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<b>'OBSERVE' EVAPORATION FROM GOD'S PERSPECTIVE</b>	<b>2</b>
<b>WONDER WOMEN NEEDS BULLETPROOF BRACELET</b>	<b>4</b>
<b>THE BEST IS YET TO COME</b>	<b>6</b>
<b>DUCTED WIND TURBINE - SENSE OR NONSENSE?</b>	<b>8</b>
<b>A NEW PATH FOR CURING CANCER</b>	<b>10</b>
<b>SAVING YOUR WALLET AND LIVING</b>	<b>13</b>
<b>MONITORING AEROSOLS IN THE ATMOSPHERE USING SATELLITE DATA</b>	<b>15</b>
<b>INFECTION SPREADING: AN ENGINEERING PERSPECTIVE.</b>	<b>17</b>
<b>IS SAFETY, A CIRCUMSTANCE OF ACCEPTABLE RISKS?</b>	<b>20</b>
<b>STILL STEEL</b>	<b>25</b>
<b>ARSENIC IN NICARAGUA: THE FORGOTTEN DEADLY THREAT</b>	<b>28</b>
<b>ARTIFICIAL MUSCLES TASTE LIKE MC NUGGETS</b>	<b>30</b>

# 'Observe' evaporation from God's perspective

If you have no watch, use the sun to tell time.

By Yang LU – Delft University of Technology – CiTG – Water Management

**Right now when you are reading this article, millions of people are suffering from severe droughts thousands of kilometres away in Vietnam and Thailand. Your friends or yourself may also have the unpleasant memory of droughts. Droughts are caused by insufficient water supply or excessive water loss, often in the forms of rainfall and evaporation. Rainfall is measurable from satellites, unfortunately evaporation is not. Wouldn't it be exciting if we could make it 'observable' from space with some tiny tricks?**

The impact of evaporation on our lives is often ignored: water returns to the atmosphere through evaporation, which is a vital process of the global water cycle; the solar energy is consumed during evaporation, which is also a crucial process of the surface energy balance. Evaporation anomalies may lead to catastrophic consequences, e.g., droughts.



Figure 1. Drought

*It's really important, but we cannot see it from space.*

As a fast developing industry, remote sensing techniques have unprecedentedly revolutionized our understanding of the world. It is the technique of information acquisition of an object or a phenomenon without making physical contact. Depending on the wave length, the spectrum is

divided into different bands and used for different purposes. For example, the infrared bands are used for temperature sensing, while the microwave bands are adopted for rainfall and soil moisture monitoring.

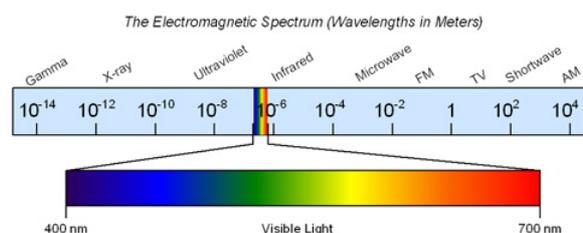


Figure 2. Spectral band wave length

It would be ideal if we can monitor evaporation using satellites. Unfortunately, evaporation is not directly observable from space as it has no signature in any spectral bands.

*The tiny trick: Although unobservable, we can estimate it from something we can see.*

We use watches to tell time, but what if you are in the wild without a watch? Use the sun! Although it is not as accurate as using a watch, we could still get a satisfactory estimate of time. Likewise, in this research we try to use some visible remote sensing data (the 'sun') to estimate the invisible evaporation (the 'time'), and this is how we make it happen.

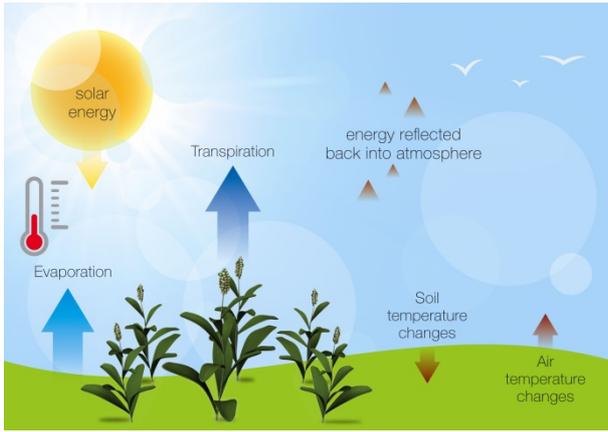


Figure 3. Surface Energy Balance

The solar radiation is partitioned into evaporation (LE), sensible heat flux (H) and ground heat flux (G), therefore we need to know at least two components to estimate LE. We introduce a parameter called evaporative fraction (EF), which represents the partitioning between H and LE. The extraordinary feature of EF is that it is almost constant in the daytime on a sunny day, and this could greatly reduce the dimensions of parameter estimation.

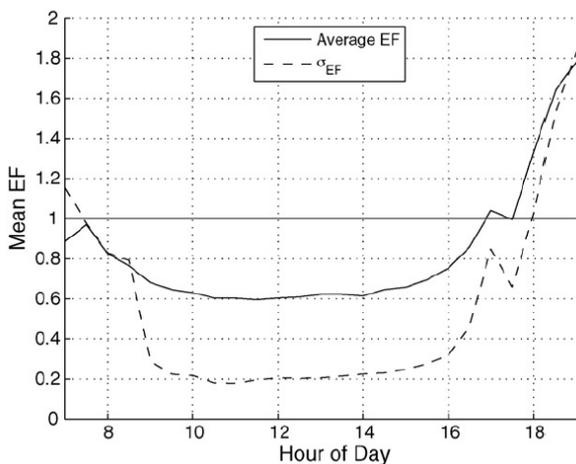


Figure 4. Typical diurnal behavior of EF

We also need a sum of H and LE to estimate LE after estimating EF. This sum is governed mainly by the landscape and vegetation, which changes very slowly over a long period. If we assume that the local constraints (CHN) are constant over a month, we can derive LE using different

combinations of EF and CHN, and this will have their signatures in land surface temperature (LST), which is observable from space.

Aside from that, we put more constraints on EF using soil moisture. As a common sense, the wetter the soil, the larger the LE, thus the larger the EF.

*Data assimilation: the tradeoff between forecast and observation*

Here we used a data assimilation method called the particle batch smoother (PBS) to constrain model forecast with observations.

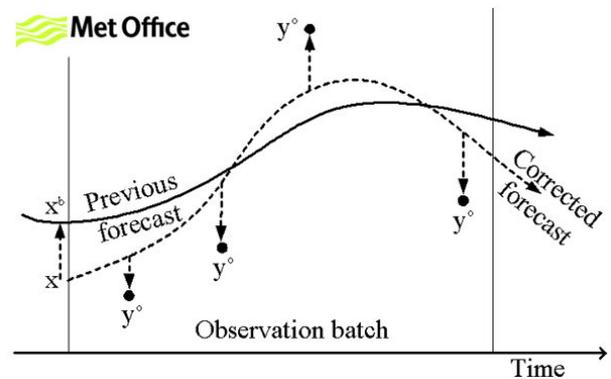


Figure 5. Schematic of data assimilation

As LST and soil moisture observations contain information about LE, they are assimilated into the model to get better LE estimates. In this way, we indirectly obtain evaporation estimates from remote sensing, which could be used to make us better prepared for potential droughts. If only God is omniscient, science brings us closer to him.

Data assimilation is the technique of combining complementary information from model forecast and observations over time and space into an optimal estimate of the geophysical field.

The PBS is an extension of the particle filter algorithm. Imagine you run the model 100 times and every run is a particle in time and space, so you get 100 particles. When an observation particle is available, you choose those particles that are closest to the observation particle and throw away the particles that are far away, so you get better and better model simulations.

## Wonder Women Needs Bulletproof Bracelet

The electricity transfer pattern is shifted from alternating current (AC) to direct current (DC). This change makes our electrical power systems much more sensitive and vulnerable.

