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What we need today is a new pump handle. Let me explain.

Victorian physician Dr. John Snow of London has affected all of us today -- both as we use water and as we contemplate the future use of water.

150 years ago, 500 people died of cholera in just ten days in one London neighborhood, marking the beginning of another dreaded epidemic. Dr. Snow had already written a controversial pamphlet suggesting that cholera was not caused by "vapors," but was instead a disease of the "gut," spread by contaminated water.

With the high number of deaths in this neighborhood, he studied the cases and was convinced that a pump at the intersection of Broad and Cambridge Streets was the sole source of contaminated water. In an emotional public meeting,

he suggested removing the pump handle so no more water could be drawn from that location.

The rest is history. The handle was removed, cholera abated, and huge engineering projects were launched for sanitation systems and clean water across Europe.

Dr. Snow's pump handle affected all of us. It led to improvements in the areas of sanitation and purification. Huge projects led to success. But today complacency about water quality and availability has resulted in a lack of progress.

Snow's pump handle has certainly come to symbolize innovation in a time of crisis. It represents a moment of awareness and transition that improved many things; most importantly lowering infant mortality rates and increasing life spans.

So strong is Snow's influence even today, that Dr. Andrew Hayward, a professor at the University of Nottingham, begins his lecture to medical students with this slide:

- Did you come into medicine to save lives?

- If the answer is yes -- perhaps you should give up medical school and take a course in water engineering.

Well, we are not medical students, and only some of us are water engineers, so what do we need to do to improve our global water situation?

Today, I am going to suggest that we look for the next "pump handle" innovation, while reminding ourselves that successful as we have been, we must move forward. Just as the pump handle represented a moment of historic enlightenment in understanding the environmental importance of clean water, so we are again at a defining moment. We are required to understand and take action on three very real global threats:

1. Scarcity of inadequate supply
2. Sanitation and environmental issues, and
3. the Efficient use of energy.

Let's look first at conditions for innovation so we can build on Snow's success and to lead us through this time of transition.

What are the conditions essential for innovation to meet the challenges of our Water Century? There are five:

We must be

I. Time Travelers

We must have:

II. Global Vision, Global Links

III. Will Power, and

IV. Brain Power

Finally we must make a decision to have

V. Proactive instead of Crisis Innovation

Time Travelers

Let's begin our look at the conditions for innovation. **First** we need to be **Time Travelers**, looking backwards to help see our path forward.

Sanitation

On the issue of sanitation, if we look back to our efforts to eradicate disease and health risks in the world, yes, we have wiped out smallpox, but 90% of the diseases of the world are still water related. Four out of every five deaths are the result of water-related disease. This means that approximately 6 million people die every year because of contaminated water.

Despite the engineering marvels that have delivered clean water, many developed nations today face problems of purity. Many of the water delivery systems are fragile and aging. Contamination is increasing in many “modern” countries. The trend is clear, but rarely commented on, that even citizens of the most developed nations now carry water in bottles, and have home purifiers and residential delivery services simply because they can’t trust municipal supplies. And we continue to identify more pathogens and contaminants to be addressed as we raise the standards of what is considered safe pure water.

Scarcity

If we travel back to 1950 we see there were only two cities larger than 8 million people.

Today there are 23 cities larger than 10 million – 18 of these are in the developing world.

By 2030, just 25 years from now, the urban population will be two times that of the rural areas, representing an amazing 160% urban growth! Many of these cities are in areas of major water shortages. Many do not have the resources to deliver and purify the water they do have.

Three hundred million people now live in areas of serious to severe shortages. In 25 years that number will be 3 billion people in areas of shortage. BUT, the amount of available fresh water will remain constant: One percent.

This map of the world shows that no area is free of the problem of scarcity and the stress it inevitably creates. A major problem is that most of our fellow citizens are unaware of this alarming picture. That is why we must also be educators to inform people of the enormous water challenges.

Many countries depend on others for the inflow of their water. Look at this chart which shows Egypt, the Netherlands, Cambodia, Syria, Sudan, and Iraq. All get more than half of their renewable water from neighbors. Note also how quickly populations will double in these areas with a shortage of fresh water. With increasing population density and no increases in available water, is there any question that we must think of water the way we once thought of oil? -- A fluid which will define this century -- for good or ill, for peace or war.

