



RICE  
CATALYST

# eureka

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# LETTER FROM THE EDITORS

In the fall of 2016, Eureka began as a collaboration between Catalyst, Rice's undergraduate science research journal, and the Energy Institute High School. Catalyst has always had two main goals: creating exceptional and accessible science communication, and providing educational opportunities for those who want to develop their writing and communication skills. For Catalyst, partnering with Energy Institute AP Environmental Science students was an obvious next step in expanding our outreach efforts.

Eureka's first issue would not exist without the tireless work of AP Environmental Science teacher Jillian Estrella, the Catalyst mentors, and, most importantly, the Energy Institute writers. The ten high school students who wrote these articles were amazingly hard working and motivated. With the guidance of their mentors, they chose topics to research, collected information from reliable sources, and learned how to organize, write, and edit their articles. Much of the work was completed outside of the weekly one-on-one meetings between the writers and their mentors, and the quality of the articles reveals the passion with which the writers created them.

This issue explores a variety of subjects ranging from artificial intelligence to the cognitive effects of hunger. These articles cover not only the scientific research being carried out, but also how it intersects with social issues: the most important part of research is how its results ultimately impact our lives. By learning how to communicate the necessary details but also the broader implications of scientific research, the writers of Eureka developed the skills necessary to promote scientific literacy in their communities.

Due to the success of the first issue, Eureka is expanding. While continuing to work with Energy Institute students, mentors will also partner with students at Young Women's College Preparatory Academy to help them develop their own articles. All of the original mentoring staff is staying on to support new students this semester, which is an incredible sign of dedication. In addition, we would like to offer special thanks to the Hilda and Hershel Rich Family Endowment grant for providing essential funding for Eureka, as well as the Rice Center for Civic Leadership, for their continued support of Catalyst activities. We look forward to another eight weeks of watching mentors guide their students through the writing process and seeing the students find their voice. We are grateful to all those who support Eureka and its mission of making scientific writing accessible to all.

**IN PARTNERSHIP WITH THE ENERGY INSTITUTE HIGH SCHOOL**

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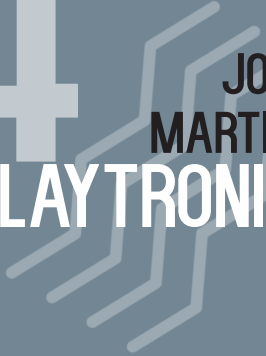
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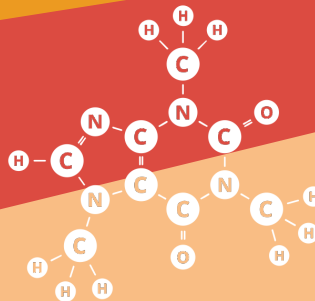


12 ANDREW  
FARIAS  
GOT MILK?



# CAFFEINE CRASH

BY CHANCE BEDNORZ



In past years, the usage of high-caffeine energy drinks has increased in young-adults despite warnings against consumption of caffeine in minors.<sup>1</sup> Meanwhile, the amount of teenagers that smoke has decreased immensely since 1967. With increased efforts to eliminate cigarette smoking in adolescents, it is no wonder that the number dropped from a high of 36.4% of teens to a mere 16.7%.<sup>2</sup> However, is there any correlation between the two? Determining this correlation could reveal more insight as to why nicotine use is prevalent and how we can combat its usage.

A recent study examined the effects of caffeine on persistence and nicotine-seeking behavior in rats. The researchers discovered that caffeine addiction prior to the administration of nicotine and usage of caffeine after the withdrawal of nicotine increased nicotine seeking behaviors within the rats. In other words, as the rats were forced to quit nicotine consumption, the caffeine negatively impacted their brain, increasing the rat's desire for nicotine.<sup>3</sup>

So it becomes that much harder to quit nicotine usage when consuming caffeine, but is there any correlation with caffeine usage and the likeliness of people to take up smoking or begin using nicotine products?

While cigarettes have been downcast regularly in the public eye more and more each year, caffeine, on the other hand, increased in popularity, specifically through the usage of high energy drinks like Red Bull and Monster.<sup>1</sup> Interestingly enough, the energy drinks themselves also pose tremendous health problems, especially in the adolescents that energy companies market too in America. Such health problems include potential cardiac arrest, increased anxiety, higher risk for type 2 diabetes, and higher blood pressure.<sup>1</sup> Government programs were put in place

in recent years to minimize the amount of teenage smokers - campaigning using fear-tactics, celebrity spokespeople, and creating a bandwagon effect that add up to an anti-smoking America.<sup>2</sup> On the flip side, the United States is one of the more lax countries with regards to regulation of highly caffeinated energy drinks, while many European countries ban the sale of these drinks to minors.<sup>1</sup>

Addictive substances all share several things in common. Any addictive substance, be it alcohol, nicotine, or caffeine, causes physical changes in neurons. These neurons, which are the nerve cells of the brain, send and receive signals from neurotransmitters. The addictive substance releases feelings within the brain that make us feel good, differing depending on the substance in use. As a person continues using the substance, they develop a tolerance, meaning that they require larger and larger doses in order to achieve the same feelings of pleasure. This is where addiction comes in. As the usage continues increasing, the tolerance and the dosages increase, creating a vicious cycle. It is this cycle that creates addicts.<sup>4</sup>