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By Lian Liu – PhD Student – TUDELFT – EWI – ESE – IEPEG



*Diana Prince. She is powerful and graceful, however, also vulnerable. Luckily, it seems that she is aware of her mortality. Remember the Bulletproof Bracelet on her wrists? Thanks to her high reactivity, she is “immune” to the bullets flying to her. The high-voltage DC converter is the “Wonder woman” in electricity word: “she” transfers millions watt of electricity for human beings 7\*24! And, I dare to say nobody wants his or*

*her life be interrupted or even threatened by the black-out of the power system: remember the unsaved paper on your computer? Remember the cancellations of the train in Amsterdam last year? Remember the people died in the extreme blizzard in China in 2008? But these situations had happened.*

Knowing that the “wonder woman” has been introduced to the world for several decades, one may ask “why you technical guys are still working on this?” The truth is, the high-voltage DC converter has one fatal defect: the lack of high reaction ability (the real Wonder Woman has it...). In theory, the converter can survive an attack or a fault (such as a lightning hitting on a transmission line) if it can defend itself in 10 millisecond. In practice, however, this is very hard to achieve, because of the natural features of the essential semi-conductors in a converter. What the engineers have to do next is to find the way to protect the converters. Nevertheless, the protection for her cannot be guaranteed by far; the Bulletproof Bracelet is still on its way.

### Why we cannot keep the traditional AC system?

Good question. In fact, it has been asked for a long time. In 1800s, Tomas Edison and Nikola Tesla had already debated on this issue: AC or DC? At that time, Tesla won. Yet it seems that the situation is turned over. The world is now changing to a renewable-energy-resource mode. The traditional fossil energy like natural gas, coral are being replaced by much clearer energy resources like wind energy, solar energy etc., because of the former generates carbon-dioxide after burning. It is the Green House gas, right? Nevertheless, the problem is “have you ever seen a day that the wind blows a whole day, or the sun shines 24 hours?” Definitely you have not... Therefore, the power has to be stored and manipulated after. We can assume that the stored energy is a rechargeable battery. And the battery has to be in the DC form.

### What is the "Bulletproof Bracelet"?

The "Bulletproof Bracelet" I am talking about is actually called circuit breaker. More specifically, it is DC circuit breaker. It is a switch gear that can disconnect a cable from a power system. Although in the AC system, the circuit breaker is a quite mature technology, but it turns out that the DC circuit breaker is still a baby and this state will continue for considerably a long time. The reason for this is that it has to face a very mean enemy. When a fault happens on a DC system, it will travel to the DC circuit breaker at the a high speed. The difficulty to deal with this fast attack makes the baby grow slowly. Some electrical enterprises have built some functional DC circuit breakers, but they are still alpha version and very expensive.

### What if we cannot create the "Bulletproof Bracelet"?

It is one possibility actually, although I hate to admit it. The lucky thing is that scientists and engineers are now looking for the Plan B: they are now considering and trying to make the converter itself "bulletproof". Yes, it means that Wonder Women can become Superwomen. The researchers in University of Aberdeen, U.K. have proposed a new type of converter that can resist the fault for a longer time; the University of Glasgow, U. K. is now testing a converter that is capable to block the faults totally. These two new types of converters have attracted concerns from both academia and industry. Maybe there is relatively high loss of energy on these prototypes, but the investment has been put into to figure it out.

Where the future go is still unpredictable, yet the future will be promising.

*"Introducing HVDC*

*It's time to connect*

*Shaping the grid of the future*

*Bringing power to the people"----- ABB Company*

# The Best is Yet to Come

## More oil and gas for the world

By Abdulrahman Alshuhail – PhD Candidate – TUDELFT – TNW – Acoustic Imaging

***Oil and gas energy has become an essential part of our day to day lives. Industries as well as people make use of it for transportation, heating, and lighting up the sky. However, where does it come from ? where can we find more, and what ensures that we will continue to produce more than 100 million barrels a day to sustain the economy. This is where seismic technology comes in to better image the subsurface and better. We present a new technology that will ensure that more oil and gas will be found.***

The discovery of the seismic method has heralded a new age for oil and gas. After its discovery the oil and gas industry has witnessed a sharp increase in proven reservoirs. So the question that asks itself: What is the seismic method ? It the process of generating a sound wave at the surface of the earth and recording the reflected vibrations. What happens to this waves is that it travels into the earth and gets reflected at the layer interfaces back to the surface. By analyzing these reflected vibrations it is possible to reconstruct an image of the subsurface.

Imagine waves on the surface of a pond, is it possible to measure the waves at the end of the pond and know what jumped in where and when? That is exactly what geophysicists are trying to do with the seismic method in order to understand the subsurface. Obviously, the better the image of the subsurface the better the interpretation and hence better the chance of finding oil and gas. Which will ensure that more oil and gas is discovered for the world.

*“Formula for success: rise early, work hard, strike oil.” J.Paul Getty.*



### Anisotropy

One key physical effect that must be taken into account is anisotropy.

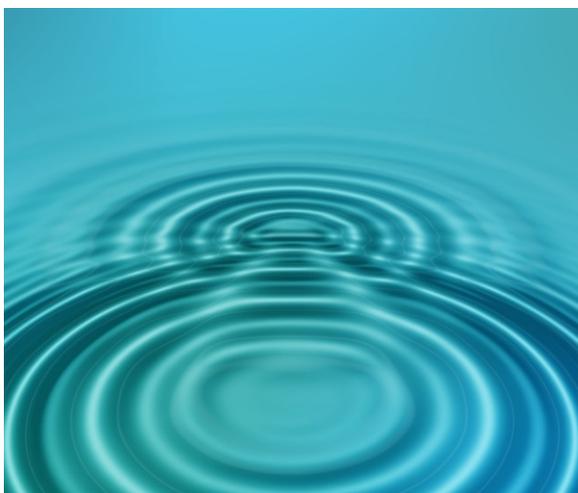
#### What is anisotropy ?

The dependence of seismic velocities on the direction of wave propagation at some physical points.

Anisotropy is the preference for waves to travel in certain directions. Let's, go back to our original example of throwing a stone in a pond. The waves that are generated are circular. However, when the media is anisotropic the waves will no longer be anisotropic but look more like a

potato. Many rocks exhibit anisotropy and the effects are commonly seen in the seismic industry. However, not many have done anything to understand it and utilize it.

Leon Thomsen one of the leading scientists in seismic said "Anisotropy if not taken into account will definitely lead to more dry wells". By dry wells he means drilled wells that have no oil and gas in them. Other scientists have corroborated his statements by studying the effect of imaging without taking anisotropy into account.



## Imaging

Ignoring anisotropy in imaging causes significant errors in the images of the subsurface. Therefore, it must be taken into account. However, incorporating anisotropy in imaging is not trivial it requires a lot of effort in describing wave propagation. It also require that you already know

This technology will ensure that we find more of the world's oil and gas reserves and drill for it more accurately. Ensuring a new era of abundant oil and gas for the world. Moreover, the technology can be used in other fields such as medical imaging and in metallic inspection.

the anisotropic parameters of the subsurface before applying the imaging. This becomes like the chicken and the egg conundrum. Which comes first Imaging or anisotropy estimation. Both require information from the other.

At the Delphi consortium a consortium at the acoustic imaging department of TUDelft we believe that estimating these two parameters together will lead to the most accurate solution. By coupling them together it is possible reduce the nonlinearity associated in inversion. One issue that scientists struggle with is one parameter compensates for the other. However, by coupling the estimation each parameters naturally finds its correct value without compensating for the other parameter. The Joint Migration Inversion (JMI) method dose exactly this, it couples these two parameter estimation. It is a recently developed technology (2013) and is gaining the attention of national and international oil companies rapidly.

Applying the JMI method to synthetic examples shows that we get a clear image of the subsurface, however applying a traditional imaging technique produces extremely poor results. Most of the objects are not where they are supposed to be, hence drilling here would pose a financial as well as a safety risk due to not knowing what to expect. We expect to test on real data in the coming months.

# Ducted wind turbine - Sense or Nonsense?

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By Juan Tang – PhD candidate – TUDELFT – Faculty of Aerospace Engineering – Wind energy

***Almost every man knows the need for energy sources is increasing and the need for clean sources even more so. It is a fact that wind power is the best dilute and unpredictable source of energy that works with efficiency of great importance in the conversion of this energy to electricity. Wind turbines have been used as a source of energy for many hundreds of years. The last forty years has seen rapid growth in energy generation from the wind power industry. As such, wind turbines have become the fastest growing energy capture machine in the world.***

Today's wind turbines are the result of over a millennium of windmill development and modern engineering. It is used by many countries as part of a strategy to reduce their reliance on fossil fuels. The smallest turbines are used for applications such as battery charging for auxiliary power for boats or caravans or to power traffic warning signs. Slightly larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid.

