MARCH 2023 • ISSUE 40

THINK

IDEAS • MALTA • RESEARCH • PEOPLE • UNIVERSITY

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THINK

editorial

Sustainability

My first thought when it comes to sustainability is trees and cotton shopping bags. In truth, sustainability is a far more complex issue and, regrettably, there is no silver bullet that will magically solve the problem.

Sustainability incorporates a number of issues; our struggle with energy usage, individual, social, and corporate responsibilities, minimising our carbon footprint, and pushing for stronger environmental representation on a political level. However, we should first consider what is understood by 'sustainability.'

Sustainability means meeting our current needs, without compromising the ability of future generations to meet their own. We could say the defining zeitgeist of the current age is an attempt to rectify the unbridled consumption of previous generations. It certainly seems that way when we consider a significant portion of millennials refer to eco-anxiety.

It is worth focusing primarily on the changes we can make. As a magazine, we have carefully weighed our options to see what sustainable practices we can adopt. We have chosen to rethink our printing options and have opted for a less harmful approach - choosing to omit the use of gloss paper and stick to more environmentally friendly options. However, sustainability is not merely a passing trend. Sustainability demands a consistent effort, and it is for this reason that we are also considering long-term practices that we can implement to that effect.

Besides examining research that could improve sustainability practices, we have introduced a new section to the magazine; "Beyond Academia." In this section, we feature research connected to Malta conducted by institutions or individuals not linked with UM or other academic organisations. For this edition, we take a look at cutting-edge cancer research being conducted at Mater Dei Hospital.

We hope that you enjoy our 40th Edition of **THINK**, and if you have any suggestions on sustainable practices do get in touch!

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L-Università ta' Malta

toolkit

The Future of Campus Energy

Author: **Ines Ventura**

Of all energy resources, solar energy is the most abundant. Harnessed even in cloudy weather, the rate of solar energy that arrives on Earth is 10,000 times greater than the rate at which humankind consumes energy. Solar technologies can deliver heat, cooling, natural lighting, electricity, and fuels for a host of applications.

But how does this technology work? Can the University of Malta (UM) lead the way towards greener energy?

PHOTOVOLTAICS: THE MAIN SOLAR ENERGY TECHNOLOGY

'Solar technologies convert sunlight into electrical energy, either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation,' explains Dr Ing. Francarl Galea, researcher at the Department of Microelectronics and Nanoelectronics. 'With no greenhouse gas emission, the production of this clean energy is a clever way to fight climate change.'

The first PV system installation at UM was back in 2010. Then in 2013, another three were installed. Finally in 2015, 10 more PV systems were installed across various buildings at UM. There are plans to further increase this number in the future. 'Every building with PV panels installed has a TV monitor situated in the foyer/corridor showing the energy

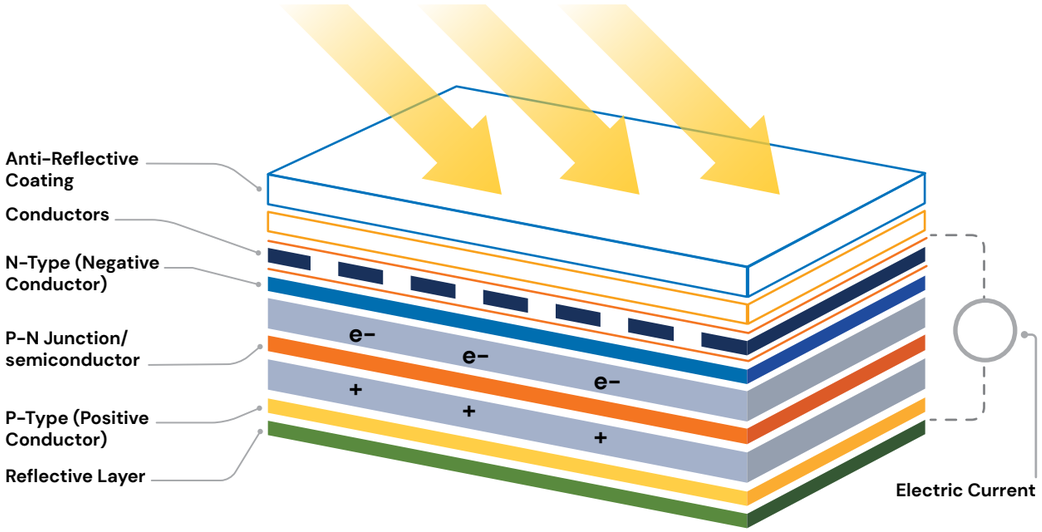


Diagram of a generic silicon solar cell construction illustrating the separation of charges at the P-N junction.

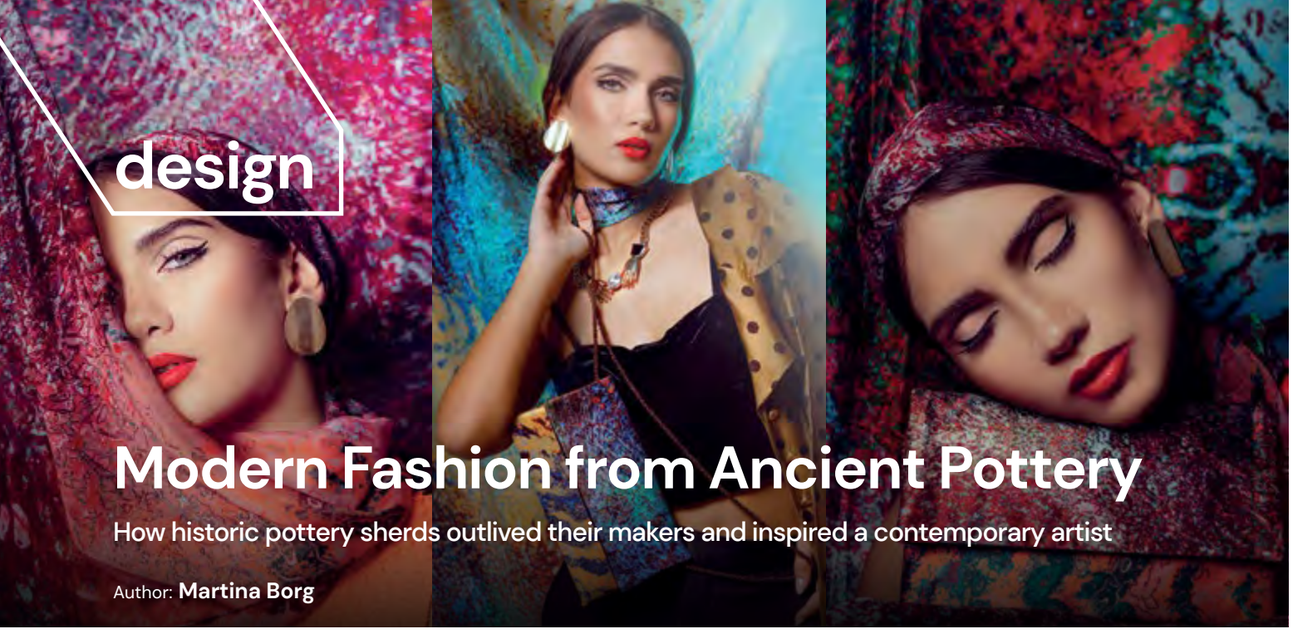
generation of the PV system, which apart from giving data on the generation, increases the environmental awareness and showcases UM's commitment to renewable energy,' explains Galea. These panels cover 80% of UM's rooftop. Researchers are currently trying to improve PV panel efficiency: the amount of electrical power generated compared to the solar energy hitting the PV module. This indicates how effective the panel is at converting energy from one form to the other.

The amount of electricity produced depends on several characteristics such as the intensity and wavelength of the light available and multiple performance attributes of the panel. With this in mind, local researchers are coming up with solutions, working on new designs and layouts that capture more light by optimising panel orientation and inclinations, ideal for our geographical location, balancing the investment cost with the energy that can be generated by a PV system.

Each PV panel is formed by several solar cells that contain a material that conducts electricity only when energy is provided – by sunlight, in this case. This material is called a semiconductor. The 'semi' means its electrical conductivity is less than that of a metal but more than an insulator. When the semiconductor is exposed to sunlight, it absorbs the light, transferring the energy to negatively charged particles called electrons. The electrons flow through the semiconductor as electrical current since the other PV cell layers are designed to extract the current from the semiconductor. As long as sunlight continues to reach the module and the circuit is connected, electricity will continue to be generated. Outside, environmental conditions like heat, dirt, and shade can reduce conversion efficiency, along with other factors.

Galea explains how 'the PV systems at UM generate the equivalent of energy required to power 700 households. Throughout these seven years of PV installations, the electricity generation from PVs saved 4,500 tons of CO_2 from the atmosphere. They generated around 15% of the campus' electricity consumption, although the university's load is always on the rise due to new buildings being constructed. This, together with smart BMS (building management systems), efficient LED lighting, and temperature limits and timers on air conditioning systems, can maintain the electricity consumption of the university in check and under control.'

As these past 7 years have shown, by generating its own energy and increasing the amount of electricity obtained with the same number of PV panels, UM continues to work on reducing fossil fuel use. In doing this, UM is contributing to increasing the share of renewable energy in the global energy mix.



design

Modern Fashion from Ancient Pottery

How historic pottery sherds outlived their makers and inspired a contemporary artist

Author: **Martina Borg**

When Dr Ing. John Charles Betts embarked on his latest research endeavour analysing ancient pottery fragments, he couldn't have foreseen the potential artistic inspiration it would set off. **THINK** sat down with local designer Saz Mifsud and Dr Betts to talk about this unlikely combination.