Several factors contribute to a person's addiction to various substances. In one study conducted, the authors claim that the factors maybe be genetic. They state that the use of alcohol, nicotine, and caffeine might have correlation through a common genetic factor (polysubstance use). In contrast, a different study contradicted this statement but only slightly. The author claims that only nicotine and caffeine have genetic factors that are unique to just those two substances. A study conducted on caffeine-dependent adults "reported a clustering of histories of caffeine, nicotine, and alcohol dependence", so there is most assuredly some relationship between dependence on nicotine and caffeine. Basically, a person with the poly-substance gene has a genetic

predisposition to get addicted to the substances more easily than other people. And according to the last study mentioned, adults with a dependence on caffeine had also been addicted to nicotine and alcohol sometime in their life.<sup>5</sup>

In conclusion, caffeine and nicotine addiction definitely have a correlation in that the usage of caffeine while simultaneously trying to quit nicotine is exponentially more difficult. Whether or not the two are linked through genetic factors is uncertain, and needs more clarification and research in order to be conclusive. From a social perspective, it is clear that there is a lot more of a societal stigma towards smoking nicotine than there is around consuming high quantities of caffeine. With this information in mind, it is that much more important to determine the correlation of caffeine usage and nicotine, especially in young adults.

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# CLAYTRONICS

BY JOSUE MARTINEZ

Claytronics or Catom (for short) came from the idea of programmable matter, which is the ability to change an object's physical properties by using a form of tactile material to take any shape imaginable. One might suspect that the basis of this idea may take thousands of years to develop, but in reality achieving this feat is closer than expected. While 3D printers can create such things on a three dimensional scale, their production does not come anywhere close to the idea of transforming the same object into three different objects. This is where Claytronics comes into play. The idea came from Carnegie Mellon University and Intel Research Labs in Pittsburgh.<sup>1</sup> In order to garner a better understanding of Claytronics, we will investigate the hardware, software, scaling over time, setbacks, and potential applications of Claytronics, showing us how Sci-Fi technology is becoming a reality.

The bases came from a program known as Catom, which utilizes forms of computerized atoms. When joined, they can morph their shapes, sizes, colors, and functions creating different 3D objects allowing the user to interact with this technology.<sup>2</sup> In many preliminary designs each Catom is a unit with a CPU, an energy store, a video output device, often times one or more sensors, and a means of locomotion. Early prototypes worked via electromagnets for movement. The sensors themselves would have photocells to sense light and allow them to see the changes in light on surfaces with emitting diodes. The Catom units each move in the appropriate direction when they are in close proximity to each other by simply moving different individual parts. The programming consists of tasks such as computing, communication, and adhering senses powered by two basic mechanisms: a processor and an arrangement of conductive plates on the surface. Creating the Catom is 20% of packaging, while 77% is mainly used for magnets and support circuits.<sup>3</sup>

There are two alternatives to the single-program-multiple-data (SPMD) programming model.<sup>4</sup> The process of planning autonomous agents, which creates a coordination system for a good

runtime system, is conducted via local communication and deformation. The system itself would also need to prevent over-usage of a massive number of Catoms.<sup>5</sup> When programming these Catoms, the process requires different computing language for each Catom, debugging each Catom, shaping, localization, and dynamic simulation testing of each Catom.<sup>6</sup>

In future years, the hardware components in these Catom mechanisms will be scaled down to a micronized size to yield millions or more of Catoms in order to create programmable matter. An analogous example to scaling down Claytronics is the M-TRAN3, which was present at a robotics expo in 2005. The justification behind the close comparison is due to the fact that it is a self-configuring modular robot, consisting of interlocking parts allowing it to take different forms of movements and assembly.<sup>7</sup> In 2014, John Romanishin, a student from MIT, created the M-Blocks, which are 5 cm cubes on each side and are able to rotate at high speeds allowing themselves to assemble a lot quicker.<sup>8</sup> The 2D Catom format has a diameter of 0.7 millimeters and a usable area for circuits of just over 1.5 square millimeters. The MEMS circuit was developed in 2002 and could be used to create 3D devices. J. Robert Reid had constructed a spherical shape of the circuit with a radius of one mm by printing the projection and by harnessing the inherent stresses in thin-film silicon dioxide.<sup>9</sup>

As with any new technology, there are always setbacks. Creating more advances in this type of technology poses problems, such as software issues, specifically functionality, managing concurrency, handling failure robustly, dealing with uncertain information and controlling resources usage.<sup>10</sup> The reason is that the programming has an upper limit on the number of individual Catoms that can function altogether. Carnegie Mellon students have broken down this issue into 3 specific points: specifications, compilation, and runtime support.<sup>11</sup>

An example of the potential of the Catom project would be a sofa in a living room

being suddenly transformed into a desk and then into a television with a stand. The possibilities with this type of technology are astonishing. Another application would be for medical purposes for searching for things like tumors, cancer, and other diseases. We have seen this type of technology already in pop culture sci-fi movies, books, video games, and on the internet. It is only a matter of time before digital reality meets with the physical reality, allowing us to perform more advanced concepts than ever before.

