for revenues.

We can do better than this. We should avoid the competition that potentially results from a growing desire among the affluent to be free of the grid – using new technologies to create isolated enclaves within a collapsing urban framework that doesn't reach many residents of today's developing urban areas. The solutions we are striving for at the Patel College should reach the entire urban community and do so quickly.

Finally, there is a need for all of us who shape the form and functions of cities to engage with the political and stakeholder institutions that enforce compliance with requirements and standards established to solve yesterday's pressing problems of public health and safety.

Cannot Become Part of Urban DNA without Broad Policy Changes

The successful reimagining of how the water cycle is introduced into tomorrow's urban environment offers huge potential gains in the provision of water and sanitation to rapidly growing cities in the developing world, but it will require altering the DNA of how we currently manage water and develop water infrastructure in an urban setting.

To really accomplish change we must translate the results of our joint efforts into new policies, codes, and standards.

As I have suggested we are very much locked into the infrastructure forms that have been successfully propagated through codes and ordinances.

There are many good reasons for the intractable standards of performance and care that go into producing this infrastructure. Public health and public safety are at the top of the list. The success of our Progressive era forbearers in building in safeguards, codes, and ordinances that prevented creative shortcuts that might lead to loss of life and property must be honored. They erected a bureaucratic system for replicating the underlying networks that are the platform on which raw land is turned into cities.

That bureaucracy and its associated regulations must be reimagined as well. In fact, recent progress in places like New York City would suggest that we are being successful updating the building codes associated with vertical construction. We've made much less progress when it comes to the codes and ordinances associated with horizontal infrastructure. Both can be done however.

New Models as the Basis of Developing Future Infrastructure

As I have moved outward from what's happening within the small circle of water management, to the primary drivers of urban design and development, and finally to the wide arena of public policy and governance in cities, I hope it is obvious how the Habitat Partnership University Initiative can contribute to this on-going transformation of our built and natural environments.

This is the type of ambitious undertaking a partnership like ours should embark upon.

This multi-disciplinary, multi-university partnership has the opportunity to help develop transitional strategies that go beyond technological breakthroughs to explore the governmental and institutional enablers needed to radically reshape the overall urban landscape. Processes to ensure that 21st century buildings are built on a platform of 21st century infrastructure – rather than the 19th century templates we currently employ.

Once we, in the realm of horizontal infrastructure, transition from independent, single-purpose centralized systems to a hybrid approach that relies on multi-purpose, smaller-scale distributed technologies sown into a green urban landscape -- we open up the potential for more entrepreneurial solutions at the local level, more rapid and responsive deployment of services, and the ability to reduce risk incrementally at a faster pace, leaving populations in the developed and more importantly the developing world less vulnerable to the hazards of water borne disease, food shortages, and the predictable and unforeseen consequences of climate change and extreme events.

Works Cited

Novotny, Vladimir, Jack Ahern, and Paul Brown. *Water Centric Sustainable Communities: Planning, Retrofitting, and Building the Next Urban Environment.* Hoboken, New Jersey: John Wiley & Sons, Inc., 2010.