'This all started because I was looking at the microscopic images of these materials, and they turned out to be more colourful and interesting than ever,' Betts said, explaining that the pottery fragments dating back some 7000 years revealed various unexpected shapes and colours.

'The shapes visible in these images are a result of materials purposely included in the pottery to reinforce the final product, as well as natural materials such as foraminifera – single cell creatures that produce a shell. These shells survived the tempering process because of the relatively low firing temperatures used to make these artefacts at the time.'

Saz explains, 'I initially received an email from John with a few images and cross-sections of various samples of pottery showing different concentrations of the individual materials. I was particularly struck by these previously mentioned foraminifera,' adding that the images reminded her strongly of marbled paper.

Saz went on to explain that her collections are often a mix of her personal experiences and photographs of her everyday life interpreted into the stunning designs and patterns that have now become familiar to many Maltese fashionistas.

'This time I was very lucky and the inspiration landed on my lap without me having to look for it. It took me a few weeks, but I soon started experimenting digitally and mixing the pictures with a few textures that I had seen over the previous months,' she said.

Saz added that what ultimately caused her designs to pop, was a visit to the minerals room of the Natural History Museum in London.

'The stunning colours you see there don't look like they would occur naturally,' she said, adding that many of these hues ended up in her Sirocco range. 'That's how the designs started to take on a new life of their own,' she laughed, adding that Betts was ultimately very surprised to see the final result.

Betts went on to explain that he was thrilled by the final result, and that interdisciplinarity was one of his favourite aspects of his work.

'As a department, we try to collaborate with many other departments, and we are currently working with the Department of Biology and an undergrad Biology student who is researching the foraminifera for instance. However, this is the first collaboration of its kind, with its more artistic and commercial tinge.'

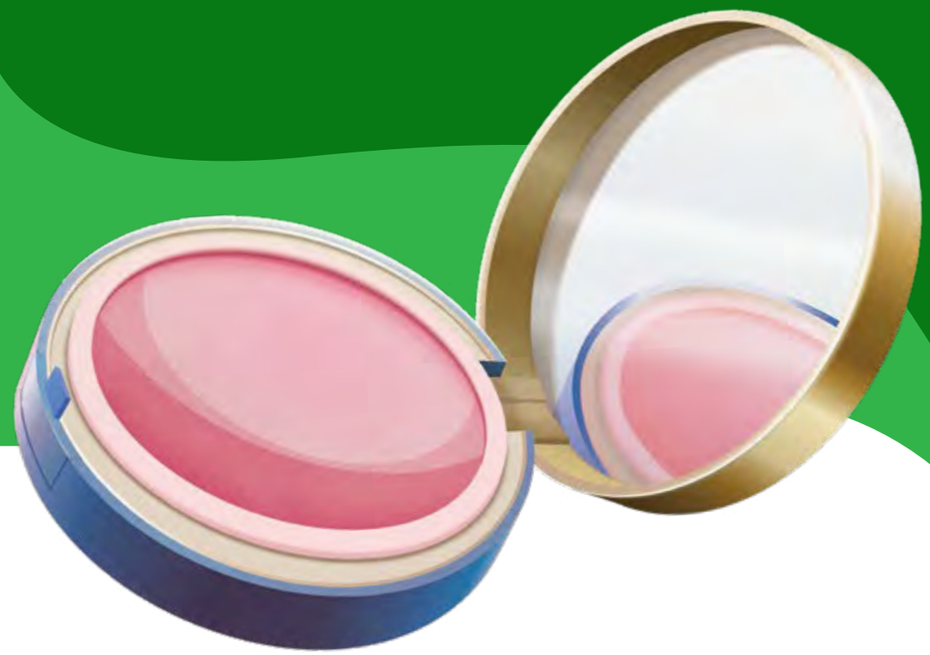
'I am hopeful that there are other opportunities and ideas to be explored in our research, and I also think that this project will help raise awareness about the projects we carry out and about the fact that this is not necessarily a purely scientific endeavour. There is a beauty and an inspiring aspect to archaeology, and it welcomes people from all backgrounds, not just scientists.'

Saz nodded enthusiastically and said that she had felt utterly inspired by the way that the past had informed the future in such a way.

'I viewed it as a piece of history that we can carry with us. And the scarves will ultimately outlive us in the same way these pottery fragments did the people who made them.'

The pottery sherds that inspired Saz's 'Sirocco' range were part of the MaltaPot and CoFIPoMS Projects.

Saz Mifsud's "Sirocco" range
Photos by Maria Galea



Green Cosmetics: An Engineering Perspective on Cosmetic Packaging

Author: **Isaac Gatt**

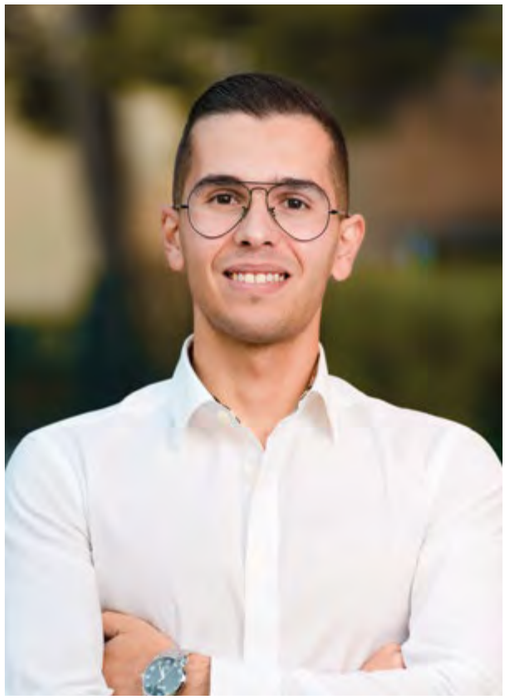
The global cosmetics industry is a multi-billion euro business that shows no signs of slowing down. A large percentage of this evaluation is attributed to product packaging, which introduces a considerable environmental issue due to the skyrocketing demands for plastic packaging.

The environmental 'con' for cosmetics can be traced to its packaging, which has a significant impact on the product's overall sustainability. Both primary (the container holding the cosmetic itself) and secondary packaging are commonly found in significantly high or even excessive quantities. To make matters worse, this high level of packaging is almost always unnecessary and is solely used to create a premium unboxing experience, such as by including thick ribbons, individually packing items, or including lots of paper separation.

The severity of the situation motivated me (Isaac Gatt) to carry out my bachelor's in engineering (Hons) dissertation on this topic, in the form of a life cycle assessment. The study was aimed at comparing the effects of reusability and recyclability on a specific case-study product (in this case, a cosmetic blush). The ultimate goal was to evaluate and generate solutions that could be implemented by a global cosmetics packaging manufacturer. Recycling of such packaging lacks significantly, with studies citing that less than a third of cosmetic plastic waste is recycled in Europe. The primary issue faced is that materials such as aluminium foil are notoriously difficult to recycle, since these are usually attached with adhesive and are considered a contaminant to the packaging as a whole. This in turn renders the entire package unrecyclable.

The main results from this study clearly highlight the environmental gains should the product design be altered to allow for disassembly and part separation at the product's end of life (as this greatly facilitates recyclability). Results also show that it would be significantly more sustainable to establish a product which could be continuously reused via a refill system, rather than applying dematerialisation techniques (attempting to use less material). Finally, it was determined that eliminating components made of environmentally damaging materials (such as aluminium), would result in a 74% improvement in global warming potential when compared to the existing case-study product.

One positive aspect that should be recognised is that consumers are becoming ever more aware of the environmental impact behind the products they are consuming. Keeping up this positive momentum and increasing consumer pressure is essential to ensure a better world for tomorrow's generation. This bodes well for the sentiment that sustainability should be considered a life-long journey, not a destination.



Isaac Gatt

Isaac Gatt holds a bachelor's and a master's degree in mechanical engineering, with both of his course theses focusing on the practical application of sustainable engineering tools. He has also published a number of conference and journal papers from this research and is the founder of Green Circle Engineering, an engineering firm focused on providing technical sustainability services.

Further Reading

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Full STEAM Ahead

Author: **Karen Fiorini**

Change is unavoidable. Yet as creatures of habit, it is safe to say that change is not a comforting prospect to most, because let's face it, change can be pretty darn scary. Many dread the loss of control and autonomy that accompanies the unknown, choosing an unpleasant situation over opting to take the proverbial leap that would change their lives for the better.

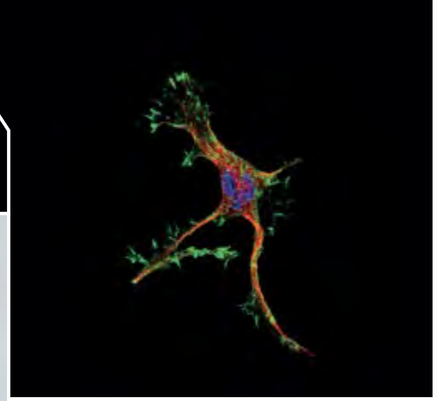
And yet, social and environmental change is a stark reality. It is knocking on our doors, demanding attention, threatening to overcome and leave us reeling in the aftermath of what we ourselves have created. How then do we take the leap; how do we eschew the devil we know and look to make the changes we so desperately need?