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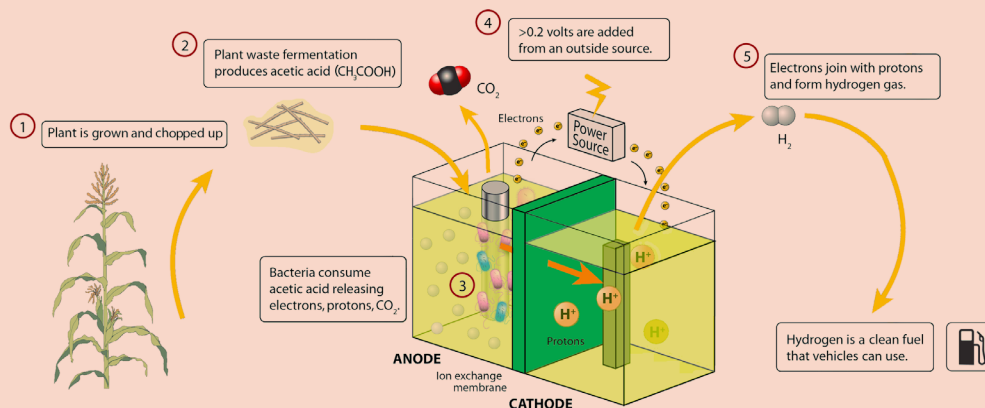
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*Images from Carnegie Mellon University*

# WASTE TO ENERGY

# FUEL OF THE FUTURE

BY FRANCISCO ANANYA



Greenhouse gas emissions are at an all time high. With the increase of greenhouse gases in the earth's atmosphere there is a negative impact on the environment. Climate change is one of the biggest problems that arrives from greenhouse gas emissions. The Earth absorbs sunlight and then radiates it outward as infrared heat, yet 90% of that infrared heat is then re-absorbed by greenhouse emissions and radiated back to earth.<sup>1</sup> The overall climate of the earth gets warmer as a result, which will cause devastating habitat and environmental changes. Climate change also affects earth's water system. Oceans absorb 90% of earth's heat, so increasing that absorption can disrupt ocean currents, and lead to many oceanic organisms dying. One of the main causes of the abundance of greenhouse gas emissions is our current energy sources. Our leading source of energy is fossil fuel, which accounts for 65% of greenhouse gas emissions.<sup>2</sup> While fossil fuels are the leading energy source they are responsible for the large increase in greenhouse gas emissions. This shows a need for a new energy source that can reduce greenhouse gas emissions but still efficiently provide large amounts of energy. One potential energy source being investigated for this purpose is the microbial fuel cell.

A microbial fuel cell (MFC) is a bioreactor that uses bacteria to produce electrical energy. Two types of microbial fuel cells are being developed. One type generates electricity using bacteria that break down substrates like wastewater or sugars and metabolize them into electricity.<sup>3</sup> A microbial fuel cell is built in two chambers: the anode and the cathode. The wastewater

is fed to the bacteria at the anode. The bacteria digest the substrate and produce electrons, which flow into the aqueous cathode, causing an electric current that can be harnessed for energy. A salt bridge connects the anode to the aqueous cathodes to prevent charge buildup and keep the electrons flowing.<sup>4</sup> The second type functions the same way as the first, but uses photosynthetic bacteria that take in sunlight and produce electrons.<sup>5</sup>

An ideal environment for microbial fuel cells are wastewater treatment plants. Many wastewater treatment facilities are built to break down organic material, so they are a perfect place to apply microbial fuel cells.<sup>6</sup> Emefcy is an Israel based company that has built a microbial fuel cell waste treatment facility. Inside their fuel cells, Emefcy coaxes anaerobic bacteria, primarily *Shewanella oneidensis* and *Geobacter sulfurreducens*, to release electrons in an oxygen-free environment. This facility produces four watts of electricity for every kilogram of wastewater the bacteria consume, which is enough energy to power the treatment facility itself.<sup>7</sup> Even though MFCs may be a solution they still have many challenges. The biggest challenge of MFCs is being able to scale it up in order to produce more energy.<sup>8</sup> Currently the microbial fuel cell facilities are not efficient enough to make MFC a leading energy source.<sup>9</sup> However smaller-scale MFCs are more efficient than larger scale MFCs, so networks of small MFCs may be a potential solution to the efficiency problem.<sup>10</sup>

Today the Earth is in a very severe situation in which huge amounts of energy

consumption is increasing greenhouse gas emissions at a global scale. These gases are causing major problems for the environment. However, microbial fuel cells are a potential alternative energy source that can reduce greenhouse gas emissions. With a little more research microbial fuel cells problems of scaling up would be solved and making it the next leading energy source.

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Image from NSF<sup>7</sup>

# VIDEO GAMES:

## BOOSTING BRAIN POWER??



BY FERNANDO SANCHEZ

*Icons from Vardan Stepanian  
from the Noun Project*

58% of parents say that their kids do not play videogames, also claiming that games are a negative influence. There have been many discriminations against games such as Grand Theft Auto or Call of Duty, suggesting that they may inspire ideas of violence. Some experts would say that some games help to improve with cognition and processing speed such as hand-eye coordination or working memory. Even with short bits of maybe 15 minutes of gaming a day can help to increase these skills of cognition. Even though parents say that some games are all negative based on what they are, new studies that are conducted can show what good games do.