There is, however, no need to hypothesize about the future to be reminded about the gravity, the implications, and the results of our water problem. Let's look at the recent cholera epidemic in South America in the early 1990s.

The cholera epidemic resulted in 11,000 dead, a million or more sick, and an economic impact beyond calculation.

And lest we think that such things don't affect us, for example, in the United States, let's look back to the 1993 Cryptosporidiosis contamination in Milwaukee.

This water contamination cost 58 deaths and 96 million dollars. Contaminated water is not just a problem in developing countries. It is a global problem.

Clearly then, the past and the future must be our province, or "today" will be out of our control.

Global Vision, Global Links

The **Second** condition for innovation is Global Vision to recognize the Global Links of all peoples and all problems. We must be able to look at our globe and recognize it is not a traditional "local" issue. All local issues have become global.

For example, there was a day when many in the US thought that drugs were a problem of the poor, and of the so-called "marginal" in society. Needless to say, the problem is now a problem for us all. There was a day when some nations thought AIDS would never affect them. The world now faces a pervasive AIDS crisis. Just as local supply chain productivity is affecting global economies, the interdependencies of water related issues have become one global issue.

For a long time, water was not a priority for most developed economies. It seemed readily available and endless in supply. Shortages and sanitation are now problems for us all, developed and developing.

Global Vision/Global Links: Scarcity

Let's first look at Scarcity and the world. The availability and distribution of water is a major problem for many in the world. For example, agriculture uses 70% of the world's water. Whether California, Texas, or the Sudan, irrigation is very frequently inefficient and wasteful. Often cities just a few hundred miles away from farms struggle with shortages and high prices while poor farming practices and subsidies result in wasted water.

If we look at manufacturing, the picture is also discouraging. The world manufacturing systems are largely open, meaning water is drawn in for production and then discarded at the end of the process. More often than not, we are discarding a valuable renewable resource.

In both developed and developing countries, it is not uncommon for communities to be unable to account for over 40% of their water. This may be the result of leaking, aged systems, or corruption. Whatever the case, we are all the losers.

Global Vision/Global Links: Sanitation

If we look at economic costs, they are enormous. India, for example, lost 73 million working days in the 1980s because of water illnesses, costing the economy \$600M. In human costs internationally, one child dies every 8 seconds from water-borne disease! Whether India or Milwaukee, the human and economic costs are staggering. Imagine if we could really focus the general public's attention around this dramatic and increasing loss of human life.

Global Vision/Global Links: Energy and Water

The purification and movement of water depends on energy. Whether a generator in a rural village, or a mega city of 20 million, energy is inextricably tied to clean, available water. Energy is expensive no matter what part of the world, and it is increasingly scarce. ***The Electric Power Research Institute*** estimates that by 2050 the world will need 7000 GW additional electrical generation for clean water. Today's total available is 3000 GW. We may well ask: do we have the resources to deliver that power? Probably not. This is clearly not a path we can take. It is a mandate which dictates the application of innovation in efficiency and technology.

What can we do to meet the energy needs of the future or to find new ways to purify and deliver water?

Thus, our **Global Vision and Global Links** should make clear to us there is no longer such a thing as "someone else's problem." It is now our problem. Remember, those who noted that oil was the fluid of development and contention of the 20th Century, now believe that water is the fluid of development and contention of the 21st Century.

Will Power

The **Third** condition for innovation is **Will Power**. It is not enough that the people in this room recognize the enormous threats posed by water scarcity, sanitation, and energy use. We must have the steady will to help others realize the many issues, dangers, and, opportunities.

There are difficult and complex issues that the public at large must understand. We must have the will power not to waver in introducing and addressing complex and controversial issues.

First, Water and Market Pricing

Despite remarkable advances, there is still little public understanding of the risks of the status quo. In most countries and communities, water has not been offered at "market value." It has been subsidized by various governments so that the true cost of water is rarely clear. We must have the will power to consider offering water at market value and of offering water through private/public partnerships.

There must be a connection between the cost of producing a good and what people pay for it. Without that connection, waste and inefficiency result. It is our responsibility to increase the awareness that if people undervalue water they are far more likely to waste it.