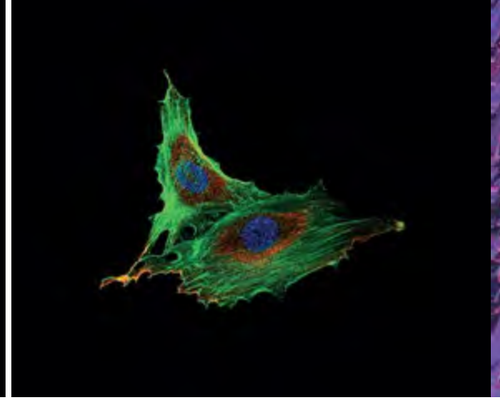
The answer lies in five letters, STEAM: Science, Technology, Engineering, Arts, and Maths. We're not talking rocket science, although all innovators and researchers do look to STEAM to develop ideas and knowledge. STEAM skills are what empower changemakers working within their communities on all kinds of projects, big and small. Whether we're designing a recycling initiative, creating a website, or learning about biodiversity and local ecosystems, we need to draw on a powerful set of STEAM skills. It is this skill set that can help citizens all over the world face current challenges: climate catastrophe, lack of inclusivity, and health issues, to name a few.

Through creativity, the Science in the City (SitC) team is looking to engage people from all walks of life with STEAM. The 2023 festival's goal is to empower and encourage citizens to be the change they want to see. Cliché? Definitely, but it's today's reality, and every one of us needs to wake up to this particular reality if we are to have a future on this planet.

The festival activities for 2023 will challenge convention and work to alter the mindset that has brought us all to this point. We cannot simply wait for the education system to implement changes for tomorrow. We need to mobilise our youth and our young-at-heart today to become agents of change. STEAM is key to achieving Sustainable Development Goals, living in an inclusive society, and embracing diversity. So join the SitC movement, get unstuck, and start leading change from wherever you are, because the world has never been more ready for it!

student





Cells under fluorescent light with Cytochalasin D added (left) and without (right). Green represents actin, red the microtubules, and blue the DNA.
Images courtesy of the author

Scrambled, Messy, and Squashed: The Cell's Skeleton and a Toxin

Tymoteusz Piasecki

Imagine swallowing a substance which suddenly causes your entire skeleton to collapse in on itself: all your bones squashed and squeezed together in the most unnatural positions. What a tragedy that would be! Luckily, such a toxin does not exist for humans, but it does at the cellular level. In fact, I (Tymoteusz Piasecki) together with my colleagues, supervised by Prof. Zenon Rajfur and his Ph.D. students at the Jagiellonian University of Kraków in Poland, focused on the effects of such a toxin (Cytochalasin D) on cells.

The skeletons of cells (the cytoskeleton) are made up of roughly three parts: threads called **intermediate filaments**, which help keep the shape of the cell; tubes called **microtubules**, which also help keep the structure of the cell in addition to helping transport materials inside the cell; and another type of thread, **actin**, which is partly responsible for cell movement. In fact, the toxin we used actually disrupts the actin part of the cytoskeleton.

I first video-recorded our cells without the toxin added. They looked quite healthy, able to divide and roam around the dish. However, upon adding a high concentration of the toxin Cytochalasin D, cell movement suddenly stopped as the cells became smaller and assumed spikier shapes. Next, I killed and stained the cells, not out of cruelty, but to observe them under a more complex confocal microscope in fluorescent light (see pictures). The cells with the toxin showed major abnormalities in the actin part of the cytoskeleton, which differed for different concentrations of the toxin. During the project, I should add, it was necessary to supply the cells with the correct food, making sure they did not overgrow while also keeping everything sterile to prevent bacterial infections.

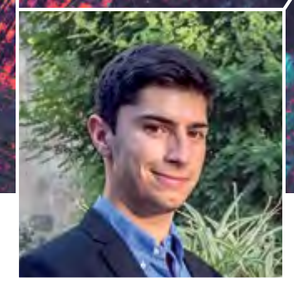
I then analysed the recordings to obtain data such as changes in direction of movement, velocity, area, etc. and look for any patterns. One such numerical outcome was that, upon adding the toxin, the area taken up by the cells decreased, pointing to large changes in the cells' internal structures. These results are to be used in future projects by the researchers.

In general, toxins which affect the cytoskeleton (such as Cytochalasin D itself) are in fact used to study the cell's skeleton, but some are also used as pesticides. More importantly however, these toxins are used in certain medicines as well as chemotherapeutic agents, which makes this field of research truly an important one.

The following colleagues worked with me on the project: Daria Chigarina, Agata Cournuaud, Dawid Marcisz, and Piotr Musiał, supervised by the following Ph.D. students: Armin Mirzaki Ebrahimi, Asia Hajduk, and Tomasz Kołodziej.

Tymoteusz Piasecki is currently following a course leading to Doctor of Medicine and Surgery at the Faculty of Medicine and Surgery, University of Malta. The internship at the Jagiellonian University in Kraków, Poland was organised independently by the author.

student



Schizophrenia and Art

Robert Pisani

Schizophrenia is a mental disorder regarded as a deficit in the way reality is perceived by an affected individual, often leading to associated behavioural changes. Such individuals may experience persistent hallucinations which can affect any of the senses. Moreover, such individuals exhibit disordered thinking patterns as well as disorganised behaviour, leading to a reduced ability to carry out the activities of daily living without treatment. The causes of schizophrenia are thought to be due to both genetic and environmental factors, and onset typically starts in late adolescence or the early twenties.

Psychiatric illnesses and art are not uncommonly associated with one another, with numerous accomplished artists having been diagnosed with schizophrenia or other mental disorders. Prominent examples include Louis Wain, well-known for his illustrations of anthropomorphised cats, and Richard Dadd, who was renowned for the obsessive detail in his paintings. Several other artists have been diagnosed with schizophrenia – either during their own lives or through speculation after their deaths.

A number of studies have indicated that individuals with schizophrenia tend to have superior creative skills and that the arts may serve as a resource to better cope and adapt in their daily lives. In fact, art therapy is frequently used with such individuals alongside other conventional treatments. Art therapies aim to address negative aspects of the disorder such as social isolation, poor communication, and lack of motivation. Art therapy has also been used to help diagnose schizophrenia in children, although art is not generally used to diagnose schizophrenia due to its variable nature.

The manifestation of schizophrenia in artwork itself is not always evident; however, artists may use art to express themselves when other means of communication fail. This is a common feature in other mental illnesses such as depression, which may be exhibited in Edvard Munch's piece *The Scream*, or visual hallucinations, as in Van Gogh's *Starry Night*. That said, studies comparing the artwork of healthy and schizophrenic individuals have concluded that no significant differences in art style were noted. What did vary was the content of the art itself, and that element is a more useful indicator of psychosis. The content tends to be stranger and more unusual or bizarre in schizophrenics, perhaps reflecting the individual's perception of themselves or their perception of the disease.

Common features of schizophrenic work include the following:

- Symmetry
- Desexualised figures
- Strong border lines
- Fusion of objects
- Misidentification of objects or individuals

Interestingly, a study conducted in 2014 noted that such artists may be depicting the world as they wish it to be as opposed to how it actually is by incorporating their hallucinations or delusions associated with the illness. Thereby, art may serve as an outlet to express what cannot be described in words.

Numerous artists have been diagnosed with schizophrenia, and this diagnosis may be associated with a higher creative capacity. Art may serve as a therapeutic outlet for patients suffering from schizophrenia and may indeed be used to help manage the illness. The content of art tends to vary between those with schizophrenia and healthy individuals, which may serve as a tool allowing for the recognition of the disorder through art in certain cases.

A full list of references will be available on the digital version of the article at thinkmagazine.mt

Sustainability

Sustainability means meeting our own, current needs, without compromising the ability of future generations to meet their own needs. While discussions on sustainability usually revolve around the environment, it also connects to other aspects. For example, finding more efficient ways of using energy, sustainable practices in medicine, water usage, and the way we heat our homes. Even though the road to sustainable development should lead to effective policies and solutions, it all starts with research.

Making Electrical Drives More Efficient

Author: **Josse Schubert**

The climate crisis urges us to use every means of reducing CO_2 emissions. To reduce the energy consumption of electrical drive applications, researchers from the Faculty of Engineering at the University of Malta are working on a hybrid inverter drive. This device will be able to adjust the power input to an electric motor, thus avoiding power losses. With 8 billion electric motors in the EU alone, even small energy savings can scale up to big contributions towards a sustainable future.

Human activity needs to become more efficient if we want to stand a chance against the climate crisis. Sources of renewable energy are growing, but they are only one part of avoiding CO_2 emissions. Another piece of the puzzle that leads to zero net emissions is reducing energy consumption. One way to do so is by rendering machines in such a way that they deliver the same task but require less energy. In other words: make them more efficient.

Efficiency is a term that is used in a variety of contexts. Generally, it describes the ratio of output to input. Applied to electrical drive applications, it describes the mechanical energy generated divided by the electrical input energy. In reality, there are always some energy losses along the way, but the closer this number comes to one (where energy output equals the energy input), the less electrical energy is needed for the same task.

In the EU, there are about 8 billion electric motors. About half of all the energy consumed in the EU goes into running them. With so many opportunities for application, even relatively small improvements in energy efficiency can scale up to save vast amounts of energy. Dr Ing. Reiko Raute and doctoral student and researcher Daniel Lendi from the Faculty of Engineering at the University of Malta are working on a device that reduces the energy consumption of electrical motor applications. They are improving the design of variable frequency drives. Connected to an electric motor, these devices can adjust the frequency of the motor's voltage and thus change the motor speed, thereby matching the load's or application's needs as closely as possible and bringing them closer to perfect efficiency.