There have been several different studies in order to see what kind of effect video games can have on the mind. Many include results with improvement in cognitive abilities. Games such as Brain Age or Tetris have been shown to assist with skills such as attention span and working memory as well as overall processing speed. A study has been done to test the effects of 2 games on 2 different groups. Both groups were told that they had to play a game for 15 minutes a day and 5 days a week for 4 weeks and had cognitive tests taken beforehand and after to show the difference. The first group was assigned Brain Age and the other Tetris. The Brain Age group showed an improvement in executive functioning and processing speed. The Tetris group did show improvement in attention and visuospatial ability. There are many unknowns such as the effects of other games such as Call of Duty. An example can be such as students or kids who play games such as Minecraft have shown an increase in creative thinking styles. The same researchers had conducted the test again, changing the age of the test subjects. Brain Age and Tetris were used once more to compare improvement dependent on age. Surprisingly, the Brain Age group had shown improvement in executive function and processing speed but not global cognitive status nor attention. However there are still uncertainties in the the long-term effects of this type of training nor functionality in

everyday life. Even so the short term effects have shown to be effective as a training tool. Even studies on how well someone drives has been linked to video games. Players of action video games such as Call of Duty and Battlefield had shown a higher visuomotor control than those who play non-action video games, as evidenced with things such as lane-keeping. Visuomotor control is the way that visual information is transformed into motor acts. Studiers had trained a

### THERE IS A LINK BETWEEN THE ACTION GAMING AND ENHANCEMENT IN VISUOMOTOR CONTROLS

group of non-action gamers with action games and a group of action gamers. For the non-action group, after playing a first person shooter game or driving game for 5-10 hours had shown a significant improvement in visuomotor control. After completing this study, the findings had shown that there is a link between the action gaming and enhancement in visuomotor controls. Even so it suggests games can be used as training tools.

Video games get a negative reputation from those who don't know that it is advantageous, though if they get more information on it they would be more apathetic towards games. Processing speeds, cognitive abilities, and working memory are a necessity in this world. With an improvement in video game research methodology studies can be more applicable and appreciated. But the existing results suggest merit in the idea that videogames can improve cognition, and is perhaps worth exploring further.

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# PIEZOELECTRICITY

ONE STEP TO POWERING THE WORLD  
BY ABIGAIL PARAKOYI

*Icons by my name is mud  
from the Noun Project  
Flow chart adapted from  
cyrielkortleven.com*

The idea of traditional energy harvesting has been proficient throughout the years, however recently there has been an introduction to a new form of energy harvesting.

Alternative energy comes from energy sources that would otherwise be lost. Piezoelectricity, also called the piezoelectric effect, can be defined as the ability of certain materials to generate an AC (alternating current) voltage when subjected to mechanical stress or vibration. Conversely, the inverse piezoelectric effect is defined by an object responding to an AC voltage with a mechanical vibration.

Before discussing the topic of piezoelectric energy harvesting, let us discuss what energy harvesting is first. According to the Institute Of Physics, energy harvesting can be defined as the capturing of small amounts of energy in our environment that would otherwise be lost through the form of heat, light, sound, and or vibration.<sup>1</sup> Energy harvesting has created several solutions to the world's energy crisis, such as wind energy, kinetic energy, solar energy, etc. In recent years, piezoelectric energy harvesting has been proposed as another means of large scale energy harvesting. Utilizing piezoelectric energy on this level would aid in filling the energy gaps left behind by the other forms of alternative energy harvesting.<sup>2</sup>

Piezoelectric energy harvesting can be defined as the use of piezoelectric crystals to harvest kinetic energy from movement. Piezoelectric crystals, by undergoing mechanical stress, generate electricity. The same process could occur vice versa through the application of electricity on the crystals which then vibrate the crystals. They are several forms of piezoelectric crystals. While quartz and ferroelectric crystals, such as tourmaline and Rochelle salt, are good examples of piezoelectric materials, ceramic lead zirconate titanate – more commonly known as PZT – is the most widely-used

piezoelectric material used for energy harvesting. A key advantage of PZT materials is that they can be optimised to suit specific applications through their ability to be manufactured in any shape or size.

While the piezoelectric effect was first discovered in the 1880s, There have been huge strides in recent years resulting in the production of several modern piezoelectric products.<sup>3</sup> This makes piezoelectric energy harvesting extremely unique from the several other alternative energy harvesting forms. While traditional energy harvesting focuses on large scale forms of energy, piezoelectric energy instead focuses on collecting the small amounts of energy that is otherwise lost in modern civilization. This is ideal for metropolitan settings as it not only can reclaim a substantial amount of energy, but also spreads awareness to the amount of energy individuals consume, helping to reduce their energy waste.

Pavegen is an example of a modern product that utilizes piezoelectric energy.<sup>4</sup> The idea behind this product was to use piezoelectric energy harvesting methods through the use of energy harvesting crystals to cultivate kinetic energy through the compression of vibration and heat from human movement.<sup>5</sup> As piezoelectric energy is an up and coming energy source they are still areas that require more research on how to make the product more efficient. This research is currently in the works as it is recent. As this field is new and developing there have been many research developments and improvements in efficiency. They have been developments of using piezoelectric fabric and crystals have been introduced to cultivate kinetic energy.

