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Toilet innovation and water management – revolutionary steps for a green society and wellbeing

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Abstract:
Water scarcity is one of the most concerning issues for our future. Development and implementation of combined strategies focused on decreasing water pollution and wasteful consumption are vital for mankind survival. Despite efforts have been made in improving the sanitation conditions in developing countries, little attention is paid to the water wasteful system of western flushing toilet - using purified and drinkable water (between 3-7 L every flush). The work herein presented combines anthropological research with design thinking to address this lacuna. Here, we discuss the urgent need for technological innovation and social reorganization within toilet design. Moreover, the taboo topic of toilets and human excrements is presented as an important place for intervention. Innovation within toilet design could/should be a significant game-changer for our self-sufficient and sustainable future. The reduction of water waste, along with human excrements reutilization, would benefit both people and planet, and even be economically profitable.

Key words: Toilet, water, sanitation, sustainability, social taboo.

1. Introduction to real life – water and toilets

The water supplies are dropping all over the world (Frankel 2015) and "the pressures on the world's freshwater reserves are steadily increasing due to population growth, increased demand from consumers and industry, urbanization and changes to

global hydrology system" (Fuad-Luke 2009, p. 63; Fry 2009; UN, 2010). Climate change, drought and over-consumption are placing our fresh water supplies in peril conditions. Thus, the need to implement methods to constraint and decrease water consumption becomes imperative. In fact, "water scarcity already affects every continent. Around 1.2 billion people, or almost one-fifth of the world's population, live in areas of physical scarcity, and 500 million people are approaching this situation" (UN-Water, 2007). The prospects for the future are even more concerning, since it is estimated that by 2025 half of the world's population will be living in water-stressed areas (WHO, 2015).

The same freshwater, once purified and potable, is used to flush our toilets in our daily lives. Today's western flushing toilet system account for nearly thirty percent (30 %) of an average home's indoor consumption, being the biggest amount of potable water used in our households (EPA, n.d.; Waterwise, n.d.; EC DG EV, 2009).

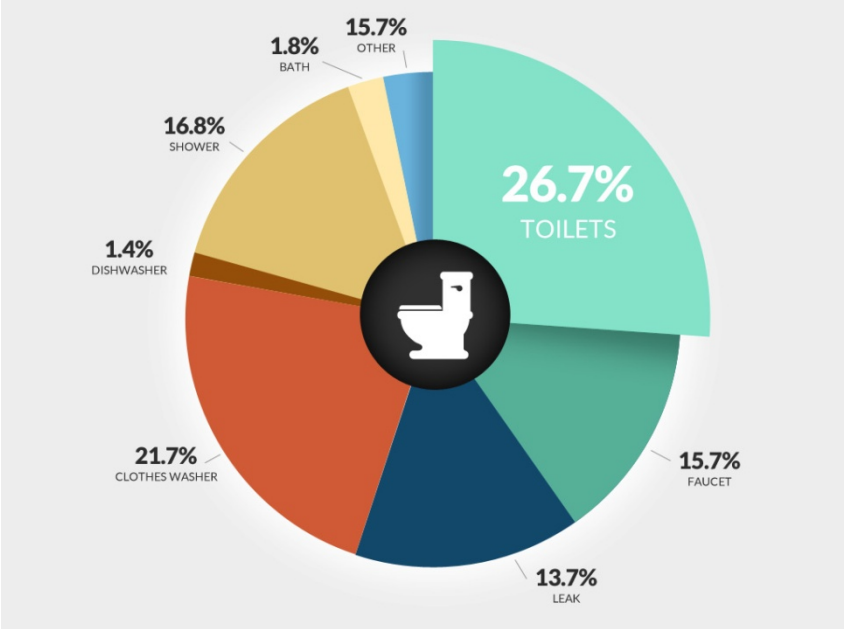

Figure. 1 Average water use in households in America; by Environmental Protection Agency
Source https://www.indiegogo.com/projects/get-a-free-drop-a-brick-through-shock-top#/

Putting facts in context, in a single flush we expend more potable water than other people which lack access to drinking water in the world has to drink and use for cleaning, cooking and hygiene. According to the United Nation, "most of the people categorized as lacking access to clean water use about 5 liters a day-one tenth of the average daily amount used in rich countries to flush toilets - between 4 – 7 L- each flush or more" (UN, 2010). Moreover, "750 million people around the world lack access to safe water" (WHO and UNICEF 2014) and there are still 2.6 billion people who don't have access to sanitation. It

is accounted that “four in ten people have no access to any latrine, toilet, bucket or box” (George, 2014, p. 2) and 1.1 billion people still defecate in the open (p.2). This is causing the spread of infectious diseases, soil contamination and water pollution (UN, 2010). Noteworthy, infectious diarrhea, which is closely linked to poor hygiene and the lack of proper sanitation, is still the cause of death of 2.2 million people per year, most of them children (George, 2014, p. 2; WTO, (n.d.); WHO 2012),
Sanitation and drinking water were declared as human rights in 2010 by the UN, who declared sanitation and drinking water as the 2015 Millennium goal (UN, 2010). It is important to understand how human and nature changes are impacting available resources in order to develop sustainable attitudes and ensure adequate access to freshwater.