*Wind turbines are used to generate electricity from the kinetic power of the wind. . . .*

Wind turbines can rotate about either a horizontal or a vertical axis, the former being both older and more common, usually called conventional wind turbine. The new forms of wind turbines also include blades (transparent or not) or be bladeless. It's an interesting concept that attempts to address a number of challenges facing conventional wind turbines. It is believed that wind power generation in wind turbine increases with the cube of the wind speed so any increase in speed could offer a

significant power boost. If we can increase the wind speed by exploiting the fluid dynamic nature around a structure or topography, the power output of a wind turbine can be increased substantially.

## Wind Turbines That Push the Limits of Design

In conventional wind turbine the wind speed served from the location is directly used to generate power. Scientists thus proposed a new wind power system that can produce higher power output even in areas where lower wind speeds are expected would be cost effective. One of the most promising concepts in the wind energy field is the development of wind power augmentation systems. By the use of duct, or you may call diffuser, around the wind turbine, wind power augmentation system is named as ducted wind turbine. It was a hot topic at the 1979 wind energy innovative system conference. Duct generates separation regions behind it, where low pressure regions appear, as we all know, air flows from the high pressure to the low pressure, hence more wind drew through the rotors compared to a conventional 'bare wind turbine'.

These devices usually take the form of a horizontal axis wind turbine. Some of the technologies also utilize a duct or a shroud, in the form of a diffuser or an augments, in search of enhancing the flow and increasing the energy extracted per device.



Another advantage is, for a ducted wind turbine, an extra force will be generated by the duct which attracts more air flow through the duct. Therefore, more power output could be generated.

### **Can it be a commercial product?**

Wind energy technologies have become one of the fastest growing energy sources in the world and it symbolizes a feasible alternative, as it is a virtually endless resource. However, in comparison with the overall demand for energy, the scale of wind power usage is still very meagre. As for the reasons various causes are possible including cost.

The ducted wind turbine concept is probably most suited to small and medium sized wind turbines (probably less than 25 ft. diameter). Any size larger than this would probably require substantial reinforcing of the entire structure due to wind load (and the associated initial capital cost). The investment therefore increases, however, which is expected to be as less as possible

### *Fantasy wind turbines or if it's too good to be true . . .*

One advantage of the duct is that it should align itself into the wind, thus eliminating the need for a rudder downstream of the blades. Another advantage is that it should be maintenance free. It is simply a passive device that allows increased production of electricity over the life of the turbine. It could even outlast the turbine and be recycled on the next turbine.

For large wind turbine, the duct placing around the blades has to be large, therefore it is materially expensive. This causes two, as yet insurmountable problems. You have to pay for the duct and it has so far proven cheaper to simply extend the blade on a conventional wind turbine to make up for whatever multiplier effect the ducted turbine provides.

The duct adds to the drag on the wind turbine, tower, and foundation. It thus requires all to be much bigger and heavier than they would on an equivalent commercial wind turbines. Why? Because all wind turbines have to withstand high winds and storms. Ducted wind turbines are effectively big blobs of material stuck into the wind. Conventional wind turbines have long slender blades that typically can be feathered to ride out storms. Since new cost effective materials keep proposing now, it is believed that the ducted wind turbine will eventually have a good trade-off between its cost and profitability.

When the computer was reported to public at first time, no one expected the boom of personal computer/ laptop at present.

# A New Path for Curing Cancer

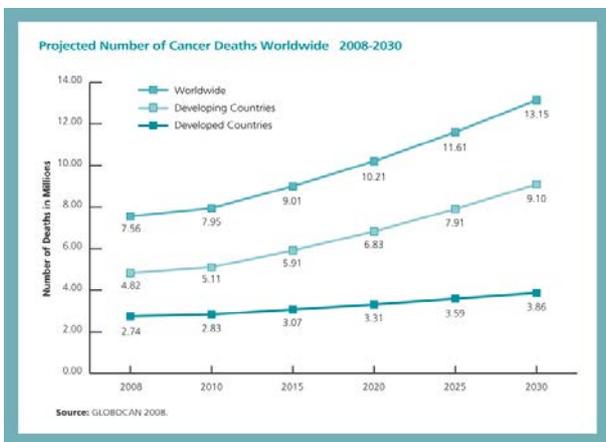
When someone has cancer, the whole family and everyone who loves them does too!

By Kai Zhang

***As a major problem of disease worldwide, cancer affects the normal life of tens of millions of people. And more than half of them eventually died from it, resulting in a disrupted family life. Magnetic-responsive soft materials, which can be used for magnetic guidance and drug releasing, could potentially open a new path for curing cancer in the future.***



Cancer has a major impact on society across the whole world. Since it always not only breaks the patients' life but also the life of the whole family, cancer has attracted more and more attention. Around globe, the increasing tendency of the projected number of cancer deaths actually raised an important question to everyone, i.e., how to improve the cancer therapy or how to cure cancer effectively.



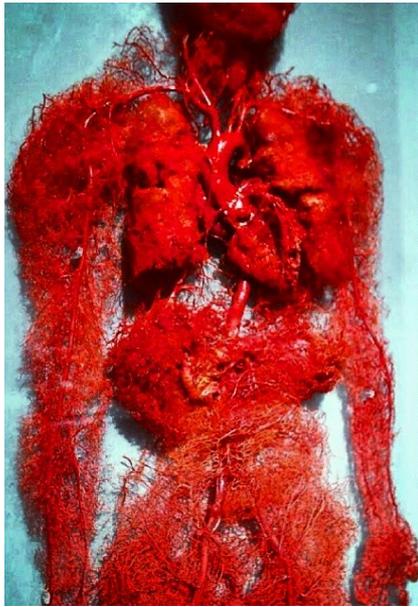
To answer this question, scientists designed various approaches to solve the problem and tried

to give people some hope and bring us out of the shadows by using stimuli-responsive materials.

*“Your body likes a maze. Sometimes, the drug could get lost inside.”*

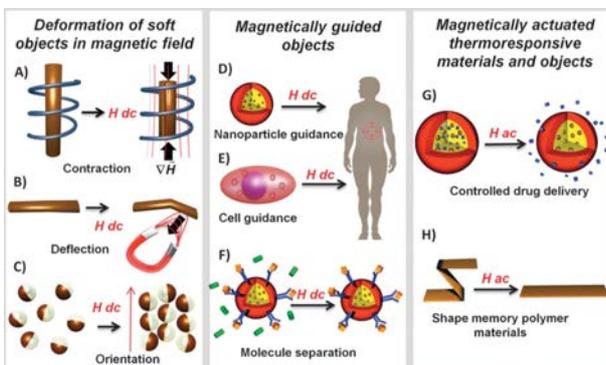
Our human body is so complicate that there are many blood vessel systems, which connect various organs. Through these vessels, nutrients can be delivered from one place to another place and help our body remain healthy.

But because of this complicate system, we can imagine that when the drug used for curing cancer travels in our body, it will be very difficult for them to move to the specific place without any control. It seems like they can get lost in our human maze. Meanwhile, before arriving the right place, the drug can also be fully “digested” by the other cells in our body. All of these build the main limitations of conventional drug delivery, i.e. their difficulty to overcome the natural physiological barriers and their lack of tissue/cell specificity.



*“The small magnets and invisible magnetic field have great applications.”*

As one of the most important methods, stimuli-responsive materials open a new path for curing cancer in the future. Magnetic-responsive materials are one important kind of stimuli-responsive materials, which can be used in smart or intelligent devices for many applications. For instance, the properties of their stretching/contraction and bending under magnetic field can be used to build artificial muscle.