INDUCTION MOTORS AND ELECTRICAL FREQUENCY

To understand how a device that adjusts the frequency of the electrical current can improve the efficiency of an electric motor, it is unavoidable to deal with some of the technical basics of electricity. 'In our project, we focused on the most common type of motors for many applications in industry,' Raute points out. In their simplest form, induction motors use electrical current to create a changing electromagnetic field in its stationary part, the stator. This changing or rotating electromagnetic field induces (hence 'induction' motor) a current in the motor's rotating part, the rotor. It is the interaction between the stator's rotating electromagnetic field and the current in the rotor that creates a rotational force, known as torque. Thus, electrical power is converted to mechanical power. Raute adds, 'induction motors are

Dr Ing. Reiko Raute (left) and Daniel Lendi
Photo by James Moffett

To run induction motors at different speeds, there must be something between the grid (which is fixed at 50Hz) and the motor (the speed of which is determined by the incoming frequency) that can change the frequency. This is where variable frequency drives come in.

also called fixed-speed-motors, because the speed of the rotating movement is determined solely by the electrical input frequency.'

In electricity, the term frequency is closely tied to the concept of alternating current (AC). Electricity consists of electrons that run from the negative to the positive pole. In an alternating current, which is nowadays standard, the poles switch at a high rate. Along with them, the electrons switch their running directions. The rate at which the switching happens is called the frequency. Frequency is measured in Hertz (Hz), which describes the number of changes per second. In Europe, the frequency of the mains electrical power grid is 50Hz.

To run induction motors at different speeds, there must be something between the grid (which is fixed at 50Hz) and the motor (the speed of which is determined by the incoming frequency) that can change the frequency. This is where variable frequency drives come in.

VARIABLE FREQUENCY DRIVES

'Variable frequency drives are devices that change the frequency of the electrical current,' Lendi explains. 'They can thus also change the speed of an induction motor.' This feature becomes highly important in machines that run long hours at different speeds. 'For instance, ventilation units at airport terminals are a very good example for the application of variable frequency drives,' Raute adds. 'An airport terminal is ventilated all the time, but at night hours, the required air ventilation is lower than at day,' Raute tells. 'To reduce the air flow at night, flaps were usually used as an air-block while the motors driving the fans ran at full speed. This system was obviously very inefficient, because the motors ran at full power/speed when it wasn't needed. That's why these days, variable frequency drives are installed for terminal ventilation units,' he elaborates. 'The use of the variable speed drives enables the system to actually let the fan run slower at night instead of blocking the air current. The power loss due to the inefficient way of blocking the air flow at night was averted.'

Variable frequency drives solved one problem, but they created another one: during the day, when the air conditioning runs at full speed, the drives are still active, although all they do is convert the 50Hz grid frequency to a 50Hz frequency to feed the motor. This unnecessary power conversion results in a power loss of approximately 3%. While the variable frequency drive can help to increase the application efficiency at some operation points by reducing the motor speed, it becomes redundant once the motor is running at full speed for a long time. 3% doesn't sound like a lot, but the same issue applies to many motors. Remembering the vast amount of induction motors all over the world, the small effect sums up to giant energy losses.

To avoid the energy loss when the motors are running at full speed (50Hz), Raute and Lendi are creating a hybrid inverter drive that can be bypassed when it's not needed.

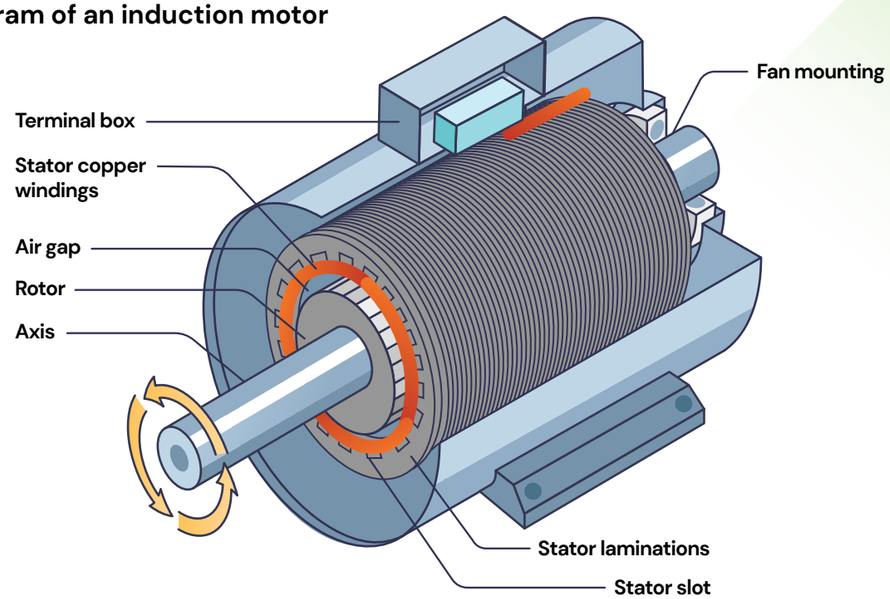
THE HYBRID INVERTER DRIVE

The hybrid inverter drive (HID) is a variable frequency drive that adds the feature of being able to take itself out of the electrical circuit. 'When the induction motor runs at low speed, the hybrid inverter drive changes the frequency of the motor voltage. However, when the motor runs on the full 50Hz of the power grid, the HID's inverter drive is bypassed.' Bypassing the inverter saves the 3% energy loss that a common variable frequency drive can't avoid.

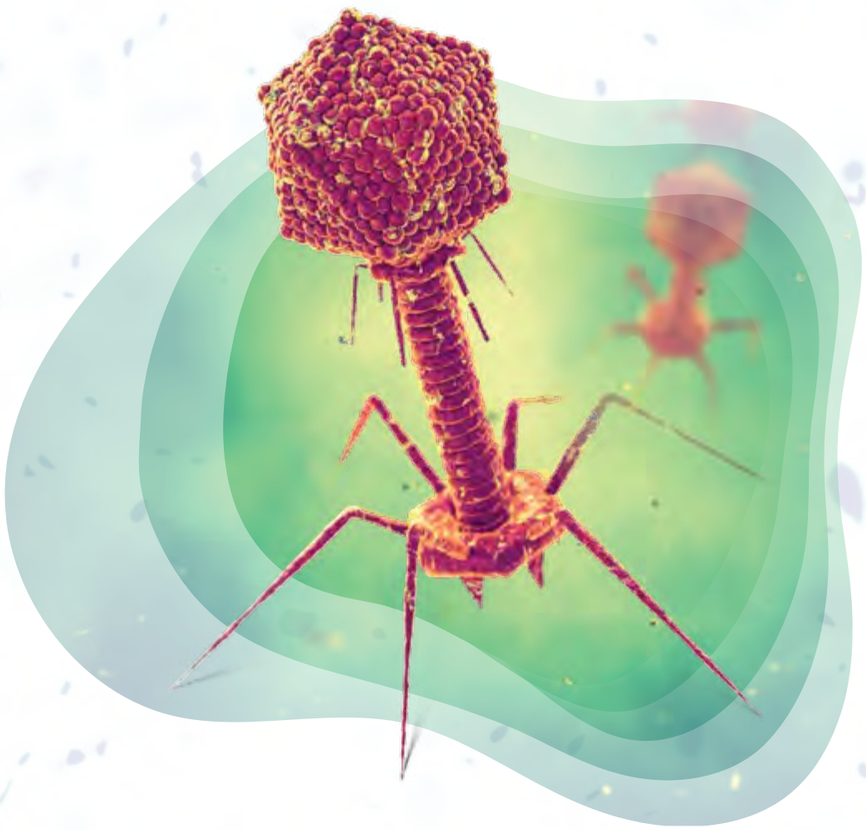
There are many applications in industry that could benefit from the hybrid inverter drive. With most pumps, compressors, and air conditioning systems running on induction motors, the device can have a huge effect once it is implemented on a large scale.

By improving the energy efficiency of many electrical drives by a small amount, the hybrid inverter drive contributes to the goal of zero CO_2 emission in a different way than wind farms and solar panels. The device that these Maltese researchers are building can't generate renewable energy, but it can save us from wasting energy in the first place!

Diagram of an induction motor



Power to the stator copper windings is applied via a terminal box. This generates a magnetic field. The stator and rotor contain slots for the copper windings and rotor bars respectively. Fan mounting allows the motor to self-cool. The rotor is only accessible from one end of the induction motor shaft. The rotor usually contains a 'key', which allows for a coupling to be mounted on it.



ENGINEERING ANTIBODIES TO OUTWIT VIRUSES

Project Accelerate Takes on the Challenge

Author: **Andrea Cuschieri**

Vaccines are very good at preventing infections from becoming severe. Case in point are the SARS-CoV-2 vaccines which effectively brought the world out of lockdown. Despite receiving all doses of a vaccine, however, immunocompromised individuals may not be protected, putting them at risk of developing severe infections. ***Prof. David Saliba****, associate professor at the University of Malta's (UM) Department of Applied Biomedical Science, explains how his research group is using bacteriophages to engineer antibodies which can provide passive immunity against infectious diseases.*

Infectious diseases are often considered humanity's bane, affecting us since early prehistory. Our capacity to prevent and treat infectious diseases has increased rapidly, thanks to key figures such as Ignaz Philipp Semmelweis, who identified the importance of hand hygiene, and Sir Alexander Fleming, who discovered the first antibiotic: penicillin.