This manuscript aims to show how climate change, water scarcity and population overgrowth are impacting the availability of water resources. Additionally, we call the reader attention to re-think our every-day water usage, choosing the flushing toilet as the interventional object. Finally, we present greener and environmentally friendly solutions that can benefit people and planet, and could even bring economical profit as we advocate for interdisciplinary approach in finding the solutions.

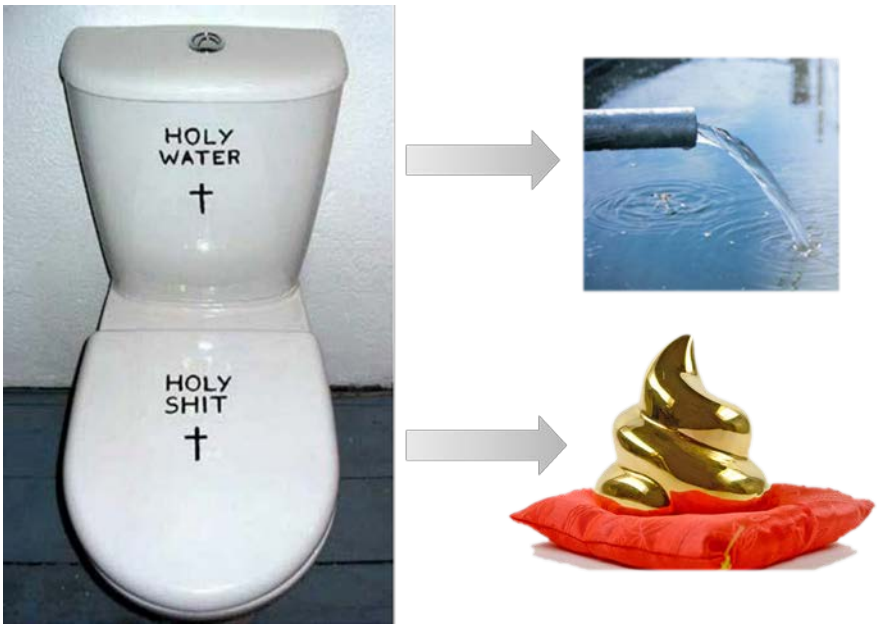

Figure. 2 Objectives of the project presented through artistical installation of artist Michael Radcliffe, Holy Water/Holy Shit, 2006. Acrylic paint on a found object.

2. Western flushing toilet, outdated?

We are living in the time where we are facing "under consumption" of "under – consumers" (Faud-Luke, 2009, p.55-56, 125), which are actually focused on survival and striving to meet basic physiological needs, such as potable water, food and shelter. On the other hand, we are experiencing an increasing unsustainable way of living, with "overconsumption" being more the rule than an exception. In fact, within societies with "over - consumers" (56), 20% of the population is using approximately 83 % of the world's resources (56).

If we take a closer look to the example of toilets, over-consumers are using a precious finite resource of freshwater to flush away their excrements. Meantime, under-consumers even fight wars for their water resources and are exposed to high mortality rates potentiated by water-related diseases (WHO 2012). This contradictory situation is claiming for a social intervention, driven by any technological innovation of the classical toilet that would allow a transition towards a greener and more sustainable society. Toilets represent a hallmark of civilized, developed and modern societies (Sim, 2015; Young, 2010; Korčulanin, 2013). Being one of the biggest game-changer inventions of our History, toilet impacted different aspects of human life, solving health issues, sanitation, and hygiene. Additionally, it made a big impact inside of art, tremendously influencing contemporary art with Marcel Duchamp, ready-made object, urinol – Fountaine (1917) (reviewed in Korčulanin, Barbosa and Ferreira, 2015). Toilet had saved more lives than any other invention until today (WTO, n.d.) and, by the British Medical Journal, represents the biggest medical milestone of the last two hundred years (George, 2014, p.3; Kennedy, 2004; Sournia, 1992).

However, this topic today represent one of the most concerning taboo topics rarely being spoken inside of academic world, public discussion, media or development policies. When the word heap up to toilets it's mostly related to sanitation issues in developing countries, the western flushing system of toilets mostly stays overlooked or excluded from discussion.