The research done on piezoelectric energy harvesting can be a great solution to the issue of the population energy demand to be met by the year 2050. As mentioned before, piezoelectric energy harvesting can be from several forms of kinetic energy such as heat, vibration, movement, light and so

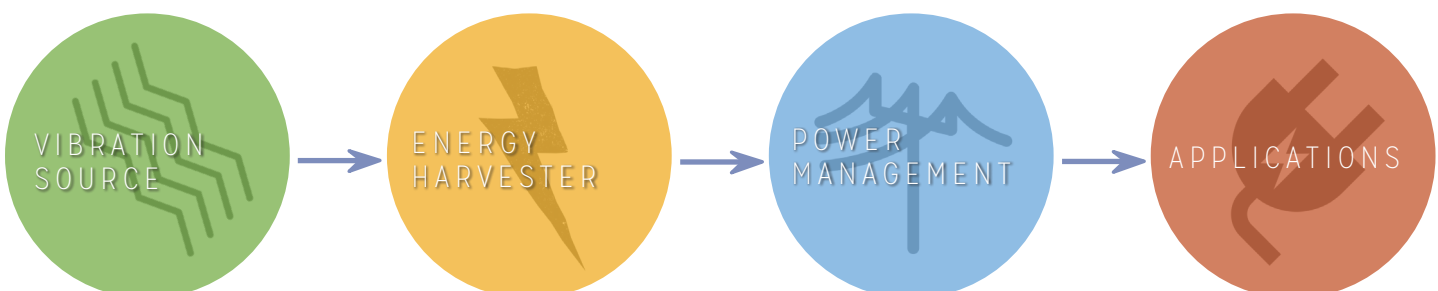
forth.<sup>6</sup> All of these sources of energy tend to be lost in the atmosphere, rather than being used to fuel technology in our current day and age.

Even though piezoelectric energy harvesting is viewed by many as a solution to the world energy demand, the practice is quite expensive to both research and implement in society. Piezoelectric energy harvesting is still a brand new topic in the science world that requires intense amounts of research. By being an expensive area to invest money in, several researchers and entrepreneurs have shied away from the energy form.

Piezoelectric energy harvesting can provide power to several energy consuming devices, such as batteries, cars, lights, etc.<sup>7</sup> This can also encourage individuals around the world to see the importance of energy conserving, because they can directly see where the energy for their everyday objects comes from. This can impact humanity by increasing the availability of clean energy to use in society. With the use of piezoelectric energy harvesting the next generation will have a new source of energy to fall back on. Piezoelectric energy is a new form of energy discovered in the recent decade. Several researchers have been studying the benefits and the implementation of piezoelectric energy in the functionality of several products. Through the use of piezoelectric energy harvesting society would be able to move to a carbon free environment as well as an energy aware society. According to Nisha Patel and her co-authors the world's energy demand would be met if more research and awareness was brought into the field of piezoelectric energy harvesting.<sup>5</sup>

**WORKS CITED** on page 8

## TYPICAL COMPONENTS OF VIBRATIONAL ENERGY-HARVESTING SYSTEMS







Icons by Joana  
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from the Noun  
Project

# FINDING FUEL

BY DAVID BURBANO

A growing population requires energy in order to sustain the 9 billion people estimated to be on earth in the year 2050. Fossil fuels are providing over 70% to meet the demand for a growing population, but the problem does not lie in the lack of resources currently at the disposal of government leaders but in innovating current methods for the extraction of oil and gas. Currently there is more oil and gas left inside the earth than the production of it brought back to the surface. Methods used in the present include air pumps and natural pressure but neither fully solve the problem of recovering oil and natural gas.

Onshore and offshore drilling require various methods for completion which range in levels of productivity and prices. Oil and gas require the operations team to analyze the cost of drilling, seismic data, and the capital for each of the completion projects. The ideal well completion is composed of maintaining maximum well productivity, sustainability of well conditions, all at a minimal cost. The composition of drilling engineers, reservoir engineers, and facility engineers work towards the goal of providing the world with energy. The natural pressure below the earth provides enough force to bring the oil and natural gas to the surface, and through various layers of piping, the sublevel is protected from the harmful effects fossil fuels can have on the surface. Additionally, the miles of piping traveling through the earth's crust prevents harmful effects on civilians and their livestock.

Some of the challenges facing recovering oil and gas is the extraction process, and the reservoir difficulty can vary on the type of rock. High permeability and porosity are important for the fuels to naturally reach the surface. Fluid is specific to the type of rock that is being broken. Unconventional wells utilize shocking guns which send sound waves into the rock. The cracks in the rock will then be filled with cement which then gets hard and breaks the rock even more. Then smart devices close the crack and send fluid in order to break the rock even more in order to boost porosity and permeability.

There have been various reports of an immense amount of natural gas known as the shale revolution. The innovations in the previous years have seen an increase in drilling and completion technologies. The common way of completing a well in recent years involves multiple horizontal wells which are called hydraulic fracking.

Though the completions process has its challenges, goals for the oil and gas industry include minimizing constraints on production. The pumps and other mechanisms require a lot of surveillance and minimizing pressure drops would not only save money but increase maximum flowing pressures which will produce a high return of investment.