One key breakthrough in the fight against infectious diseases was the creation of vaccines, attributed to Dr Edward Jenner, who invented the world's first successful vaccine against smallpox. Vaccines expose our immune system to antigens (the molecular surfaces of pathogens). Exposure to antigens triggers an immune response, causing our bodies to create antibodies. These antibodies are 'magic bullets' specific to the antigen being injected into the body. Vaccines thus prime our immune system by ensuring that our bodies would already have produced antibodies against specific diseases to prevent the development of severe infections.

Specialised white blood cells, known as B-cells, are responsible for producing antibodies. A singular antibody, referred to as a monoclonal antibody, is the product of a single B-cell and will bind specifically to a singular antigen. A collection of B-cell clones generate a population of antibodies, collectively termed polyclonal antibodies, which all bind individually to different surfaces on the same antigen.

Our body generates antibody populations upon exposure to antigens injected during vaccinations. In this regard, vaccines provide us with active immunity, since our body is actively working to produce antibodies against the infectious disease. Thus, vaccines act as a preventative measure against infectious diseases by ensuring that the antibodies against pathogens are already circulating within our bloodstream upon secondary exposure.

Unfortunately, even when immunocompromised individuals receive all doses of a vaccine, they may still be at risk of developing serious infections due to weak immune systems. Thus, these individuals must rely on other therapeutic approaches to treat infectious disease.

While bacterial infections can be treated with antibiotics, these medicines are ineffective against viral infections. Viruses pose a challenge for our immune systems as they can 'hide' inside cells. This explains scientists' frantic pace to

So far we definitely have a really good team of scientists that work very well together. In such a short time frame, we set up a fully validated phage display platform, and I am indeed impressed that we have managed to generate antibodies which bind very specifically to a variety of target antigens. We are also expanding these techniques to other antigens of interest, including cancer-associated targets.

(opposite) **Team Accelerate [Ms. Giuseppina Monda, Dr Godwin Grech, Dr Tessabelle Sultana] with ICCVS scientists during an ERASMUS+ visit).**

(top) **Masters students Jasmine Spiteri and Mariana Grima presenting their findings to ICCVS scientists.**

Images courtesy of Project Accelerate.

engineer vaccines against the SARS-CoV-2 virus and protect the masses against this disease. Yet, immunocompromised individuals still remain at risk of developing severe infections on exposure to SARS-CoV-2, necessitating the development of novel treatment approaches.

At UM, Prof. Saliba and his team are working to engineer antibodies against the SARS-CoV-2 and Zika viruses to discover therapeutic approaches against these infectious diseases, using a technique known as phage display.

BACTERIOPHAGES AND PHAGE DISPLAY OF ANTIBODIES

'Since the 1970s, scientists have been developing techniques to produce antibodies in the laboratory, and one of the most successful methods is phage display,' explains Saliba. Phage display was first discovered by Prof. George Smith, and later work by Sir Gregory Winter realised the technique's potential in producing antibodies. Their work was ground-breaking – to such a degree that they were jointly awarded half of the 2018 Nobel Prize in chemistry.

In nature, viruses known as bacteriophages infect bacteria with their genetic material to hijack the bacteria's intracellular machinery and produce multiple copies of themselves, destroying their hosts in the process. Prof. Smith and Sir Winter devised a method to genetically modify bacteriophages. These bacteriophages do not kill host bacterial cells to replicate and can display antibodies on their surfaces.

'We can engineer the bacteriophages' DNA to code for specific antibodies which are eventually displayed on the bacteriophage, and in doing so, a huge repertoire of antibody fragments may be produced,' says Saliba. The created bacteriophage population forms a library of different antibody sequences, which can be managed using routine laboratory methods. Isolating antibodies from these libraries that bind and neutralise SARS-CoV2 target antigens would have prophylactic and early-stage therapeutic potential in the immunocompromised COVID-19 patients.

PHAGE BIOPANNING

An antibody phage library serves as a store of billions of unique antibody fragments. Scientists use this library to identify the appropriate antibody phage against the target antigen being investigated. However, antibody phage libraries do not come with a handy Dewey-decimal classification system, and scientists must utilise phage biopanning to identify complementary antibody phages against the desired target.

Saliba explained how phage biopanning is reminiscent of panning for gold. To fish out a target antibody phage from billions of variations, scientists need to expose the phage library to a target antigen. Then, scientists must purify and replicate the phage antibodies which bind to the antigen to produce a sub-library. This process is repeated until a collection of antibody phages against the target antigen is obtained. Ultimately, single antibodies with high target specificity would then be purified from this collection.

GENERATING NOVEL ANTIBODIES AGAINST SARS-COV-2 AND ZIKA VIRUSES

In a previous interview with **THINK**, Giuseppina Monda, a research scientist working with Saliba, explained that the team created 3-dimensional magnetic beads coated with the SARS-CoV-2 spike protein, the active part of the virus responsible for infiltrating our cells. These magnetic beads were then exposed to the research group's phage library, obtained through international collaborations with the University of Edinburgh and the International Centre for Cancer Vaccine Science in Gdańsk. Through phage biopanning, the research group managed to identify polyclonal antibodies which bind to the SARS-CoV-2 spike protein. By sequencing the monoclonal phages, Saliba's team was able to discover the specific DNA sequence corresponding to the antibody that binds to the SARS-CoV-2 spike protein.

With such data, Saliba and his team can engineer antibodies which bind very specifically to the spike protein. However, the research group is also working on establishing collaborations to sequence the whole polyclonal population and identify patterns and overlapping trends in the DNA sequences between the polyclonal and monoclonal populations. This process was also successfully replicated against Zika target proteins to demonstrate the technique's applicability against distinct viruses.

'So far we definitely have a really good team of scientists that work very well together. In such a short time frame, we set up a fully validated phage display platform, and I am indeed impressed that we have managed to generate antibodies which bind very specifically to a variety of target antigens. We are also expanding these techniques to other antigens of interest, including cancer-associated targets,' says Saliba.

Having successfully identified the antibodies which bind to the SARS-CoV-2 spike protein and Zike envelope protein respectively, the next step in the project is to establish the novel antibodies' precise effects. Through predictive modelling and computational biology tools, the research group is working to determine whether these antibodies have a blocking effect, which would neutralise the viruses, preventing them from causing infection.

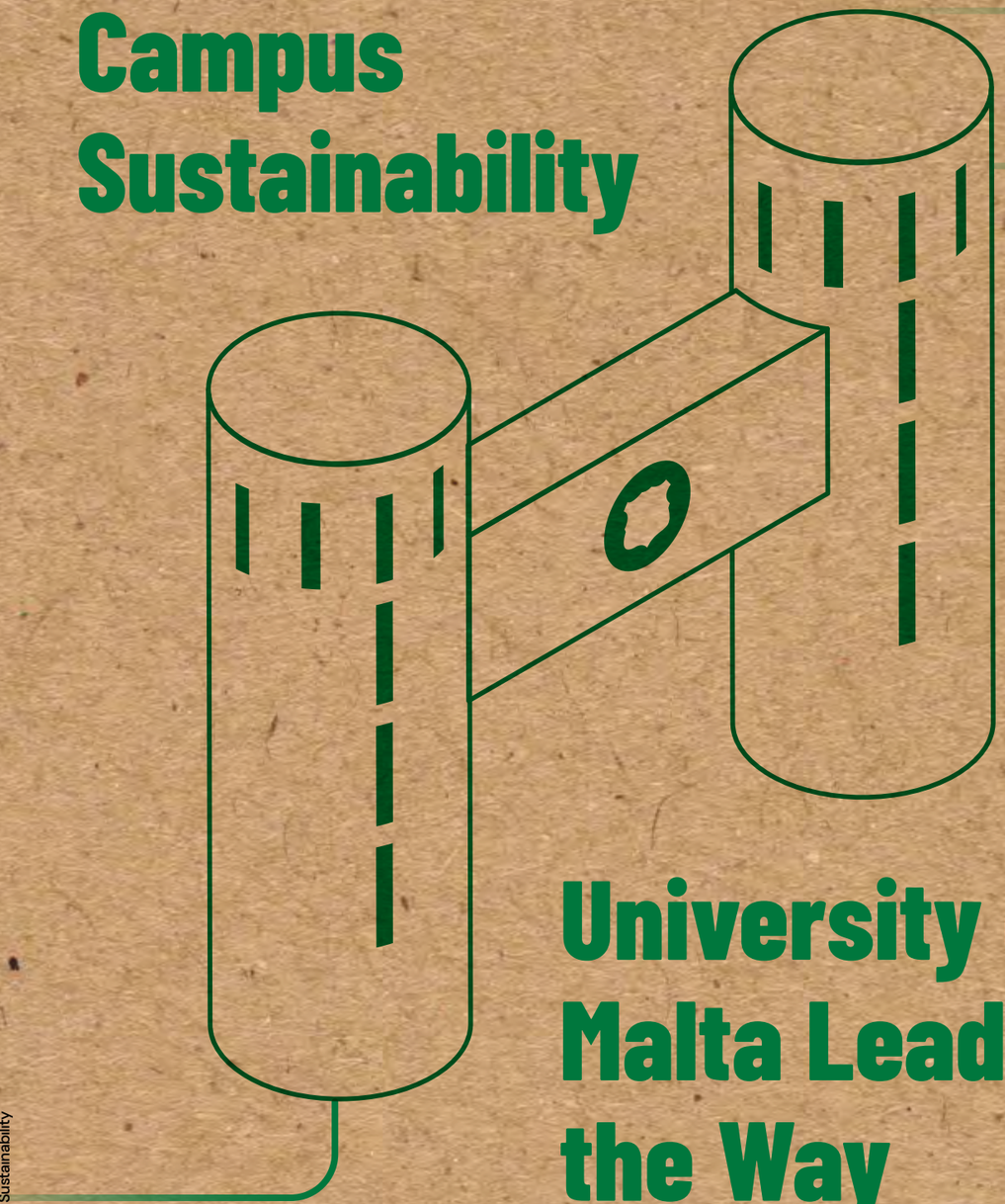
Saliba and his team are hoping that these antibodies will inhibit the normal function of these infectious diseases and act as a promising therapeutic. They anticipate that their ultimate findings will be taken up by industry to provide immunocompromised individuals with reliable treatment against SARS-CoV-2 and Zika viruses.