Today, in a home in America with older toilets, an average flush uses about 3.6 gallons (13.6 liters), and the daily use is 18.8 gallons (71.2 liters) per person per day. In a home with ultra-low-flow (ULF) toilets, with an average flush volume of 1.6 gallons (6 liters), the daily use is 9.1 gallons (34.4 liters) per person per day (Home Water Works, (n.d.)). The most commonly used residential toilets in the EU are single flush toilets. They are mostly based on 9, 7.5, 6 liters cistern (EC DG ENV, 2009, p.41) and, with the average person flushing five times a day, we use between 30 - 45 L per day of potable water flushed down the pan. Considering the average household flushes 5000 times per year,

they use between 150.000 - 225.000 L (150 - 225 m^3) of potable water per year. This is three times more potable water used into flushing than an individual in central Africa (Democratic Republic of the Congo, Uganda, Angola, Nigeria, Togo, etc.) has for his yearly usage; an average[1] of 50 m^3 (ChartsBin, 2015). Currently, domestic water consumption in the world average is 22 liters per person per day (6 gallons), what's 8030 liters (8, 03 m^3) per year (ENGS-44 Sustainable Design, 2015).

Figure. 3 Child drinking water from the nearest polluted source of water

Source http://www.seathos.org/marine-pollution-and-water-scarcity-wwd-2012/

3. Social and technological lock in

The numbers detailed above make us question why this topic doesn't gain more interest in public and political discussions. Is it social behavioral norms that limit us to give bigger importance to it? Or is it just the lack of profitable vision of toilets that doesn't bring innovation to it?

The basic flushing system, invented by Alexander Cummings in 1775, still retains its original features and is used inside of our toilets today. Apart of some aesthetical and comfort innovations, our toilets remain almost the same for last 130 years (reviewed in Korčulanin, Barbosa and Ferreira 2015). Meantime our mobile phones, computers and technological devices face improvements and upgrades at the speed of light, even though they cannot be classified as primary needs. Papanek called for attention of designers, evidencing that they only spend 10 per cent of their time designing to satisfy "real" needs (Papanek, 1974). His claim is worth to remember today when design is manipulated by marketing, »shapes the form, operation, appearance and perceptions of the material

[1] An average is calculated due to results from year 2002, (ChartsBin, 2015).

world we occupy« (Fry, 2009, p.3). Moreover, it is being mostly reduced to »appearance and 'style'« and a performance (p.6; Baudrillard, 1999). Since toilets are not sexy and desirable lifestyle products promoted in media campaigns, they for sure face bigger challenge to make a success in the market (Kama and Barak-Brandes, 2013). After all they, together with our excrements, are deeply rooted in our perception as a dirty, disgusting, shameful thing (Douglas, 2002) preferably placed in an intimate and private space that we don't speak about.

Anyhow, problems cannot be solved without being confronted. Since we cannot develop solutions without understanding the problem, we firstly need to comprehend the human perception and attitude towards excrements and toilets in time and space. To scrutinize such taboo issue, one should work simultaneously with social organization and technological innovation. In fact, we should keep in mind that it's not enough to have technological innovations implemented into particular environments if people don't internalize and use them as an important change in their daily life. »Better understanding of how norms and values can affect the environmental behavior of individuals can provide useful insights to policy makers for choosing (and combining) instruments to improve the effectiveness and efficiency of policies. Government can also influence norms in particular, through information-based instruments such as communication campaigns; this may also contribute to increasing the acceptability of policies« (OECD, 2008).

4. Perspectives

Moderate human usage of water, reducing losses, efficiency, improvement in the available technologies, recycling of water and usage of the right water for the right purpose is crucial for mankind survival. Flush toilets are the highest users of the water in an average home, representing a prime opportunity for water reduction and conservation in our daily lives. Above we mentioned the importance of intervention toward changing our habits. Combining reduction of waste water with reutilization of our excrements arises as a promising path towards our sustainable future (reviewed in Korčulanin, Barbosa, Ferreira, 2015).

On the market already exist toilets with potential for improved water efficiency, and even waterless toilets (EC DG ENV 2009, p.40-44), which being rare exceptions open up a new horizon of possibilities coming on our way.

For improved water efficiency the dual flush toilet system, which uses two buttons or handles to flush different levels of water, already exists. The patent was proposed in 1974 by Victor Papanek (1974), but started to be universally adopted only in the 90's. In

response of water conservation norms in United States the low-flush toilet (or high-efficiency toilet) was created, which uses 6 liters (1.6 gallons) or less per flush. »Regarding dual flush market shares, it is estimated in 2010 that 55 % of flushing toilets are single flush, 42 % are 6/3 l or 6/4 l (full/reduced flush) dual flush and the remaining flushing toilets (about 2-3 %) are dual flush with lower flush volumes than 6/3 l (e.g. 5/3 l, 4/2.5 l, etc.). /…/ In the EUnited WELL scheme, dual flush control is acknowledged as BAT (best available technology)« (Genty, Kowalska and Wolf, 2013, p.20). Even so this technology still uses potable water for flushing.