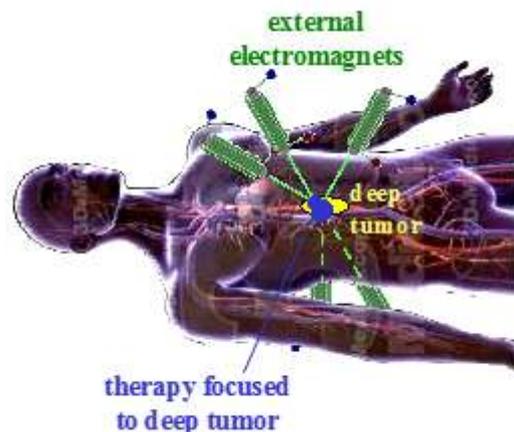


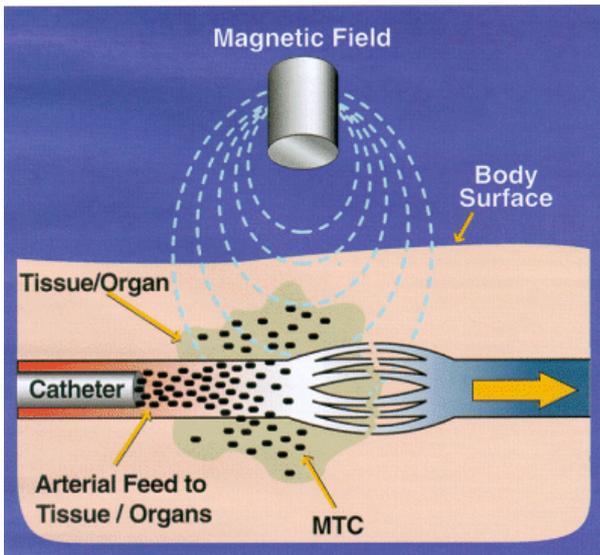
Through magnetic guidance and separation, cell targeting, sorting and separation can also be

achieved. It is similar to the process of collecting iron spheres from a bunch of metal. In this way, the magnetic field can help the drug capsules move to the targeted cells, e.g. tumor.

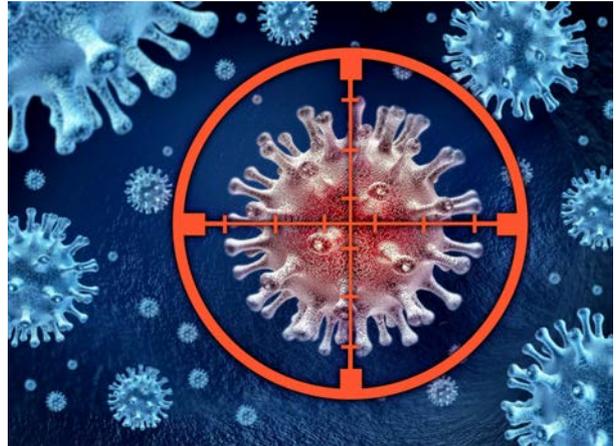


Combined with thermosensitive materials, the activation of magnetic nanoparticles, when they are exposed to an alternating magnetic field, can create localized heating. This will be useful for controlled drug release. When the medicine capsules moved to the cancer cells, localized heating generated by alternating magnetic field could lead to the broken of capsules and release of the drug.





*"Let's play the shooting game of cancer inside our body!"*



In this way, the cancer cells can be killed more efficiently, as most medicine in capsules could be delivered and released around the target cells, i.e. cancer cells.

In the future, we will use magnetic field as the aiming laser (or gun sight) to help us shoot the "bullet", medicine, at the right target. There will be no place for cancer to escape!



# Saving your wallet and living

## Enjoying comfortable environment at home/office utilizing a new resource

Hongxia Zhou – PhD candidate – TUDELFT – 3ME – Process & Energy – Engineering Thermodynamics

**Hydrate slurry, resemble as ice, is a new and promising new resource that can be utilized to replace the chilled water which has been used in the traditional air-conditioning systems for decades. The energy shortage as well as the green-house effect can be relieved with the application of hydrate slurry in refrigeration area.**

Energy consumption is an urgent topic drawing attention, which is in relation with the global warming. Space cooling consumes more and more energy as the increase of the global temperature, and also contributes a large amount of cost for residents. How to save energy as well as save money must be

*Global temperature has increased 0.78 °C in average during the past 100 years.*

taken into account in future.

*“Globally, more than 1.3 billion people have no access to electricity; and some 2.6 billion have no access to modern cooking facilities. More than 95% of these people are in Sub-Saharan Africa or developing Asia, and 84% live in rural areas—Jostein Elkeland (CEO of Aleva).”*

Chilling water is commonly used in the traditional air-conditioning system shown in Fig. 1a, which needs an evaporating temperature near zero. In this case water is

Coefficient of performance (COP) is an element that

cooled during the daytime when there is requirement for cooling. Hydrate slurry has proven to be good candidate for air-conditioning system (Fig .1b), which gives a high evaporation temperature because the formation temperature of hydrate slurry is mostly around 6 °C. It also shows in Fig. 1b that between the building and slurry formation loop there is a slurry tank which is used to store slurry. It allows for night generation by using the additional tank compared with the traditional cycle. Because of lower ambient temperature in the night, the conditioning temperature could be lowered, which is also benefit for the improvement of energy efficiency.

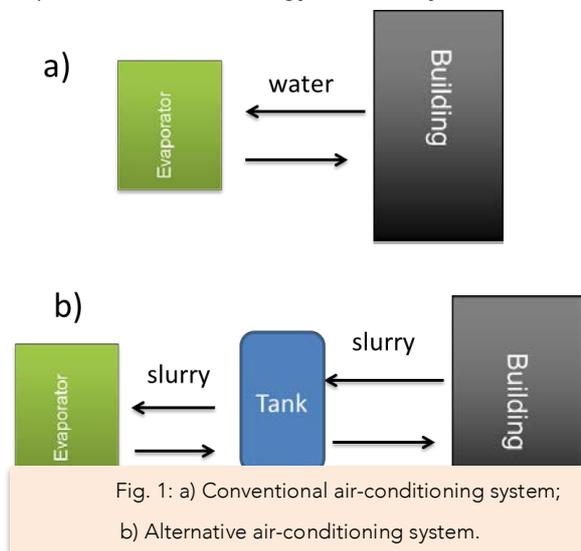


Fig. 1: a) Conventional air-conditioning system; b) Alternative air-conditioning system.

reflects the energy efficiency of the system. By experiments done in our lab, the COP with the application of CO<sub>2</sub> hydrate slurry is significantly high than that of the conventional system. The energy saving is about half of the original. From this point, human beings can save their home energy consumption, like electricity significantly, and reduce economic cost. In summary, our investigation is quite valuable in terms of energy saving.

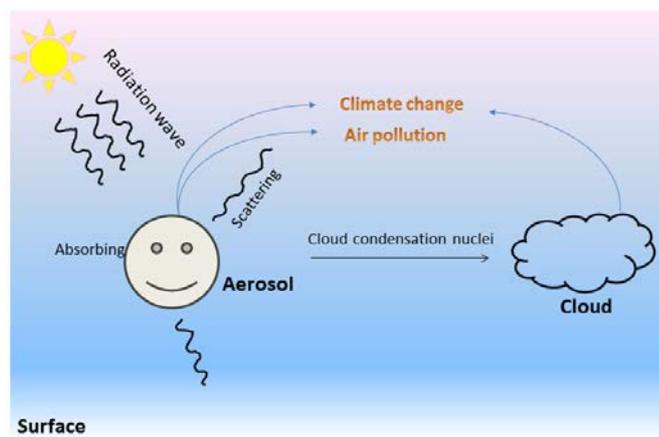
# Monitoring aerosols in the atmosphere using satellite data