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# MIRRORING THE BRAIN WITH ARTIFICIAL INTELLIGENCE

## BY SHAWHEEN ATTAR

With the rise of science fiction in the early 20th century, people began to dream up possible future worlds. Flying cars and space travel were popular within the realms of movie and television, but artificial intelligence became an idea that grew and has now taken an active role in people's day to day lives. Primitive forms of AI can be found in the palms of our hands through Apple's Siri, Google's Assistant, and Microsoft's Cortana. While these personal assistants may not be as advanced as the robots from the Jetsons, they are considerable steps in the right direction for furthering AI sophistication.

Back in the 1960's, soon after the birth of artificial intelligence, researchers believed that the existence of sophisticated AI in society was only a few decades away. Recent advances in robotics led researchers to believe that they were close to cracking AI. However, in spite of advancements in creating viable artificial intelligence systems, much of the research became stagnant. The main issues that arose with creating AI lie in the architecture of the computational algorithms, called neural networks. While these networks have proven to be successful in new technologies like Siri, Google Now, and Cortana, the algorithms that compose those systems were created from trial and error and are not the most efficient at carrying out actions. The best algorithms can be found, however, in a very accessible location: the brain.

Scientists have been interested in the brain for centuries, but only recently has its possible implementation into AI become a focus of research. One particular region, the neocortex, is the part of the brain that is most closely associated with sight and sound. Researchers want to learn how the neocortex functions, and they hope to use these neural functions in enhancing artificial intelligence.<sup>1,2</sup> One such research project

that is working to further the extent of this knowledge is the Machine Intelligence from Cortical Networks project (MICrONS). It is funded by the U.S. Intelligence Advanced Research Projects Activity (IARPA) with a \$100 million grant.<sup>3</sup> It mirrors the effort that was put into the Human Genome Project, and its main purpose is to help understand the brain, map out its functions, learn how different regions work, and implement this knowledge into developing more sophisticated artificial intelligence algorithms.

The MICrONS project is in its infancy, but there are already teams working on its main goal of reverse engineering a cubic millimeter of a rat's brain; this is an enormous feat consisting of mapping hundreds of thousands of neurons.<sup>3</sup> Dr. Andreas Tolias, a neuroscience researcher working at the Texas Medical Center's Baylor College of Medicine, is leading one of the teams tasked with reverse-engineering the neocortex. Dr. Tolias' lab focuses on studying the brain patterns and nerve cells of rodents. His goal is to "decipher the neural code," meaning that he wants to learn how neural cells interact with each other in certain situations in order to further implement those behaviors into computational algorithms and machine learning.<sup>2</sup> By focusing on the signals sent through the brains of the animals, Dr. Tolias and his colleagues hope to find out not just what the brain can do, but what steps the brain goes through to come to a conclusion. The method that Dr. Tolias' team is using is called three-photon microscopy. By introducing a fluorescent protein into the brain of small rodents, a laser scanning microscope can see neurons as they light up in the brain. This activity can help analyze specific neurons while helping researchers understand how the neurons influence the rats' recognition of various objects.<sup>3</sup> This research is in its early stages at the moment,

but once the MICrONS researchers complete the first stage of the project - reverse engineering a small portion of a rodent brain - they hope to implement that knowledge into artificial intelligence, enabling it to become more intuitive and efficient at solving problems and accomplishing tasks.<sup>4</sup>

Completing a fully sophisticated artificial intelligence system is only one aspect in a long process of change in human society. While AI is being developed, the human race is also debating the future implications that the new technology could have on society as a whole. In a world full of Terminator and Matrix movies, some people are truly scared that the creation of AI could lead to the end of human civilization as we know it. Even if humans are able to prevent an AI revolution, its use could lead to a seismic shift in human interactions, possibly benefiting or hurting people. In any case, while many scientists believe that the most challenging problem posed to them is, "How do we create sophisticated AI?" in reality, the question could be, "Should we create AI capable of human thinking?"

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THE EFFECTS OF HUNGER ON THE HUMAN BRAIN

# FOOD FOR THOUGHT

BY AVIN PASALAR



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The human race is on an everlasting rise in numbers, almost doubling in only a few years. The evolution of man leads society to have longer life expectancies, fewer infant mortality rates, and the opportunity for man to increase in numbers more than ever before. However, as populations increase, the amount of resources needed to sustain these populations increase as well. Hunger is one of the biggest problems we face as a society, as a severe lack of nutrition and food weakens the body, clouds judgement skills and can potentially kill the individual affected by it. What is even more concerning is that the vast majority of those whom are affected by hunger are children in less economically inclined situations. Poverty is the main cause of hunger amongst the people of the United States. Out of the 50 million Americans who face hunger every day 17 million of them are children.<sup>1</sup> Based on this information, it is reasonable to conclude that the neurological effects on children who face hunger negatively affects how well they perform in the future as adults.

Hunger sustained in a society is most often the direct result of poverty. Cases of extreme poverty are one of the main results of the increasing gap between the rich and the poor in America. Many find this to lead to what is known as a "cycle of poverty," where children who have grown up in a household battling financial distress is more likely to end up staying in that way of life. This results with those children who grow up with poverty pass it on to their children, hence creating a vicious cycle and further increasing the difficulty for the future generations to get out of poverty.<sup>2</sup>

This creates the idea that there is a possible neurological effects that result directly from hunger in youth. Research experiments done by Andreas Schoofs and Michael J. Pankratz involved using flies to understand the way the neurons react when they are deprived of food. This would assist in being

able to better comprehend the effects of hunger on the brain. The flies were first chosen as the primary subject in order to help better understand the consequences of hunger on various parts of the brain on a smaller organism, as well as how the body responds to it. It found that as the body was deprived of food and nutrients, the slower and weaker the movements became, with the flies showing poor decisions making skills and eventually leading to the shutting down of motor skills and the eventual death of the fly. While the results of these experiments may have seemed surprising, they helped give important understanding on the processes of the brain's nervous system.