Even the so-called "free" water of rural villages carried from distant wells is far from free. Hours of labor to carry water is hardly water without price. Add to the labor, the inefficiencies which discourage fair distribution to the elderly and ill, never mind the problems of cleanliness. The poor often pay dearly for water that is free in name only. And the cost of the water in the bottles we carry around? It is 6 to 10 times the price of gasoline – a commodity that we hear so much about.

Developed or developing countries, the true costs of water must be realized if conservation, efficiencies of use, and technological innovation are to follow.

Second, Manufacturing and Agriculture

Quite simply, if these two sectors can improve the use of water, there will be more water for others. World-wide, manufacturing wastes water and consumes large amounts of water by pollution. Agriculture uses 70 percent of the world's water. We must have the will power to look at the waste in these two areas and initiate improvements.

A look at these charts says it all.

The manufacture of a complete car requires 39,000 gallons of water. One barrel of crude oil takes 1,800 gallons, a ton of steel 62,000 gallons, and just one semi-conductor takes 3,000 gallons. Don't even think how much water it took to make the chips in all of the cell phones in this room today!!

A pound of bread or a pound of rice? Each one takes one ton of water.

We need the will power to face difficult issues. What sense does it make that farmers in the Imperial Valley of California pay \$15.50 an acre foot while residential water in Southern California costs \$431 an acre foot?

Third, Different "Markets," Different Methods, Different Players

Let me be candid here. There are not yet answers to all the questions I'm asking and issues I'm raising. Certainly financing water projects, bringing in new partners, different cultures, and different politics all affect the issues before us. However, we must have the will power to acknowledge that not everything is clear and easy if only we had the money.

We must recognize, for example, that there are different markets for financing and achieving sanitation. That means that in cities like Paris or Milwaukee, sources of funding and existing infrastructure are quite different than in Belgrade or Mexico City. The same is true in developing areas: the needs and solutions in an African village will be different from an Indian village. Recognition of these differences does not mean the answers are clear. But they are important starting points.

We can't turn away from the water issues of the world because some countries or municipalities can't "write the check." Yet we do need funds for the system. How do we proceed?

We need the **Will Power** to investigate new players and new financing. For example, what do we need to consider about village water delivery vs. urban: What are the different needs? How must delivery differ? How can we achieve results?

Or what about NGOs, Governments, and Private Industry? How can they work in concert rather than independently with wasteful redundancy? We must consider new relationships, new opportunities. That is the power of the people in this room. You have done much and know there is much to do. Through new commitments for partnerships will come new solutions.

We must have the **Will Power** to consistently educate our publics about the many issues of scarcity, sanitation, and energy. This education, particularly to raise awareness in our youth, is essential for us to succeed in planning our water future.

There is no national water policy for the US, nor is there a Department of Water. There is no single place in the US Government to get a comprehensive view of water policy and issues. There is no consortium of businesses addressing water needs and opportunities.

Water must become a policy priority. It is time for a national and international expansion of commitment to the water century which provides clean, safe water, appropriately managed and conserved for the good of all.

Our US Congress is an appropriate starting place. Lawmakers should review local and national policies in preparation for a national policy, should consider ways to increase revolving funds as sound “water improvement loans,” and finally must find ways to make policy *and* practice part of an integrated whole.

Local politicians, city planners, farmers, agri-businesses, manufacturers, and citizens must be equally involved in water planning and decision making. We all must be involved in local, state, and national forums as we make decisions that

transcend community and country. Only then can we meet the challenges of our Water Century.

Brain Power

The **Fourth** condition for innovation is **Brain Power**. I mean new ways to solve problems of scarcity, sanitation, and energy -- some are the leading edge technologies, others are changes in scale and approach.

First we'll look at some breakthrough technologies appropriate for the **Developed Economies** of the world as they deal with scarcity of water, from improved irrigation methods to recycling.

Developed Economies: Scarcity

Ambrose Bierce described our oceans as "A body of water occupying about two-thirds of a world made for man, who has no gills." Gills or not, there is no doubt that **desalination** is a large part of the future for developed economies. Florida, Massachusetts, and several Middle Eastern countries are all participants in the desalination movement.

Reverse osmosis and new technologies no longer so dependent on energy have resulted in steadily decreasing costs for water.