Yerong Wu

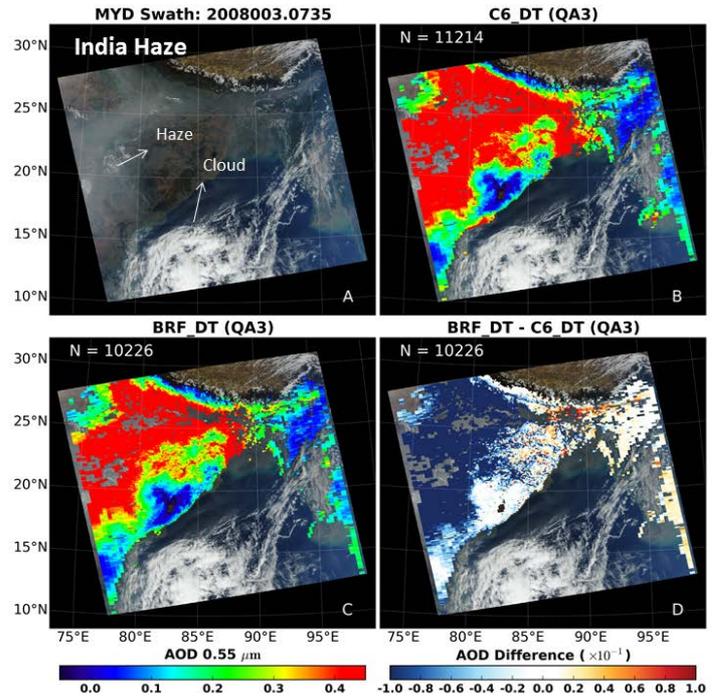


**Air pollution in Delhi, India**

Atmospheric **aerosol** is a suspension of liquid and solid particles distributed in the air with radius ranging from few nm to larger than 100 nm. Aerosols that from natural sources (e.g., volcanic ash sea spray aerosol, dust etc.) and human activities (e.g., industrial emission, forest fire smoke, fossil fuel burning aerosol etc.) play a key role on climate change and environment, and human health. Near land surfaces, high concentrations of fine aerosols (so-called Particulate Matter) with various micro-organisms can be inhaled by human and cause human diseases. Also, aerosols have a significant impact on climate change due to their direct and indirect effects. Most of aerosols affect the climate by cooling the atmosphere through reflecting solar radiation into outer space, whereas absorbing aerosols (e.g., black carbon) warm the atmosphere; but the total effect of aerosol is cooling, this is also called the direct effect of aerosol. As for indirect effects on climate change, aerosols also acted as cloud condensation nuclei influence cloud formation and albedo.



Because aerosols have a strong variability in space and time, monitoring aerosols in the atmosphere on daily basis becomes quite necessary. Among important factors in aerosol properties --- phase function, single scattering albedo, extinction coefficient and etc. --- Aerosol Optical Depth (AOD) at middle-visible band, describing the magnitude of radiation extinction of aerosol and also to some degree describing aerosol amount near the surface, has been paid more attention to.



Satellite receives the radiation or signals from space or at the top of atmosphere with large coverage over space and time, and becomes a powerful tool to monitor the earth. One of satellite products, the MOderate Resolution Imaging Spectroradiometer (MODIS) AOD product, by the aid of the maturity of its algorithm and high resolution at spatial (10 km) and temporal (daily over the globe), has been extensively used in scientific research.

# Infection Spreading: An Engineering perspective.

By Elvin Isufi – Ph. D. Candidate at TU Delft

***Airlines, high speed trains and highways have improved our lives to reach further places in a short time. Together with humans, also viruses and bacteria make use of these high-speed lanes to spread worldwide. Air spreading infections can reach unprepared countries within a few hours and find an optimal environment for exponential developing. Predicting in advance these trends will allow us to contrast them efficiently while not affecting our everyday habits.***



The Airbus A380-800 is certified up to 853 passengers. The A380-800 has a design range of 15,700 km, sufficient to fly nonstop from Dallas, USA to Sydney, Australia with a speed of 900 km/h.

In Jules Verne's roman "Around the world in eighty days", the achievement of Phileas Fogg to travel the planet in 80 days was an impossible mission for the XIX century. With today's technology this challenge can be achieved within a single day. All this thanks to the efficiency of high-speed airplanes. We can consider that the recent Airbus 380-800 can transport up to 853 passengers on the other side of the globe in a dozen of hours.

Together with our comfort to reach far away countries in such a short time, these fast communication lanes serve as highways for viruses and bacteria to spread worldwide.

This spreading may become dangerous for air-spreading infections that spread by everyday human contact such as tuberculosis or more recently Ebola. This can be the case also of illnesses where the origin country has growth a

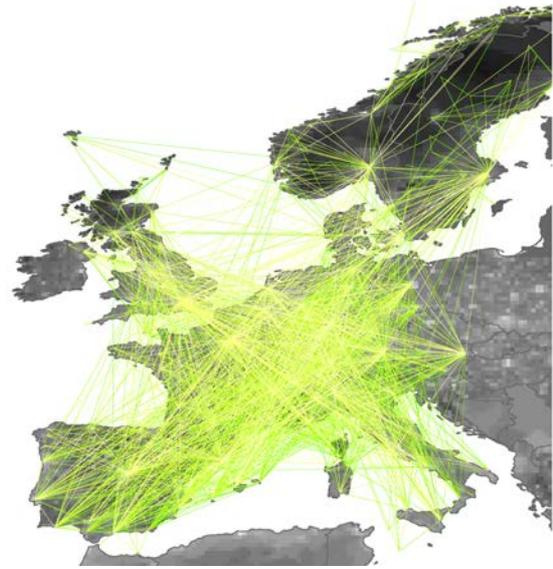
certain kind of immunity among years, while the host country may become the ideal environment for such microorganisms. For unprepared countries, this may lead to a mass epidemic and force them to close the communication ways to limit the spreading.

The research community of different disciplines is continuously trying to answer the question:

*“Is there a way to control these spreading, while allowing people to continue normally their everyday life? ”*

Before answering this question, let’s move to the more general case where a potentially infected person (PI) can also pass transit in a country. With reference to the picture below, we can consider that a PI or a group of PIs may reach London passing transit from Paris. Then, of course a local spreading in the Paris airport will be propagated by other PIs to their own destination. One may think that in the worst-case scenario, an avalanche effect will happen among all these airports. Fortunately for us, the probability that such an event happens is nonsense.

However, there is still a potential risk that an epidemic situation may appear. Then, we can come back to our question. Is there a way on how to control and contrast this epidemic without requiring the total black out of all airlines? There is not a simple answer to this question, and it will depend from a lot of factors, such as the gravity of the situation, the dispersion rate of such infection with everyday human contact, the immunity of the population to self-contrast these illnesses and so on so forth. However, this answer will take a form if



we accurately predict this spreading. With a spreading model, each country can rapidly take precautions to bring drugs to the most critical

**Map of the main European airports. The lines illustrates the connectivity map between different cities.**

places. On the other hand, we will be able to deeply understand which are the most critical airlines and which of them need to be closed and for how long. Further, considering that we have only finite amount of medicaments, an optimal distribution scheme can be done to allocate the right amount of drugs in the right place. With these few remarks, we can immediately see an accurate prediction will solve a lot of problems. This is why different research institutes, also from different disciplines are focusing more and more in this particular problem. Recently, the engineering research community and in particular signal processing scientists are proposing a novel and promising approach on how to deal with this problem.

## FROM MOBILE COMMUNICATION TO INFECTION PREDICTION

Usually when we talk about signals we imagine our mobile phones, the internet connection or voice. Signal processing, as the name suggests, process these signals in order to achieve certain tasks. With the signal processing algorithms we are able now to communicate in real-time via a mobile phone with persons, which physically are far away from us. We can capture high quality pictures, or use any browser to be virtually connected with the rest of the world in a few instances. Well, signal processing is not only this. Signal processing today is extended to sensor network, to financial markets and it is in the heart of our modern work. It powers also tomorrow self-driving cars, hearing aids, ultrasound machines and medical devices.

With respect to our problem, the airline connection between different airports can be modeled as a network and the signal now will be the percentage of infected people present at each airport. Specifically, using each airport data we can calculate the average number of people present there each day, and we can model probabilistically which fraction of this people are affected by an infection. This probabilistic can be estimated by selecting a small fraction of people in each airport and checking their state. With this in place, using the same algorithms that are commonly used in our mobile phones or TVs, we can track variations of such signals in time. Differently from other techniques, this signal processing approach lead to potentially improved performance, since it considers jointly the signal on this network (the fraction of infected people) and the network structure (local airline communication).

*“The techniques used in our mobile phones, can be extended in the infection spreading prediction.”*

Currently, the extension of the signal processing techniques on infection spreading is still on its embryonic phase but it has immediately shown promising results. One of its main benefits relies on the fact that the collected data may be limited, thus the estimation of the number of the infected people is affected by model inaccuracy. The ongoing and future research will polish this method and will find the right parameters to accurately predict and combat a possible epidemic risk, while we can normally catch our flight.

## Is Safety, a Circumstance of Acceptable Risks?

If we could decipher the term circumstances, it may unlock new ways to manage risks and improve safety. This article presents some preliminary ideas.