The nervous system in the brain works similarly to a circuit system in that one small unbalance could lead to a complete shut-down of the system. When deprived of food the brain responds to the situation in various ways. The hypothalamus is what responds to hunger first.<sup>3</sup> Since the blood-sugar in the brain drops when the body is faced by hunger the hypothalamus is responsible for having the adrenal gland release adrenaline (stress hormone) in order to initiate the "hunt" for food in order to feed the brain. When the gene that controls the energy the levels in the brain (LEP Gene in humans and SLC5A11 in flies) is deprived of the glucose it needs to function it results in the excitability of the neurons.<sup>4</sup> The LEP Gene releases Leptins into the body which is the hormone responsible for satiety when it come to thirst and hunger.<sup>5</sup> When the LEP gene is misbalanced the hypothalamus starts releasing adrenaline which in return alerts that person's body to go look for food no matter what they are doing. This resulted with both flies and people to have similar traits such as making rash decisions and irritability affecting their life choices.

The body's response to continuous hunger can affect how the person reacts and makes choices in life just as it affected the flies. The

(SLC5A11) gene in flies is responsible for this reaction and their irritability when deprived of food.<sup>4</sup> Also with humans the LEP gene's response when a person is deprived of food results in negative behavioral acts as well as decisions which could further affect that person's future based on the decisions the take. All in all the root of hunger can come from many different places and usually in modern societies it's because of poverty. Hunger driven from poverty can not only affect the way a person behaves, and makes decisions but it also can prevent them from coming out of that cycle of poverty.

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# CARS THAT RUN OFF OF IDEAS

BY CAIO CARUGATI



The introduction of electric cars has changed the way we emit our pollution; if cars do not emit pollutants, the pollution can be concentrated around coal powerplants. Now electric cars can travel on a single charge for over 200 miles.<sup>3</sup> Traditional vehicles carry a disadvantage in terms of economy and efficiency. Electric cars have an official brand and seem to be attracting more and more of the consumer market.

The design of an electric car is far more efficient than traditional combustion vehicles. Electric motors can basically take advantage of all the energy given while an internal combustion engine is less than 35-40 percent efficient.<sup>4</sup> This is because electric cars have a controller which can regulate the amount of energy delivered to a generator. When the electric car is moving, energy can be harnessed and recycled to further power the vehicle. The cost for "refueling" an electric car is a fraction of the cost of a normal gasoline driven vehicle. In a study done by ICCT found that electric cars are far more efficient and cheaper than traditional vehicles. Two of the electric cars, Nissan Leaf and Chevy Volt, were tested amongst hybrids and other gasoline dependent models such as the 2012 Toyota Camry. When converting their electricity and gas intake, the two electric vehicles have 80-100 MJ per 100 km while gasoline fueled cars consumed about 260-299 MJ per km.<sup>4</sup>

In high dense cities like Beijing, L.A, New York pollutants can get trapped within a city, making it hard for city dwellers to practice a healthy lifestyle. This is a big factor that goes unnoticed. Many cities have been increasing in volume of carbon dioxide, due to the heavy construction and tall buildings. This causes many health issues as people can

suffer from asphyxiation, heat stress and convulsions. Electric cars relocate the output of CO<sub>2</sub> across a different outlet which can diminish the concentration within cities. The most common pollutant and greenhouse gas is carbon dioxide. This natural occurring chemical has been fluctuating throughout the years, since 1959 there was approximately .96 ppm (parts per million) of carbon dioxide currently in 2015 there is 2.96 ppm (Ed Dlugokencky, Pieter Tans; November 8, 2016; ESRL Global Monitoring Division).<sup>5</sup> IPCC said "CO<sub>2</sub> emissions from fossil fuels account for 85% of our energy usage."<sup>5</sup> CO<sub>2</sub> along with other chemicals can form a thermal blanket around the earth, sheltering it and trapping heat. As scientist/politician John Tyndall said, "As a dam built across a river causes a local deepening of the stream, so our atmosphere, thrown as a barrier across the terrestrial rays, produces a local heightening of the temperature at the Earth's surface." (Tyndall, 1862, from Weart, 2004).<sup>2</sup>

Many opposing an electric future in the automobile industry argue that oil powered cars output nearly as much as CO<sub>2</sub> in the atmosphere as "coal" (electric) driven cars. While this may be true according to the EIA outlook of 2017 they believe that by approximately 2030 renewable energy will surpass coal in the powering of our electricity in the US<sup>1</sup> Others suggest change in reliance on coal will come but at a slower rate. This mix contained: coal (42%), nuclear (19.28%), natural gas (25%), hydropower (8%), wind (3%), geothermal (0.36%), solar (0.01%), and biomass (1.3%). (Dr. Deepak Rajagopal, June 12, Life Cycle Analysis Comparison of a Battery Electric Vehicle and a Conventional Gasoline Vehicle) By 2020 Dr. Deepak Rajagopal is expecting a shift

in reliance on coal anticipating a reduction of coal usage to 1%.<sup>7</sup> Electric motors will out shine and over power the traditional combustion engine. The only question is when?

