Hydraulikos: Nature and Technology and the Centre for Cyborg-Environment Interaction (CEI)

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ABSTRACT
Technology has put us out of touch with nature. A goal of the CCEI (the Centre for Nature and Technology) is to invent, research, study, and teach technologies that facilitate connection with our natural world. One project of CCEI is Hydraulikos, the Water Labs, for people to touch and be touched by the most primordial of all media = water. Hydraulikos aims to be a place where science, quantum physics, and fluid mechanics come together with nature, the environment, the arts, culture and society, health, wellness, and innovation, as therapy for the mind and body ... where music meets math, and the compartmentalized silos of academia are washed away with lateral thinking in a setting where the boundary between work and play can also dissolve.

Past projects include “Hands Across the Water” and “Hands Across the Harbour” using WOIP (Water Over Internet Protocol) to connect people through water as an Internet-connected medium that’s at once both broad and deep.

Ontario’s Great Lakes hold 80% of North America’s fresh-water; it has often been said that Ontario is water capital of the world. Thus we need an Ontario-based entity like Hydraulikos that celebrates water at all ontological levels.

Author Keywords
Interactive Art (primary keyword) Input / Interaction; Interface / Experience Design; Hardware (e.g., sensors, actuators, displays); Auditory / Sound Interfaces; Gestural / Perceptual / Vision-based Interfaces; Children / Education; Haptic / Force Feedback; Art / Music

ACM Classification Keywords
H.5.2 Information Interfaces and Presentation

GENERAL TERMS
Measurement, Performance, Design, Experimentation, Human Factors

TO TOUCH AND BE TOUCHED BY WATER
One goal of Hydraulikos is to explore relationships between technology and nature, and in particular to bring people in touch with water, through in(ter)ventions such as hydraulophone, an array of tuned resonant water containers that produce sound by vibrations in liquid (other instruments produce sound by vibrations in solid or gaseous matter).

Recently, we were invited, by the ROM (Royal Ontario Museum), to be part of the Water Exhibit. See Fig 1.

UNIVERSAL MEDIA CONNECT PEOPLE OF ALL AGES
Whereas most waterparks, waterplay features, and splash pads are designed for children, WaterTouch(TM) technology is like multimedia video games in which the water functions like a touch surface or game controller. Thus WaterTouch appeals to children, teenagers, and adults. Moreover, water-based musical instruments evoke a kind of “sophisticated frolic” in which adults and even senior citizens enjoy playing jazz or classical music on a hydraulophone. See Fig 2 (leftmost). Non-musicians also enjoy experimenting with random sounds, regardless of age.

Whereas adults often shy away from standard aquatic play features, they are drawn, like children, to water-based haptic interfaces like the hydraulophone. Presently we are also exploring the use of the gentle soothing touch of hydraulphone to combine water therapy with music therapy, to help with arthritis, and to comfort cancer patients.

WATER CONNECTS PEOPLE OF ALL ABILITIES
Hydraulophones have long history of use as accessible technologies. Unlike air-based instruments, the water instruments produce sound in a medium that is more “feelable” than air. Whereas vibrations in air displace large volumes of air with rather weak force, the vibrations in water are much more forceful, and are therefore much more audible to the deaf, as mechanical vibrations.
Figure 2. Hydraulophone appeals to people of all ages and cultural backgrounds (leftmost). Deaf musician Evelyn Glennie playing hydraulophone (rightmost). Hydraulophones are ideally suited to the deaf for 2 reasons: (1) they produce a high degree of musical content at low and even subsonic frequencies; and (2) the acoustic impedance of water is almost exactly the same as human flesh. Therefore the sound produced by water is much more “feelable” than that produced by or in air. Thus hydraulophone is unique in its ability to reach the deaf.

In fact, the human body is made mostly of water (60%). Moreover, the body has an acoustic impedance of almost exactly that of water. Thus a water instrument makes an ideal “acoustic impedance match” to the human body, and is therefore the ideal medium for a deaf person to play and experience music.

The hydraulophone has a unique property that the sound is at once everywhere and nowhere in particular. The sound of a hydraulophone appears to come from all directions, and carries through the body of the instrument, through the ground, and through the player’s hands and feet, as much as (or sometimes more than) it does through the air or the ears. Deaf musicians therefore greatly enjoy playing it. See Fig 2 (rightmost).