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By Sageed Kunhiraman – Part Time PhD – TUDELFT – TPM – VTI – Safety & Security Science



***Modern history continues to be littered with man-made accidents. We have been learning from these, in the hope of finding new ways to prevent similar occurrences. Many models and theories have been proposed and these have provided a variety of controls and defenses against accident causation. However, with the rise in technology and sophistication, accidents have become more complex and even emergent in nature. The causes of such accidents do not necessarily follow a singular cause and effect path. As such, the relevance of these theories are being questioned. This article weighs a different approach. It proposes the deconstruction of the term circumstances to identify new ways to manage safety.***

Safety or the state of being safe is dictated by circumstances. A circumstance is generally defined as a fact or an event that makes a situation the way it is.

### A Circumstance

Imagine a wet Monday morning along a busy motorway. There is a heavy and continuous flow of traffic on a well-organized road. Visibility is good but the road is slippery. A sudden reduction in speed of one car forces the vehicles behind it to react instantaneously. Unfortunately, contact is unavoidable and there is a pile up. A chain of

wrecked vehicles along with a number of injured people and onlookers share the scene.

### Conventional Approach

Typically, such an event, will be analyzed during the course of an investigation to determine the direct, contributory and root causes. The main philosophy in determining the causes would be the identification of a number of preventive barriers which had failed or were absent from the circumstances leading to the accident. Hereon the investigation would focus on making recommendations appropriate to the established causes, effects and other negative findings which

may have been uncovered during the course of the investigation. This is the conventional approach to investigation. It is event centric, limited to the facts that can be established, and based on a timeline worked backwards.



### Limitation of Conventional Approach

The integrity of the conventional approach to investigation is dependent on connecting all the established causes and effects; all of which are based on the accuracy of the recreated main event i.e. the accident itself.

However, the very nature of investigations is such that assumptions, estimations, inferences and judgements etcetera are not totally unavoidable. In fact, it could even be argued that these are necessary. Therefore, it is quite possible that some degree of error or variation of it will exist between the actual and the reconstructed incidents of the investigation. It is the magnitude of this error that determines the accuracy of the investigation. Obviously, the lesser the error the more accurate is the outcome of the investigation.

The disadvantage here is that causes and effects that were missed out or only partially uncovered will result in a story that may resemble a patchwork of the actual situation. If so, the remedial actions

too will only address the faults in the patch work, leaving any uncovered causes and effects still intact. This is illustrated metaphorically by the picture directly above this section.

### Different Approach

Supposing we take a different approach; what if the circumstances leading to this accident can be deconstructed into specific factors, such that each factor represents a source of hazard causing attributes.

Going farther, what if each factor can be deconstructed into sub factors of similar and related types of hazard causing attributes such that there exist a comprehensive list of hazard causing attributes per sub factor.

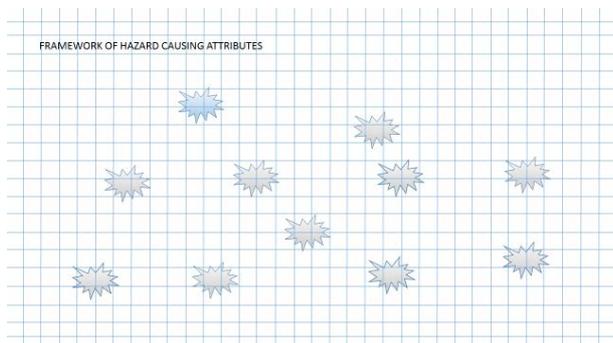
**Hazard Causing Attributes** could be considered as qualities of the factor which can induce potential errors. For example, drivers and passengers (and pedestrians, if any) can be sub factors of the "People" Factor. The drivers' health, driving skills and reflexes etc. can be considered as hazard causing attributes specific to the People Factor.

Subsequently if all the lists (i.e. one per sub factor) could be collated, these would potentially represent all the options for errors in a particular factor. If the same is made for all factors, the errors for the whole scenario would be available. In other words, the contents of the lists could form a matrix on which to recreate the incident. It is like having a "LEGO" board of sorts to work from.

It is important to note here that the checklists are factor specific, but not scenario specific. What this means is that any scenario may be re-constructed using the checklist as a guide. The checklists would serve to prompt questions on all and every potential hazard related to the scenario.

Therefore, and at least in theory it may now be possible to uncover facts which could otherwise have been missed if the investigations were purely conducted using the conventional approach. Would this not be a more wholesome approach than the conventional one?

*The dangers of life are infinite, and among them is safety. – Johann Wolfgang von Goethe*

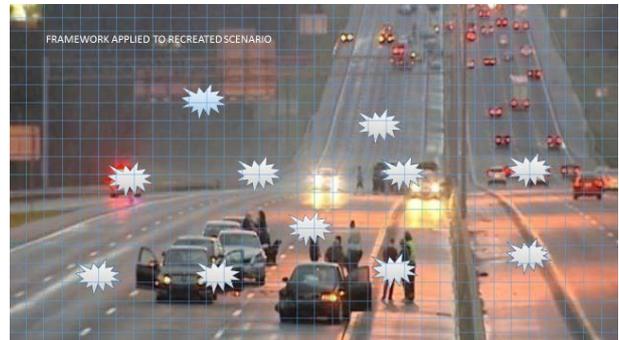


### Hypothesis

The hypothesis is that if the general framework of a circumstances can be established, it would enable a more complete understanding of accidents than the conventional event centric approach.

To be more precise, circumstances when reduced to hazard causing attributes, could serve as useful markers to re-construct accidents. This possibility can supplement the conventional approach to deliver a more wholesome result.

In order to deconstruct the circumstances, it is important to distinguish the parts and its sub factors clearly. Let's examine one example. Here six factors are being used.



### People Factor

In this scenario the drivers and passengers who were involved in the accident, are the sub factors and they can be labelled collectively as the People Factor. The hazard causing attributes could be faults or weaknesses in their personal qualities as well as actions or behaviors caused by them. For example, these could include issues with physical, mental and emotional wellbeing; lack of experiences or competencies contributory to the accident.

### Asset Factor

The asset factor in this scenario would comprise of sub factors like the damaged vehicles and contents. It would also include any other movable or immovable materials and properties (e.g. road dividers) involved in the accident. This factor is about the qualities of the assets and the use of these by the People. Hazard causing attributes of the Asset Factor would include weakness in design, engineering, procurement, construction, operation, maintenance, repairs, replenishment etcetera.

### **Organizational Knowledge Factor**

Companies, institutions, establishments etc. use organizational knowledge (i.e. management systems) to run their affairs or businesses in a desired manner. Sub factors of this factor comprise of policies, processes, procedures, practices, work instructions etcetera and the hazard causing attributes could be a lack of, or omission or incorrect use of these.

In this scenario, some of the vehicles may be using management systems (e.g. taxis) and others may not (e.g. private cars). Therefore, organizational knowledge may not be applicable in some circumstances.

*“Out of this nettle, danger, we pluck  
this flower, safety. -- William  
Shakespeare”*

### **Organizational Climate/Culture Factor**

Organizational Climate/Culture factor is about group thinking and the consequential behavior exhibited by the People who contributed to the accident. Sub factors would include beliefs, customs, traditions, values etcetera of the community or company or organization to which the person belongs to. Hazard causing attributes would be the actions or behaviors arising for these sub factors.

In this scenario, the local culture (or the company's business climate) could be one that frowns on late comers and excuses for being late are not readily

accepted. To avoid the stigma of being late, some drivers could have preferred to down play the increased risks posed by the wet road by not traveling at a safe speed nor keeping a safe distance. As such group thinking can also introduce risks.

### **Natural Environment Factor**

Natural Environment Factor would include sub factors like the weather, geographical features (e.g. elevation, bend and width of the road), wind, sea state, visibility (day or night or fog) etcetera. The hazards causing attributes would include reduced visibility, slippery road, strong gust of wind, narrow bends etc.

This factor cannot actually be managed, but depending on the specific sub factor may be tolerated to some extent with the necessary safe guards in place or at best even avoided all together.

### **Business Environment Factor**

The Business Environment is about the formal and informal obligations and expectations which come with the work or assignment that People have accepted to do. Legislation, standards, contracts, political, social and union related obligations are all part and parcel of a business environment. These issues also place demands on People and may influence the risks. In this scenario the Monday morning meeting may have been a contractual obligation expected by a client. Hence the pressure to be in time for the meeting.