If you look at the costs from 1991 to 2003, the savings are dramatic: from \$6.00 per 1000 gallons in Santa Barbara to \$1.50 in Singapore. Kuwait will soon be producing 30 million gallons a day of fresh water with our ITT technology at yet even more cost efficient levels.

Industrial **re-cycling** of water is another area which dramatically alters intake of water and the quality of discharge. A decade ago it was standard procedure for water to be "run through" a manufacturing process just once and then discharged. This was a major cause of pollution and shortage.

Now, more and more companies are looking at self-contained systems where the same water is used, cleaned, and used again.

Note the savings of self-contained systems. Our ITT Defense/Avionics Plant saves 160,000 gallons per day via a totally self-contained system of re-using the water it has, rather than regularly taking in new water and then discarding it.

Using a self contained, zero-intake water system, Israel increased water efficiency in manufacturing three-fold in 13 years. The \$100 worth of goods that required 20 cubic meters of water for manufacture in 1962 required only 7.8 cubic meters of water by 1975. This efficiency has been so successful in cutting costs and creating a better environment that Israel has a national policy requiring total waste water reuse.

What about **Developing Countries and Scarcity?**

Developing Economies: Scarcity

If we can lower agriculture's use of water, we will greatly alleviate water shortages in many areas. Poor irrigation techniques are a major culprit.

For example, drip irrigation systems are better than broadcast systems both to conserve water and to prevent saline soil.

Lining irrigation channels with water-impervious liners prevents seepage and loss. Recycling waste water for agriculture results in greater supply, thus providing more crops.

Delivery too can be accomplished with awareness of scale.

Although Jamaica was the site of the very first water system in the “New World,” 30,000 people in Withorn and Darliston were without water. All water had to be trucked in at great expense disrupting planning and daily activities. Now, for the first time, these communities have received clean, potable, running water. By means of energy-efficient phased pumping, and low-maintenance smaller plants with fewer personnel, these 30,000 people now have clean water without the inefficiencies and inevitable limitations of truck delivery.

Scale is very important as we consider the problems before us.

Brain Power must not be saved for mega projects only.

Projects smaller than the 30,000 people of Jamaica are important first steps, plus they are important incremental steps to better water. For example, ITT donated one pump to the Malawi Children’s’ Village in East Africa. Just one pump became the difference between life and death for several hundred orphans. Additionally, this availability of fresh water

has been a catalyst for accelerating local economic development.

Sanitation, of course, is a major issue if we are to affect infant mortality, life span, and productivity in both developed and developing countries.

Developed Economies: Sanitation

Sanitation options are also multiplying because of technology and awareness. For example, UV and ozone disinfecting alternatives are growing at greater than 10% a year.

Ultraviolet irradiation, for example, is low in cost, in operation & maintenance, in required contact time, and is environmentally safe.

If we look at this chart comparing chlorine treatment to UV treatment, we quickly realize that UV is the stronger option across the board whether considering cost or pathogen inactivation.

In **Developing Countries** there are new options as well.

Developing Economies: Sanitation

Portable ST1 water treatment units are capable of treating more than 1800 gallons of water every hour. The units are diesel powered – enabling them to operate in the many areas that are without electricity – and simple to operate and maintain.

These ST1 units are what ITT sent to the tsunami victims to help provide clean water quickly in Sri Lanka. These treatment systems, which are portable and relatively inexpensive, proved the difference between life and death after the devastating tidal wave. An application, which had been developed originally to support our troops in the field, proved to be a remarkable success in this tragedy. No pipes, no infrastructure, just clean water where you need it!

Point of Use products to purify small amounts of water are also an important option. Procter and Gamble, for example, has developed and tested a water-purifying sachet, called **PuR**, which has been enormously successful and cost effective.

This is truly mastering scale by making one family the unit of action and benefit. P&G's product, which was also sent to tsunami victims, does just that by providing 2.5 gallons of clean, safe water within 30 minutes.

Energy may be less obvious at first glance, but the energy required to clean and move water is very significant.

Developed Economies: Energy and Water

It takes a lot of energy to have clean water. Pumping stations typically have had 56 kilowatt pumps which cycled on and off as needed. This is expensive both in maintenance and energy. ITT created a new design which uses one 26 kilowatt pump running constantly, with a larger pump cycling on at peak usage.