Project ACCELERATE is funded by the Malta Council for Science and Technology for and on behalf of the Foundation for Science and Technology, through the Infectious Disease Programme.

glossary

Antigens: Stands for 'antibody generating'. These are molecular surfaces of pathogens.
Antibodies: Specialised proteins which bind to and counteract antigens.
Immunocompromised: Individuals who have a weakened immune system and are more likely to get ill with COVID-19 or be sick for a longer period.
Monoclonal antibodies: Antibodies which can only bind to a single surface present on an antigen.
Polyclonal antibodies: Antibodies which may bind to numerous surfaces present on an antigen.
Pathogen: Any organism that can produce and cause disease.

Campus Sustainability



University of Malta Leads the Way

Author: **Jonathan Firbank**

The University of Malta (UM) has set out to become a sustainability 'Living Laboratory'. ***Jonathan Firbank*** *speaks with* ***Prof. Maria Attard*** *about the Committee for Sustainability at the University of Malta, C-SUM, and its role in this interdisciplinary, interdepartmental experiment.*

Any built or maintained space demands thought. Urban planners call on a wide range of expertise, from engineering to aesthetics to sociology. Groundskeepers need an encyclopedic knowledge of flora, techniques for sustaining it, and a singular vision for a changing space. Even volunteers for residents' associations who administer apartment buildings find themselves needing financial and legal knowledge, not to mention diplomacy when neighbourly disputes run hot. Each of these spaces demands an understanding of sustainability for regulatory, ecological, budgetary, or ethical reasons. A university campus is no exception. To the contrary, it demands all this expertise and more. Fortunately, universities have no shortage of experts.

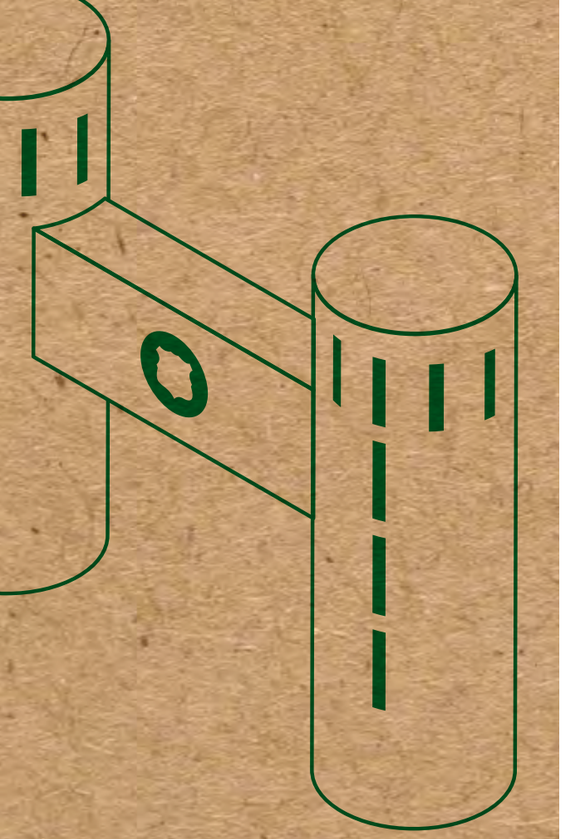
The Committee for Sustainability at the University of Malta (C-SUM), taps into this resource of thought. As its chair, Prof. Maria Attard describes it as 'distinct because of its interdisciplinary and interdepartmental nature.' In addition to academic specialisations, its members' expertise is sourced from finance, human resources, capital development, the Secretary's Office, and the University Students' Council (KSU). This brings together the academic, administrative, and outreach specialists fundamental to practical sustainability. 'Sustainability is a cross-cutting theme across administration, management, and the academic functions of the university', so engaging with people across these fields enables what Attard describes as 'wide-ranging impact.' Any venture built on bridging specialisations comes with challenges, but 'combining the efforts of administration with academic work is the only way the university's sustainability aspirations can be achieved.'

GREEN BEGINNINGS

UM's Msida campus is home to a large amount of green space that is being developed with forestation and utilisation of groundwater. Prof. Attard sees 'preserving and enhancing' this space as a starting point for a broader engagement with sustainability, 'not only through physical efforts aimed at reducing our consumption, but also to minimise UM's impact on its surrounding communities and environments.' This a primary responsibility for UM, not just in ecological terms but also to 'support economic growth and social sustainability. Any success achieved at the university can be easily shared and transferred to the rest of the island.' Attard's personal 'vision of sustainability at UM is one which transcends the university's boundaries, where good practices are replicated and shared across the islands – and beyond!'

Attard is not alone in this vision. Sustainability and C-SUM 'is embedded in the University of Malta Strategic Plan'. UM has set out to become a 'Living Laboratory': 'a place where projects can be implemented as experiments, but using real life situations and conditions.' Successful

Prof. Maria Attard
Photo by Sarah Zammit



'Msida Campus has a daytime population of around 14,000 people', more than many Maltese villages. Its space provides 'the opportunity to test some concepts for later replicability in the islands' various communities,'

experiments from this sustainability testbed will inform broader issues of sustainability in Malta, whether that be regarding Malta's environmental degradation or its problematic relationship with transport.

'Msida Campus has a daytime population of around 14,000 people', more than many Maltese villages. Its space provides 'the opportunity to test some concepts for later replicability in the islands' various communities,' explains Attard. The campus is not a world apart from Malta; it 'struggles with many of the sustainability concerns found in the various localities such as land use management, buildings and their energy performance, waste, transport issues' as well as 'shared social challenges such as public health, poverty, work-life balance, just to mention a few.'

THE SUM OF SUSTAINABILITY

C-SUM was established by Rector Professor Alfred J. Vella in 2018, with 'a remit to foster the culture of sustainability' amongst staff and students. More specifically, the committee was to discuss, support, and propose actions that need to be implemented for UM to strengthen sustainability across its programmes and spaces. 'C-SUM has oversight on the various processes' – administrative, academic, or managerial – at UM. 'It supports the development of the university's strategy and vision for sustainability, identifying the areas most important for our campuses.'

The collaborative interdepartmental relationships have three key functions. First, they enable the collection of a wide range of information impacting sustainability, which specialists often have exclusive access to. Second, they provide support to UM's diverse sustainability projects, which include 'sustainable buildings, energy consumption, waste, and transport.' This support might be in the form of research or monitoring, or as direct implementation. 'Finally the C-SUM is also responsible for communication about sustainability and the importance of raising awareness', not only of sustainability issues, 'but also the successes of the university.'

These successes are crucial. The 'Living Laboratory' needs them, and it needs to promote them in order to positively influence Malta on a broader scale. Fortunately, UM's multifaceted approach to sustainability has achieved multifaceted results. For example, 'the effort into energy conservation and renewable energy technologies is quite remarkable,' Attard explains. UM has installed photovoltaic solar panels across its buildings and upgraded its lighting, 'reducing considerably the burden of electricity consumption.'

Waste management is also crucial to sustainable spaces. 'C-SUM supported the Estates, Facilities and Capital Development Directorate in piloting the first waste management project on campus', which has improved the university's waste-separation practices. 'The small but equally important measures have been the installation of water fountains to reduce plastic waste (and encourage bottle reuse)' as well as identifying campus walking routes to promote zero-emission health and happiness. 'C-SUM also shares and promotes the projects implemented by the Green Travel Plan Committee, which work in the area of transport and mobility.'