The ideas presented above are still sketchy and in the raw form. Nevertheless, it seems to hold the possibility of recreating events by way of deconstruction of circumstances into frameworks of hazard causing attributes. If indeed true, then the same frameworks could also be developed for the study of safety management and perhaps risk assessment, auditing etc. For the moment, there is a possibility that unravelling the term circumstance, holds the key for a better understanding of term safety.

\*Note: Due to the size constraints of this report, the reasons opting for the six types of factors have been omitted.

# Still Steel

## The Material of Sustainable Future

By Hussein Farahani – PhD candidate – TUDELFT – AE – ASM – NovAM

***In a cold winter morning in north Norway, Alf starts his car in air temperature of -30 degree of Celsius (°C) to go to work. Within a few minutes the temperature of interior parts of his car engine reaches up to 300 °C; A huge temperature shock. Alf goes to work five days a week with his 15 years old car. Thousands of kilometers away in south, in a hot summer noon in Dubai with air temperature of 50 °C , Ahmad starts his car to go back home. Rapidly, the internal metallic parts of the car engine reach the temperature of 300 °C. Ahmad does this also every day. Both of car engines slowly cool down again at night to air temperature. In spite of all possible apparent differences between two cars used in two different climate conditions in Norway and Dubai, both car engines are made of the same material: steel.***



Bars of type 304 stainless steel |atlanticstainless.com

### What is steel?

Steel is a general term used for iron based alloying systems, in which many other elements are added, i.e. carbon, silicon etc. Steel is the most produced and used industrial material worldwide, known for variety of tailored properties the material can have. Boundless mechanical properties can be achieved by sophisticated production methods.

In the family of metallic materials, steel is not the only material which bears the severe working conditions of heating and cooling cycles for years working under high pressure loads for automotive-engine applications, but it's definitely the cheapest. In a bigger scale, compared to all other family of materials, such as polymers, plastics

and ceramics, steel is the best choice for many industrial applications. Boundless properties can be achieved by sophisticated production methods. By changing composition of the alloy and heat treatments after castings, steel can be designed to be as hard as ceramics or ductile like polymers, deliberated to work in high temperature conditions or cold environments, or even both, opposed to frequent temperature shocks, resistant to corrosive surroundings. Reaching the similar properties with other types of materials is not unmanageable, however considerably more complicated and unquestionably much more expensive.

*Steel is one of the world's most-recycled materials, with a recycling rate of over 60% worldwide.*

In addition to made-to-order properties, recyclability is a critical advantage of steel over other family of materials. Plastics, polymers and ceramics are almost non-recyclable materials

compared to steel which is recycled by rate of 60% globally.

Although other groups of materials are improved to a great deal in manufacturing and properties in the last decades, the all mentioned properties of steels, make consuming steel in modern industry inevitable, to the degree that the steel industry is often considered an indicator of economic progress internationally.

### **Why we need more improved steels?**

The start of industrial production and consumption of steel goes back to more than a century ago, however the research on developing of properties in steels is still ongoing. Preparation of steel for the application in different conditions like combustion engines requires a long process. The production of steel usually starts from smelting raw iron and addition of different alloying elements. Then huge ingots of raw material, which are severely weak in properties, are subjected to several hot or cold working processes and heat treatments routes, which completely create measurable new properties in the final product. As an indicator, the average ratio of strength over weight for final steel products is used for valorization of the processes it has passed. Ongoing researches in the last decades have led

to persistent increase in the reachable average ratio of strength over weight for final steel products, however, like other disciplines of science, the unknowns outdo the already categorized knowledge. More research can lead to better understanding of the mechanism of microstructural changes in the materials and can lead to more efficient designing of production and treatment methods leading to light weight robust materials. This means reduction in the total consumed energy – or emission of greenhouse gases- in production of raw steel, and moreover during service in automotive industries. This doesn't mean preparing cars for using in imaginary more sever thermal conditions ,which can happen if global warming continues with current rates, but means preventing it by using cars with stronger body and better engines, but remarkably lighter in weight and less fuel consumption and CO2 emission.

*The average ratio of strength over weight for final steel products is a very crucial factor effecting the total weight of your car. Approximately, fuel consumption is reduced by 1 lit./100 Km by 100 Kg reduction of weight of a car.*



Nigel Treblin | Getty Images

Today, it's intercontinentally avowed that global warming pose an explicit threat to future of human on earth. While recently world leaders in United Nations Climate Change Conference established an agreement to reduce CO<sub>2</sub> emissions as part of the method for reducing greenhouse, investing more funding for research on steel can be an option, as massive usage of steel is insuppressible in boosting new economies. Although other groups of materials, such as polymers or composites may apparently seem more attractive for future investments, future is accompanied with massive industrial production and consumption of steel: better to be prepared for it.

# Arsenic in Nicaragua: The Forgotten Deadly Threat

By BAYARDO J. GONZALEZ– Phd Candidate – TU DELFT – CiTG – Watermanagement – Sanitary Engineering

***Among the natural contaminants that we can find in water, the arsenic is the most carcinogenic substance. It is found in groundwater in over 70 countries and it is affecting 150 million people worldwide. The first documented case of arsenic poisoning in Central America was reported in 1996, in El Zapote, a rural community located in northern Nicaragua. There, 125 people were ingesting water for two years (1994-1996) from a contaminated public borehole that had an arsenic concentration of 132 times of the permissible level.***

Among the natural contaminants that we can find in water, the arsenic is the most carcinogenic substance. The World Health Organization has recommended a provisional concentration of arsenic in drinking water not exceeding 10µg As /l. Long-term intake of water with high concentrations of arsenic can cause the development of Arsenicosis (arsenic poisoning).

Nicaragua's concern about arsenic presence in water sources and its influence in human health began in 1996. In this year the first documented case of arsenic poisoning in a rural community was reported. In this community, 125 people were found with the characteristic skin lesions of chronic arsenic poisoning. These people were ingesting water for two years (1994-1996) from a public well that had a concentration of 132 times of the permissible level.



Keratosis caused by ingestion of water with arsenic in a resident of a rural Community (Alina Gomez, 1996)

*“In 2004 UNICEF estimated that around 60,000 people from rural communities were consuming water with high arsenic concentration ”*

According to a study published by UNICEF in 2004 around 60,000 people were consuming water with high arsenic concentration and were living in small scattered rural communities or small towns. The number of people who are currently ingesting water with arsenic in rural communities in Nicaragua is unknown.

When the potential sources of water are contaminated with arsenic in rural and urban areas, the appropriate authorities proceed to close these sources and look for alternative sources. As expected, the most affected with these measures are rural communities using public wells which do not have any source of supply water nearby or suitable alternatives. It should be mentioned that there are high chances of the existence of contaminated wells that have not been detected yet, and they are being used by people in some rural communities in Nicaragua.

*"There is a saying in the rural communities: "I'd rather die of arsenic poisoning than diarrhea"."*

In some cases, despite the fact that the authorities have banned the consumption of water from wells affected, the population still is using them because of the lack of alternative sources of water. There is a saying in some rural communities: "I'd rather die of arsenic poisoning than diarrhea".

An alternative solution for rural communities affected by arsenic poisoning, are low cost systems of arsenic removal. In Nicaragua the knowledge of arsenic removal systems comes from researches conducted by universities, World Health Organization and non-governmental organizations working with water and sanitation. However, despite the great efforts made by some universities and these organizations, there is still very little practical experience with low cost systems of arsenic removal. So far the few attempts in the implementation of some of these systems (Example: Kanchan filters) have resulted in failure. Globally, several treatment technologies are being tested and have shown promise results, but there are still many unanswered questions regarding the selection of an appropriate technology. Unfortunately, these technologies cannot be "simply imported", they have to be adapted to the

local situation of Nicaragua, and it is necessary to tested and validated them before large-scale replication.

*"From 1996 until 2015, water sources located in 84 rural communities has been reported with arsenic contamination problem, and this number is still increasing"*

It's been passed 20 years since the first case of arsenic poisoning was reported in a rural community. Even so, it is alarming to know that there is no a national strategy to deal with this problem. It should be emphasized the fact that the supply of clean drinking water, which is a basic human right, is being denied to these poor and rural communities affected by arsenic poisoning and limited access to water.