The results: 50% less maintenance and 21% less electricity. When you realize that 70% of a pump's total cost over its lifetime is the energy it consumes, you can understand why we are proud of this product. 21% less electricity may not seem significant, but U.S. sewage pumps use 3% of the nation's electricity. The savings are obvious, and they directly affect the ability for more people to have water at reasonable costs.

Developing Economies: Energy and Water

Available energy is always a problem in developing economies. It is difficult for rapidly growing economies like China to meet both industrial needs and those of residential users. For example, northern China recently suffered from a major drought. This resulted in the need to develop new

efficiencies as well as higher pricing for the use of water which ultimately led to a reduction in waste.

It is not uncommon for factories in China to use ten times more water than those in fully developed economies. This is despite the fact that two-thirds of Chinese cities are short of water, 90% of rivers are polluted, and 20% of water in China is lost from leakage. China has begun to exercise the difficult “Will Power” of innovation, including raising the price of water for the first time since 1949 to encourage wiser use of this essential resource.

Impoverished countries have even greater difficulties. One important variable for these countries is the difference between urban users and village users. Sparse populations; dense populations. Distant water carried by pumps or by hand. These variables clearly reflect one of the most difficult challenges, one where innovation can make the difference, as can new players like the NGOs and new understandings of a "market." I have no doubt that NGOs like WaterAid, Water for People, CSIS, and others will be important partners in the future as they have been in the past. As these NGOs affect and influence the media and government, water will move up

as a priority and solutions will quickly follow.

Positive Innovation

The final condition for innovation is to commit to **Proactive Innovation** rather than **Crisis Innovation**. Dr. Snow was a part of crisis innovation. A crisis forced citizens to pay attention to his theory which was formulated years before. Only when faced with disaster, was serious attention given to his ideas leading to improving London's water quality.

Crisis Innovation often forces change at a difficult rate, with many casualties, and with hasty allocation of funds. We do not want a series of droughts, outbreaks of disease, terrorist acts, and water wars to suddenly launch our water policies and actions.

Severe restrictions brought on by drought forced Coca Cola and Pepsi to shut down in India. The losses for workers, citizens, and shareholders, of course, were immense. After the crisis, Coke, by recognizing future water threats, reduced water use by 3% while increasing volume sold by 4%.

We need wide-spread study, analysis, commitment, testing, and application of technologies to lead to innovation. We can't afford to have a global shutdown like the ones faced by Coke and Pepsi.

Only through a consortium of partnerships and new technical and business approaches will we find the new pump handle which symbolically marks our transition to the innovations of the new Century of Water.

These players will be **Time Travelers** who spend their energies understanding the past as they look to the future. They will recognize that innovation now depends on the realization that **Global Vision/Global Links** tell them there are no longer local issues, but rather only global ones. They will have the **Will Power** to commit to public education and development of policies. These include the recognition that there is no such thing as "free" water, and there are new markets, new methods, and new players. They will also recognize the importance of **Brain Power** and new technologies, different ones for different stages of growth. And finally, above all, they will practice **Proactive Innovation** and avoid **Crisis Innovation**.

This is an appropriate point to discuss what my observations mean for ITT and what we think should happen.

Start with that 1% of fresh water which is all that we will EVER have. What must we do? There are 3 suggestions I would like to close with.

1. Our country and its global partners need a policy on water that is at the top of everyone's "to do" list. This will happen through education in conferences like this one and through political involvement. We are committed to enlightened policy to save lives and not only avoid, but end, the on-going water disaster. Senator Frist has made clear that this is an important personal commitment for him, and we at ITT share that commitment.
2. Scarcity, sanitation, and energy challenges can be met only when water is tied to demand and cost. With market pricing comes increased awareness, efficiencies, and public involvement.

3. Technology and innovation will quickly follow when numbers one and two are in place. Then we will be amazed at the results of our Water Century of Water Innovation.

Dr. Snow and his neighbors were fortunate that he could remove the pump handle and change history. We must seek our "pump handle," find our innovations. We must create our own future before it defines us. Francis Bacon said, "Time is the greatest innovator."

Over the vast span of history that is indeed true, but we cannot allow time to be our master for water. If we do, we will share the observation of another writer who said: "Water is a very good servant, but it is a cruel master." --- We must be the masters of our water destiny as we march into the Water Century!

Thank you very much.

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