With the new EU directive *Standardization of how much water a toilet flushes* (2013) a standard was setted by »a maximum full flush of six litres and set a ceiling for the reduced flush of three litres on dual-flush toilets under "Ecolabel". EU officials stress that "Ecolabel" is a voluntary standard that industry applies for, but note that it has the aim of becoming the norm« (Waterfield, 2013). Separating toilets are one of the interesting toilets rapidly gaining popularity in the Scandinavian countries (particularly Sweden). The front part is made for collection of urine and the rear part of the bowl for the construction of solid waste. Each part can be flushed independently. The effects of the urine-separating toilet on water consumption are dramatic. They can cut flush-water usage by up to 80%, and urine can also be recycled as a fertilizer.On the other hand we have examples of waterless toilets, mostly known as dry or compost toilets and vacuum toilets.

Figure. 4 Separating toilet from Dubbletten(on the left side), dry-compost toilet from Clivus Multrum (on the right side).

From 2011 on there are appearing supprisingly innovative waterless toilets under the project Reinvent the Toilet with patronage of Bill & Melinda Gates Foundation (2011). Toilet re-design can not only eliminate te usage of water, but also they take advantage of human excrements whom they transform into valuable resources as biogas, biochar, hydrogen fuel, fertilizer and elctricity as well as they already extract out of it drinkable water (reviewed in Korčulanin, Barbosa, Ferreira, 2015).

Figure. 5 Logo of the project Reinvent the Toilet which advocates for reutilization of human excrements. Source https://www.pinterest.com/pin/51861833179806675/

In the last years there are starting to show up even more interesting projects transforming human excrements into clean energy - transforming poop into power, biofuel, electricity and into bioplastic (Marcacci, 2011). A latest result shows impressive potential of excrements for extraction of fine metals (silver, gold, iron, palladium, vanadium and copper among others) which due to US Geological Survey worth millions (Westerhof, 2015). »For a community of 1 million people, metals in biosolids were valued at up to US$13 million annually« (Westerhof, 2015).

Figure. 7 Bio bus running on human and household waste. Bristol, 2015
Source http://www.theguardian.com/uk-news/2015/mar/15/uk-first-poo-bio-bus-bristol-regular-service

5. Conclusion

Water resources are on the cusp to meet future demands due to population growth, climate change and uneven distribution; too much of water is being wasted, polluted and unsustainably managed. Moreover, one-third of the population remains without adequate sanitation and at the same time we flush down the toilet potable water. We waste this precious finite resource, fundamental for natural ecosystems and human livelihoods, as well as we waste potential renewable resources for our sustainable future, human excrements. There is not an infinite resource of water and there is an infinite supply of human waste, free in the term of production, which enters into the same bowl. Seeing this situation from an economical and ecological perspective, there is a precious blue and brown gold being wasted with every flush, which costs enourmous amount of money and planet resources as well as causing death and extreme pollution.

Wasteful design of western flushing toilet it's concerning and is calling for an urgent technological innovation and social re-organization, to transform this taboo object into a desirable subject of discussions and as well into an attractive object for re-invention.

Even so the first step for a change starts with recognition of importance and raise of the awareness related to toilets and human excrements. We should speak to other sciences, policies and economies and especially to society to bring adequate solutions in the acceptance.

It's of significant meaning to raise the right questions in getting right answers which should lead us in participatory action within society, ethnography research, co-design and socially engaged design. »Design can find the best fit between economical viability, ethical and cultural acceptability and ecological truth. Design can seek genuine mutual benefits to humankind and nature« (Fuad-Luke, 2009, p.XXI) and can in collaboration with anthropology approach hand out relevant quality results and product ideas for user-centered design (Conti, 2015; Cerwonka and Malkki, 2007; Rabinow, 2006).
Toilets should be regarded as prospects for a sustainable future with innovation that is going to benefit our health and environment. By reduction the waste of water as well as reutilization of human excrements into potential 'gold' for our sustainable future, we would save resources and make profit at the same time. Investing in innovation within toilet design and sanitation is by any measure a winning bet: »According to the U.N., for every dollar invested in sanitation, $8 are returned in reduced public health costs and lost productivity due to disease. According to WaterAid, a $30 donation buys one person access to both clean water and sanitation« (Pappas, 2011).
»If sustainability is the most challenging wicked problem of the current era, then participation in design, as a means to effect deep, transformative, socio-political change, seems essential. This suggest a significant new direction for design to seize« (Fuad-Luke, p.142) engaging with different fields, working localy for global issues and designing for real change with help of community.

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