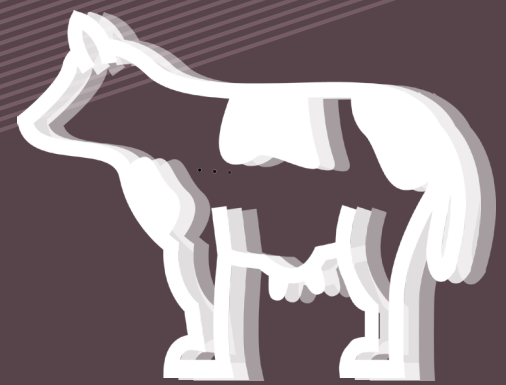
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# GOT MILK?

## CLIMATE CHANGE AND THE DAIRY INDUSTRY

BY ANDREW FARIAS



Milk is a lot like oil: their prices often fluctuate. In the same way a gallon of milk is not the price as it was a month ago, this can also be said for a barrel of oil. Like oil production and consumption, milk production and consumption results in an increase in carbon dioxide in the atmosphere. Cattle are known for producing methane and nitrous oxide, which are major contributors to Greenhouse Gas (GHG) emissions. With carbon dioxide infiltrating the atmosphere, climate change continues on its destructive path. Can these same animals, the ones who provide hundreds of millions of the world's population with milk, contribute to the decimation of our earth as well? Abnormal animal behaviors, as a result of GHG emissions, negatively influence the economy and environment through increased dairy prices and climate change.

Climate change includes global warming, the increase in Earth's average surface temperature due to rising levels of greenhouse gases, and everything else that increasing greenhouse gas amounts will affect. With almost 1.5 billion cattle around the world, this high-volume production of methane is only continuing to rise. In the United States alone, 11% of GHG emissions come from methane. The agriculture sector is a significant contributor to the amount of methane emissions that are released (EPA). Globally, the agriculture sector is the primary source of methane emissions with over 60% from human activities.<sup>1</sup> The agriculture sector is at risk as well as the cost of milk fluctuates.

With a continued rise in GHG emissions, the Earth has experienced a drastic change in temperature. As a result, the world's average temperature has increased within the past 100 to 200 years. The main GHG's that have led to this destruction are from carbon dioxide and methane. However, it is methane that holds the most potency, with 21 times more global warming potential than carbon dioxide. Cattle can generate the most methane based off of their feedstock, as is shown with the quote, "Worldwide, ruminant livestock produce about 80 million metric tons of methane each year, accounting for about 28% of global emissions from human related activities."<sup>2</sup> As lame cattle begin producing less milk,

farmers often turn to introducing more cattle into their stock.

The impact of climate change on the dairy industry is a never-ending cycle of methane-producing cattle. Decreased fertility rates, increased mortality rates, deformations, and cattle,<sup>3</sup> goats,<sup>4</sup> and even buffalo have shown signs of decreased fertility as a result of heat-stress caused by global warming. Even more worrisome is the increased mortality rate of cattle. For example, older cows over 29 months of age displayed a greater mortality when exposed to days affected by heat waves.<sup>5</sup> More cows are then added to the herd, which only leads to lameness, the dysfunction of the locomotor systems that results in the unnatural gait of an animal in the form of posture and walking, to become more prevalent in the cattle.<sup>6</sup> This overcrowding increases the occurrence of lameness, with over 70% of cattle becoming lame at least once per year, and results in milk reduction and a change in body weight. The decrease in milk yield from lame cows is due to a reduction in standing time for feeding and a lack of willingness to move for feeding and milking. As a result, climate change negatively affects cattle behavior. If cattle die, milk production also decreases as less cattle are available for production.

The milk prices forecast is higher at \$16.25 to \$16.45 per cwt for 2016 and \$16.15 to \$17.15 per CWT for 2017.<sup>7</sup> The main concern is milk prices dropping, specifically, this year in 2016. These prices are a result of lameness, which affects milk production in cattles because it leads to lower birth rates and higher mortality rates. The abnormal animal behavior would generate a negative impact on the environment and then the economy to affect our social well-being. Furthermore, less milk is produced, which leads to farmers hiking up the cost of dairy. As the supply of milk decreases, the price increases, which has the potential to drastically affect everyday life. So how does this affect everyday life? Pouring milk on cereal can get more expensive than ever as prices rise.

By decreasing methane production, the world constructs a reliable structure to combat global warming. The implementation of strategies that limit heat stress-related

impairment of animal welfare will lessen economic losses in cattle. Price increase could affect consumer surplus or welfare through an agriculture sector loss. The inclusion of non-profit organizations dedicated to assisting farmers in reducing climate change currently minimizes this economic struggle. For example, farmers are incorporating technological innovations into everyday farming life. Through organizations such as Planning for Climate Change, farmers are able to manage the structure and planning of how their cattle are raised. As a result, early identification of lameness can lead to the improvement of the treatment of cattle and predict future diagnoses. Further research and studies can assist in determining how to save cattle and prevent environmental and economic harm. Carbon dioxide from climate change negatively affects animal behavior, the environment, and the economy as a result of cattle producing methane for dairy

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