The solution of this problem requires the development and implementation of multidisciplinary strategies for the protection of the health of the rural population of Nicaragua. These strategies should be developed by the government but the participation of universities, NGOs, private enterprise, and civil society is also necessary.

# Artificial muscles taste like Mc Nuggets

What a fast-food specialty and future prosthesis share?

By Alessandro IANNARELLI – Early stage researcher – TUDELFT

***A popular idiom states that the human being is a perfect living machine. Unlike a machine, however, replacing the damaged parts that decay over time can't be done with the easiness and the efficiency of a mechanic, yet. Recently, scientists made a breakthrough in biologic mimic and in the near future inexpensive and efficient artificial muscles will be crafted by using no more than 'simple' rubber.***

Smiling. Eating.  
Talking. Kissing.  
Swimming. Walking.  
Looking. Writing.  
Playing. Singing.  
Running. Driving.  
Hugging. Make a list  
of the activity you can  
do without any of

your muscles aid and write it down. You will probably stare at a blank page. Don't worry. Just for the fact that you are alive, you are non-intentionally using the entire breathing apparatus.

Even if you are now trying to hold your breath, your powerful heart will still let you enjoy the life for a long time.

Muscles are continuously involved, they are a lot and they are essential in our lives.

Sadly, they are not forever: aging, environment and

injuries may compromise their functionality by time.



Scientists recently found a new solution to overcome nature's limitation: they are making synthetic muscles out of a special silicon-based rubber that in the

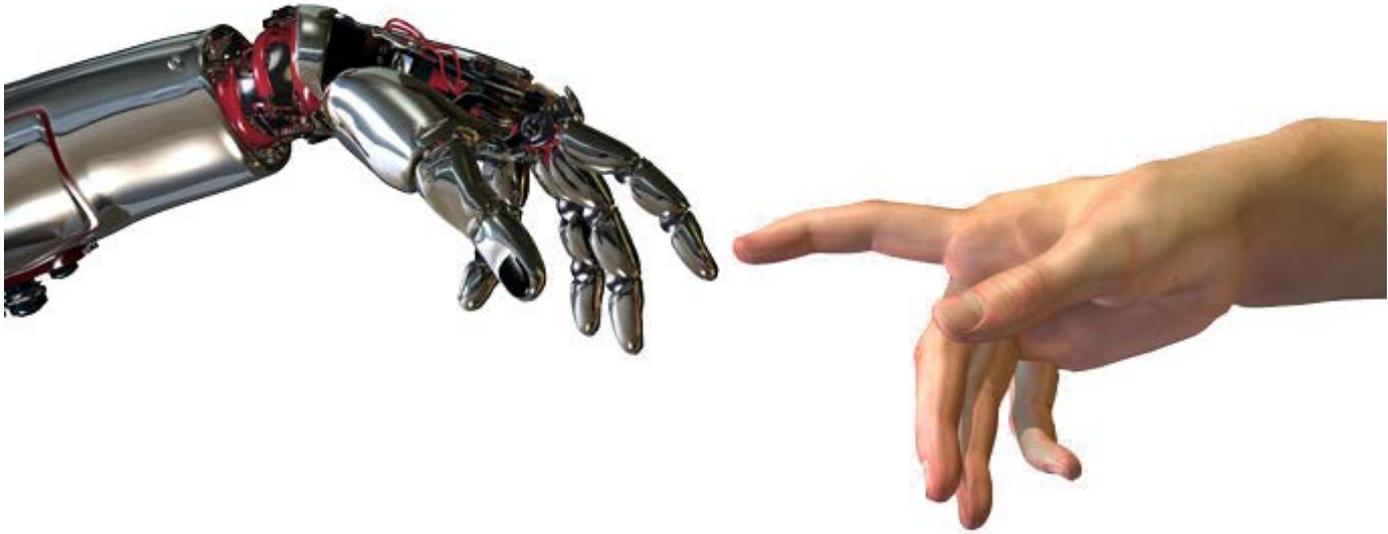
future can be used as replacement or aid for the real ones. This is not just a laboratory or fancy concept: fully working prototypes of swimming fishes, floating and moving jellyfishes, delicate as silk strong as steel grippers, soft moving robots and more already exist. Some industries started also commercializing it for specific optical-actuation applications. The use on the human body is the next coming step everybody is looking forward to see.

## Make it different

Human being is facing the problem of prosthetics since ancient Egypt, according to some archeological discoveries. We did make great progress since then, thanks to modern technology, too. Nevertheless, if we think at artificial muscles, we still have the image of bulky, noisy, heavy,

*“Human being is facing the problem of prosthetics since ancient Egypt”*

uncomfortable and joggling device, inevitably. This is because, current technology, even if at a very advanced level, is based on a combination of motor and gears. Old fashioned mechanic works, but lacks of refinement. The new idea is inspired



This material has not been pulled out of a hat, but already existed and, oddly enough, is found in several daily life fields: cosmetics, medicine, toys, breast prosthetics, lubricants, conditioners

by the essence of the real muscle working principle, instead:

A muscle is a "thing" that is able to contract (or expand) when an external stimulus is present. Researchers found out that certain materials are able to contract (or expand) when a source of electricity is applied to them. Exactly like the real muscle fibers do. Electroactive Polymers (EAP) is the name for these new-discovered materials. To make a synthetic muscle, no more than an electric source and this "special" material are needed. No engines. No gears.

A suitable EAP for mentioned application and the nowadays mostly used, is a silicon-polymer-based rubber, namely PDMS.

and...food! In fact, one among the most common uses is as additive to frying oil in fast-food restaurants: it prevents forming of dangerous flammable foam. Do not be afraid for the taste of your Mc Nugget, only a maximum concentration of 25 parts per billion of PDMS is allowed by law (For comparison, this is the same concentration African continent would have if its whole territory was populated by only 20 people!)

Every mechanical design limitation offered by old techniques is removed by using a rubber like material: it is flexible and castable, so it can take any wanted shape; it is noiseless, since no moving, rotating, sliding parts are involved; it is cheap, since rubber is cheap compared to all the material needed for mechanical equivalent parts; it is lighter and, most important, it's bio-compatible by its nature.

*"Every mechanical design limitation offered by old techniques is removed"*

For honesty's sake, it must be mentioned that electroactive polymers are not the only materials with the mentioned characteristics and other materials like Shape Memory Alloys (SMA) actuators and Magnetic Field Actuators can do the job, but they lack of quickness and strength, that are the strongest advantages of using EAPs, especially if we want to use them as muscle replacement.

In 1999, NASA laboratory R&D, posed an arm-wrestling challenge between an artificial arm and a human opponent., for proving EAP operation,

### Not only muscles

Interesting materials have interesting applications and EAPs are not only limited to be a replacement for muscle-like device.

They can be alternatively used as sensing device and this is already leading towards a new era of touch-sensors as we never seen before. In fact, they can be reversely used and they can generate electric signal when they are deformed or touched, even slightly. Starting from this simple behavior, it has been possible to manufacture electronic skin that can substitute the damaged one.

“Recently, a research group has successfully build a Braille display for blind people”

Moreover, building of stretchable touch-screens, wearable electronics, deformable solar

cells or any deformable sensor is now possible thanks to the flexible property of this medium.

Recently, a research group has successfully build a Braille “display” for blind people, with variable characters whose Braille pins are pushed up thanks to the the driving force of artificial muscles.

Another different application still under construction is energy harvesting: EAPs may be the future green energy source. Major off-shore companies are investing their money on new powerhouse design that stores the electricity generated by deforming big EAPs devices floating on the sea and release later into the electric network.

All this mentioned applications were just unthinkable by using common electronics, that relies on stiff conductors like copper or silicium.

### Jumping the obstacles

All the new discoveries come with some limitations, and EAPs are not an exception.

This material need an external electric source to be activated, since it needs power. The problem is that the source's voltage is of the order of some thousands of Volts. Unfortunately, this is too close to the threshold of the electric breakdown of the material, making most of the devices fail within few application cycles. Likely, new technology allows to better engineering the material and by use of nanoparticle technology scientists are on the right way for finding a solution to lower down the huge voltage now applied.

We can confidently say that in the near future you will benefit of a full artificial muscle application on your body. Meanwhile, you can await and try to do your best to find their taste in your favorite fast food restaurant!