FIGHTING HUMAN HABIT

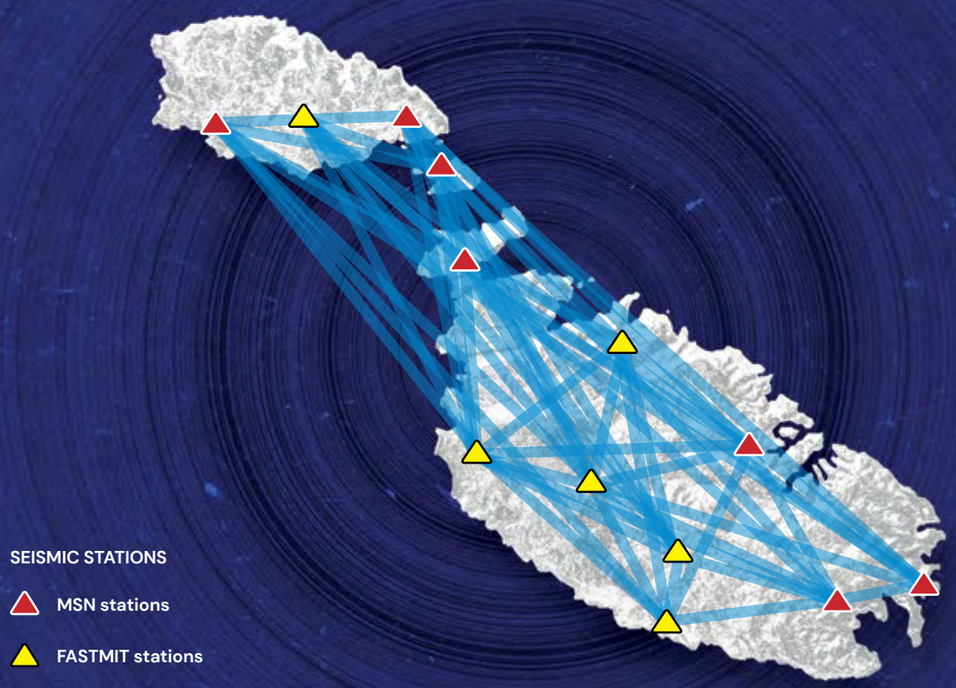
It almost goes without saying that C-SUM has met the same obstacle all holistic sustainability efforts meet: human habit. According to Attard, 'The main challenge is culture. Many of the things we need to see changing stem from human behaviour. Changing electricity consumption habits of individuals or changing the manner in which people dispose of waste are just two examples of these difficulties' – and ingrained behaviours are institutional as often as they are personal. But these challenges 'are not insurmountable. In all, we believe there is a very positive attitude across the university to instigate necessary change.'

UM's positive influence on sustainability outside campus grounds is already emerging. 'We are delighted to be sharing our experience with other campuses. Since UM is part of the SEA-EU alliance, we have contributed our experiences to a number of interuniversity events sharing good practices about sustainability. The positive feedback received from our partner universities is quite rewarding.' Attard fondly describes C-SUM's impact on a United Nations Programme: 'Just a year or two after C-SUM was set up, the University of Malta featured in *The Little Book of Green Nudges*. This publication was launched by the United Nations Environment Programme to inspire students across the globe' to reduce the environmental impact of their campuses. It targeted that great obstacle to sustainability, human habit, by facilitating behavioural change. 'The book contains 40 nudges – simple measures to make green choices easier – and includes evidence-based guidance on how to reset "default options", changing the framing of choices and harnessing social influence. The University of Malta was one of the few (around 25) universities featured in the publication,' thanks to some of its many initiatives – in this case paper usage reduction and sustainable interventions regarding air conditioning. It is C-SUM's aspiration that this global reach will be replicated locally, benefiting everyone within or without campus grounds.

Today, the world; tomorrow, Malta.

WHAT'S THAT NOISE?

DISCARDED SEISMIC SIGNALS MONITOR GROUNDWATER



Nationwide coverage of Seismic Imaging of Groundwater for Maltese Aquifers
Illustration adapted from Project SIGMA research

Author: **Jonathan Firbank**

*Malta depends on subterranean groundwater for agriculture, industry, and a large population. A University of Malta initiative, **Project SIGMA**, is monitoring groundwater sources not by digging for them, but by listening. **Jonathan Firbank** speaks with the Project SIGMA team about this novel approach and the impact it could have on our future.*

Fresh water is the first and last concern of any country. Settlements spring up at river mouths and lakesides. Food grows where there is steady rain or easy irrigation. Conversely, drought can destroy nations, and the struggle against it drives scientific development. If no fresh water is found above ground, it must be found below. The search for this precious resource is so desperate that, to this day, diviners wielding dowsing rods can find employment, despite the practice having long been proven useless.

Of all European countries, Malta has the most challenging relationship with water, 'facing the highest stress on its water resources,' explains Dr Matthew Agius (Research Support Officer, Department of Geosciences). Malta is known for its semi-arid climate and little rainfall. Agius goes on to explain how 'Malta also has no major surface water bodies such as rivers or lakes. Furthermore, Malta has a very high population density,' compounded by its tourism, which hit a record high before the global pandemic in 2020. This places incredible pressure on Malta's two sources of freshwater: desalination and groundwater.

The less vital of the two is desalination, which is the removal of salt from seawater. This is costly both from a financial and an environmental standpoint, as resources such as oil or gas are required to power the desalination process. More crucial is groundwater. This is rainwater that has pooled below ground in porous rock formations known as 'aquifers'. In Malta, this precious resource is extracted from boreholes or underground galleries. Groundwater supports Maltese industry and contributes 80% of the water needed for agriculture. 'Sustainable management of groundwater resources in Malta is essential,' explains Prof. Sebastiano D'Amico (Head of the Department of Geosciences and the project's principal investigator). This has already motivated initiatives such as supporting irrigation by treating and recycling greywater (the excess water produced by our kitchens and bathrooms).

D'Amico goes on to explain how 'conventionally, groundwater in Malta is monitored using a network of boreholes managed by the Water Services Corporation and the Energy and Water Agency (EWA). Water level data is recorded from these boreholes, and these measurements provide the most accurate site-specific data on water levels. However, this conventional practice may not provide insight into the changing groundwater levels in the remaining regions.'

The Project SIGMA Team holding one of the seismometers used to record vibrations in the ground. (From left to right) Prof. Sebastiano D'Amico, Prof. Pauline Galea, Dr Matthew Agius, Mr Luca Laudi, and Dr Emanuele Colica.
Photo by James Moffett

The dynamism of Malta's remaining groundwater demands a dynamic means of finding it.

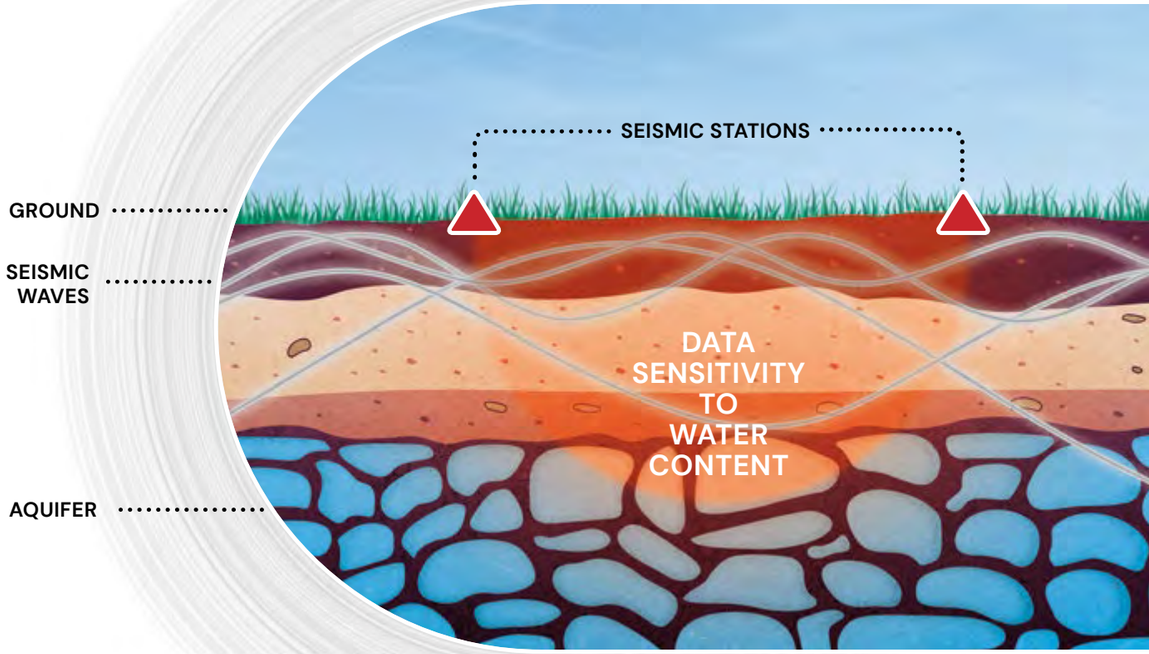
MAPPING CHANGES IN SEISMIC VELOCITY

SIGMA stands for Seismic Imaging of Groundwater for Maltese Aquifers, a University of Malta project funded by the EWA. The space occupied by groundwater cannot be seen or physically explored without invasive techniques such as drilling. It can, however, be 'heard'. Different materials reflect, absorb, and transmit seismic waves (vibrations generated by an earthquake, explosion, or similar energetic source which travels through the earth) to different degrees. The presence (or absence) of water in porous rocks alters these properties. In particular, water-saturated rocks have increased pore pressure, which in turn, leads to the opening of cracks in the rock that reduces the contact area between different grains of rock. This leads to a decrease in seismic velocity. SIGMA analyses these seismic properties in order to determine the state of the aquifer.

Something does have to generate the seismic waves in the first place, though. Fortunately, Malta has no shortage of ambient seismic noise, from the vibrations produced by sea waves hitting the coast to the noise produced by its roads. As these vibrations pass through Malta's crust, they are recorded on seismographs of the Malta Seismic Network and can be analysed to map Malta's sub surface and, crucially, its groundwater. The question is how to read it.