Water is a natural and primordial medium that most people can immediately relate to. It has unique properties that make it understood by persons with special needs. For example, the author helped in the construction of the Outdoor Classroom where one of the author’s musical instrument inventions is being used by the CNIB (Canadian National Institute for the Blind). Because of the multimedia and multi-sensory nature of water, the instrument is being used extensively for teaching music to deaf-blind children.

SPLASH 2011

In order to promote the idea of building the Ontario Water Centre, a water festival was recently organized, by the Ladies of the Lake (Lake Simcoe), and attended by more than 2,000 people, including dignitaries and politicians working on water policy. The main event was a concert, situated on a stage built in Lake Simcoe specifically for this event. See Fig 3. The event included the inaugural performance on what might have been the world’s largest musical instrument, made from the lake itself. The stage supported an array of three-phase water pumps feeding into a lakewide resonant water vibration system.

WOIP: WATER OVER INTERNET PROTOCOL

Various art installations were constructed for SPLASH. An important design goal of these art installations was to facilitate aquatic play (i.e. frolicking in water) by people in formal business attire. For example, the Prime Minister, Premier, and Mayor, among other distinguished guests, were invited to the event. Thus the intention was to design a WaterTouch piece that was dramatic and splashful but would not get participants soaking wet.

A piece entitled ARCHITouch was created, in which a garden fountain was used to remotely activate a laminar flow jet to create a parabolic water arch. When participants blocked a very small water jet emerging from a decorative fountain, a massive flow of water was launched from the laminar jet.

Before bringing and setting up ARCHITouch for use by the dignitaries, the piece was field-tested in a wide variety of public settings. See Fig 4.

ARCHITouch allows a person to touch a tiny trickle of water and cause a massive spray to occur elsewhere. The two elements (the “MagicFountain” and Laminar jet output) can be located as far apart as desired. For example, an interface was created to allow “packets of water” to be sent over HTTP as WWW messages. Thus blocking a water jet in one country can spray a water jet in another country.

This piece presented WOIP (Water Over Internet Protocol), i.e. water-as-data, and is captioned and presented as follows:
transmitters and HeadGames, rightmost). The result...

7 difficult to stop at the exit port than further...

...serves as the activator to activate a laminar water jet (center), which forms a natural parabolic water arch (due to gravity). Extremely quick response creates a natural user-interface, e.g. participants have the sense that blocking one water jet redirects the water out of the other water jet. The transmitter and receiver can be located many miles apart, giving rise to other pieces entitled “Hands Across the Water” and “Hands Across the Harbour” in which a WOIP transmitter in Hamilton activates a WOIP receiver in Toronto and vice-versa (rightmost).

ARCHITouch

Try to stop me if you will
I’ll keep on spraying, spraying still.
I am water, still as glass,
so block me, block me, still I pass.  
Steve Mann, 2011

EARLY BATH
A piece entitled “Early Bath” or “Early Bather Advantage” was built from two identical copies of ARCHITouch, i.e. from two transmitters (“MagicFountains”) and two receivers (Laminar Jet Outputs).

A transmitter (Transmitter 1) and receiver (Receiver 1) was setup in one location (Location 1), and another transmitter (Transmitter 2) and receiver (Receiver 2) was set up in Location 2. Transmitter 1 activates Receiver 2, and Transmitter 2 activates Receiver 1, as shown in Fig 5.

Building upon the success of EarlyBath, another interactive multimedia water game was created using two identical water jets, each equipped with a sensor (e.g. listening device) and a capacity for computer control of the strength of the same water spray jet used for sensing. In this way, each jet becomes a water-packet transciever (i.e. both a transmitter and receiver of water data packets). This piece was called “First Mover Advantage”.

HEAD GAMES: LEARNING ON THE “TEACH BEACH”
An important goal of Hydraulikos is education outreach, and fostering DIY (Do-It-Yourself) creativity. A number of weekly “teach-ins” at various beaches were undertaken in the Summer of 2011, for research through improvisation+tinkering.

All of the art pieces described so far are Fluid User Interfaces, i.e. touching water generates multimedia content, either mechanically (e.g. acoustically) or computationally.

“PrimeTime™” and “HeadGames™”, however, are very simple, even primordial art installations using the most primitive of technologies, and doing nothing in response to touching the water, other than allowing the participant to see how quickly they can prime a pump (PrimeTime) or feel the water itself at various quantities of head (HeadGames).

HeadGames teaches concepts of water pressure (head), and water-column, using a bucket hung from 3 pieces of driftwood. See Fig 6.

This allowed participants to experience varying degrees of head, e.g. zero (or 1 inch of head), versus a foot, then a metre or two of head, etc., by running their fingers down the water column and/or adjusting the height of the bucket when fed to a hose.

Many participants were amused and surprised by this installation. For example, most people were surprised at how easy it was to stop the water right at the hole in the bucket. This runs contrary to our everyday experience with city water which comes out of the tap at more than 100 feet of head (and is thus more difficult to stop at the exit port than further from it).

With high-head water supplies that most people are accustomed to, the water feels stronger as you get closer to the opening. But the reverse is true with the bucket, and it was noteworthy that few people had experienced this very simple phenomenon before experiencing HeadGames.

The water opening in the bottom of the bucket was also connected to a hose so that the water in the bucket could be used to supply a hydraulophone (Fig 7, rightmost). The resulting gravity-fed water instrument became an interactive art installation in its own right. Other variations of HeadGames included a waterfall made from a slot in a plastic case with a transparent lid, as shown in Fig 7 rightmost.

FIRST NATIONS AND FORESTRY
In conjunction with the Faculty of Forestry at University of Toronto, we are collaborating with First Nations on projects related to sustainability and the environment. See Fig 8.

A forest concert situates wind instruments (Native Flutes, etc.) high up in the air (in the forest canopy), earth instruments (Native Drums, etc.) down on the ground, and water instruments (hydraulophones) on or in the water, for a series of situated forest concerts that celebrate the Elements (Earth, Water, Air, etc.).
Figure 6. HeadGames, an improvised DIY interactive art installation made from a discarded pickle barrel, scraps of rope, a pulley, and three pieces of driftwood. Participants were invited to feel the difference between zero or low head, near a hole in the bucket, or high head further down as the water fell. A musical water instrument (rightmost picture) was also fed from the bucket. The gravity-fed hydraulophone allowed participants to experience different amounts of head (water pressure), depending on the height of the bucket.

Figure 7. Gravity-fed hydraulophone with counterbalanced water supply bucket (leftmost). Another variation of HeadGames is an interactive waterfall (rightmost). The ruler shows head in inches of water column. Additionally, a video camera inside the box allows a computer system to “see” down into the waterfall and measure the degree of touch, such as to make the waterfall into a multitouch surface. Note the solar panels in the background. All of the exhibits run on solar power or batteries charged by solar power. (Photograph retouched to make numbers on ruler legible.)

Figure 8. Hydraulikos meetings bring together water researchers, policy makers, Forestry, and First Nations from across Ontario to examine the interplay between nature and technology.

Figure 9. Steam-powered research vessel includes a steam calliope. An olympic-sized pool is cleansed with biofiltration (a forest) rather than chlorine, and includes a hydraulophone (water instrument). A hockey rink below deck includes a pagophone (a musical instrument that makes sound from ice) instead of a traditional pipe organ.

FUTURE WORK
The Great Lakes of Ontario hold 80% of North America’s fresh water, and Ontario has been said to be the “water capital of the world”. We aim to celebrate this fact at all levels of art, science, and innovation. Some kind of water epicentre needs to be created. Perhaps it could take the form of a research vessel for doing water research “on the water”. See Fig 9.

CONCLUSION
Various art installations, exhibits, and the like were constructed for teaching and research.

It is hoped that the success of this and other related work will help in the creation of “Hydraulikos, The Water Labs” that brings together art, science, technology (invention and innovation), research, education, and play.

ACKNOWLEDGEMENTS
The author would like to acknowledge the help of Ryan Janzen (science, musical), Mike Zandwyk (drawings, logistics, etc.), and the rest of the research team, as well as the Ladies of the Lake, Larissa Koniuk (H2Orchestra member), Evelyn Glen nie (musician), and Crystal Fountains, as well as numerous participants.