SIGMA began with conversations between international colleagues who specialise in interpreting this data. Prof. Pauline Galea, coordinator of the Seismic Monitoring and Research Group and co-principal investigator on SIGMA tells how the team 'was proposing an EU-funded project that would look at ambient noise monitoring of groundwater at different scales, in different geographical settings. Until funds are procured for this project, Research and Innovation grants from the Energy and Water Agency gave us an excellent opportunity to carry out a proof-of-concept of the technique within the Maltese islands, an idea which was totally new to the country.' The Malta Seismic Network already records a large amount of seismic data on stations across the country. Each station utilises GPS timing, data acquisition, and data transmission systems to process information collected from seismometers. These seismometers 'are generally sensitive enough to record microns of ground displacement. For example, vibrations from a large earthquake in the Pacific Ocean would be easily recorded on a seismometer in Malta,' explains Galea. SIGMA also makes use of six temporary stations deployed between 2017 and 2018, supplementing the Malta Seismic Network's stations and providing better coverage across the islands. This creates a comprehensive net for the sensing of Malta's noise.

Agius explains how 'the team used signal processing techniques that correlate signals recorded on the different stations' to detect groundwater changes by listening to 'seismic noise made up of continuous vibrations of the ground surface and shallow rock layers.' These vibrations can be equally useful whether they come from the natural world or the bustle of Malta's population. 'This method gives us the opportunity to assess the groundwater over a greater area and may provide a broader picture of the subsurface groundwater,' says Agius. Master's student Luca Laudi has seen results detecting seasonal and annual changes in seismic wave speeds that may be correlated with the levels of Malta's groundwater. 'This is important since most studies that have been conducted abroad have been from large groundwater basins, complex aquifer systems, volcanoes, mountain regions, geothermal fields, groundwater exploitation fields, larger islands, and volcanic islands.' Malta is subtler than these spaces; 'it has relatively smaller aquifer systems, it is surrounded by saltwater at close distances, and it has no rivers, lakes, or mountain regions. Despite this, the results of the study show that this signal processing technique can be used to monitor Malta's groundwater levels.' Unlike systems based on boreholes, SIGMA's methods are non-invasive. Additionally, apart from its novelty, this approach utilises resources that already exist.



Different materials reflect, absorb, and transmit seismic waves to different degrees. The presence (or absence) of water in porous rocks alters these properties. In particular, water-saturated rocks have increased pore pressure, which in turn, leads to the opening of cracks in the rock that reduces the contact area between different grains of rock. This leads to a decrease in seismic velocity.
Illustration adapted from Project SIGMA research

MAPPING THE FUTURE

This approach has clear utility. Should its findings be more definitely corroborated by readings from Malta's boreholes, SIGMA's next task is to determine whether the approach can be adopted in a more permanent and continuous manner. If Malta turns to 'listening' for water instead of digging for it, more seismic stations would be invaluable. This would 'provide a more accurate representation of the changing groundwater levels. Additionally, collecting more seismic data in the future may help in understanding whether this technique can identify long-term trends in the groundwater levels i.e. over decades,' says D'Amico. More data enables more targeted experiments. These could include work to better determine the specific volume of groundwater in a space. They could also correlate data with Malta's limited rainfall to better understand rainwater's lifecycle in the aquifers below the surface.

Malta's need to optimise freshwater access is great, but it is in no way unique. The climate is becoming harsher, surface water is being mismanaged, and population growth puts an exponential strain on its availability. Groundwater, often contaminated or overexploited, is in extremely high demand. Malta's dependency on it makes this a natural place for innovation, but project SIGMA's methods are just as applicable elsewhere. Agius goes on to say how 'groundwater level decline is an ongoing global concern. Utilising different subsurface imaging techniques for sustainable groundwater resource management is becoming essential. These systems are easy to install and cost-effective to maintain in the long run, making it an ideal tool to provide understanding of groundwater bodies. For these reasons, these techniques should be investigated further, to continuously manage groundwater as an essential resource for future generations.' T

Project SIGMA is financed by the Energy and Water Agency under the National Strategy for Research and Innovation in Energy and Water (2021-2030). Principal investigators of SIGMA are Prof. Sebastiano D'Amico and Prof. Pauline Galea, Dr Matthew Agius and Dr Emanuele Colica are Research Support Officers on the project, and Mr Luca Laudi has submitted his Master's thesis entitled 'A novel approach to groundwater monitoring in the Maltese Islands: Analysis of auto- and cross-correlation functions of ambient seismic noise'.

ZEROCO2 Buildings: A Step Closer to Carbon Neutrality

Author: **David Mizzi**

There is more to making a building energy efficient than simply installing PV Panels. To create a truly zero-energy building, a holistic approach involving engineers, architects, and builders needs to be taken. **THINK** *sits with* ***Prof. Ing. Charles Yousif*** *and his team to see what such an approach looks like.*

The Interreg Europe Project ZEROCO2, led by Prof. Ing. Charles Yousif, aims to identify energy policy measures that can accelerate the implementation of the EU Energy Performance of Buildings Directive. The ultimate goal of these policies is to push us closer towards near zero CO_2 emission buildings. But before we go any further, we need to clarify what zero CO_2 emission buildings are. Ing. Krista Rizzo, a research support officer for the project, explains: 'The EU's definition of "zero emissions" is one that focuses on energy efficiency first. Once energy usage is reduced as much as possible, the remaining energy should come from renewable sources.' Simply put, it is not enough to create green energy, but rather our buildings need to be more efficient, minimising the amount of energy wasted in the first place.

WHY ZEROCO2 BUILDINGS?

The COVID-19 pandemic and the surge in gas prices has thrown our dependency on fossil fuels into the spotlight. The invasion of Ukraine and supply chain issues have caused the price of gas, one of the main methods to heat homes and generate electricity in mainland Europe, to spike. As an example, because of this, over three million low-income households in the UK could not afford to heat their homes this winter. This, coupled with the threat of rapid climate change, has forced many nations to rethink their energy strategy.

While the ZEROCO2 project originally started in 2016 and was concluded in March 2020, the team secured funding from the Interreg Europe Fifth Call for an additional year to September 2022, focusing on the impact of COVID-19 on achieving energy efficiency in buildings. The project is being led by the Local Energy Agency Spodnje Podravje in Slovenia and has seven partners from Malta, Germany, France, Italy, Greece, Finland and Lithuania.

'We realised that a number of regions (from international partners in the project), including Malta, have issues with indoor air quality. They do not have clear regulations with regards to minimum fresh air requirements in public buildings such as schools, offices, and so on. This was the direct link between the project and COVID-19. Given that COVID-19 is an airborne virus, the lack of proper ventilation increases the risk of transmission,' Yousif explains. Rizzo also points out that 'when designing zero CO_2 buildings, we also need to make sure that indoor air quality is catered for. These spaces should be healthy and comfortable besides being energy efficient.'

From left to right: Ing. Krista Rizzo, Prof. Ing. Charles Yousif and Dr Ing. Damien Gatt
Photo by James Moffett

AN INTEGRATED APPROACH

When it comes to designing a zero carbon building, the team advocates for an integrated approach. A zero CO_2 building is about more than just reducing your energy bill; it encompasses comfort, indoor air quality, and well-being, as well as energy stability. The latter point is especially relevant in the wake of the invasion of Ukraine and inflated energy prices.

'It is not enough to simply install PV panels and call it a day. First, you consider the building envelope (the physical barriers between the indoor and outdoor environment), then the energy services within the buildings, until finally moving on to renewable energy sources,' Rizzo elaborates. Installing PV Panels is rather pointless if you are still losing energy through inefficient insulation!

Dr Ing. Damien Gatt, a systems engineer employed at the Institute for Sustainable Energy, who was also involved in the project, takes this a step further: 'When installing renewable energy systems, grid integration and load-matching capabilities also need to be considered. Nearly zero CO_2 buildings need to be assessed not only by indicators for total energy consumption and generation, but using a multiple-indicator approach that gives weighting to aspects such as the building envelope quality, comfort, indoor air quality, and load matching.' Yousif and Gatt already proposed such an approach for a social housing block in Malta in September 2020.

Yousif makes it clear that for an integrated approach, 'designers, architects, structural engineers, and building system engineers need to work together from the start.' However, such an approach is still not fully put into practice within the Maltese context. The first step is introducing the right policies and tools.

POLICY RECOMMENDATIONS

Gatt explains how 'a shift in mentality from the classic design approach to the described integrated design approach is required. This kind of thinking does not stop at the construction stage but also evaluates post-occupancy building performance. Various tools

Top: Identified Good Practice – Solar Photovoltaic Communal Farm Scheme (Energy and Water Agency) Sentini Water Reservoir, Tal-Fiddien, Limits of Rabat, Malta

Centre and bottom: Sharing of experiences between local and European stakeholders

Photos by Prof. Ing Charles Yousif

facilitate the application of the integrated design approach, including building information modelling and building energy modelling. To meet the requirements of high-performance buildings, these tools must become the norm in any design project.'

After numerous discussions with the project partners, the team developed four energy policy recommendations that can be implemented locally:

1. Legislation for indoor air quality and ventilation
2. Energy consumption awareness through improved access to smart meter data
3. Benchmarking of buildings through statistical analysis of energy performance certificates (EPCs)
4. Provision of support to consumers and professionals through an energy one-stop shop

We've already touched upon the importance of proper legislation. Locally, we do not have clearly defined legislation to control indoor air quality. While there are several international standards that architects and engineers can refer to, it is still up to the designers to follow these standards. Furthermore, standards are not mandatory. Rizzo goes further and explains, 'The project is working with the key stakeholder, the Malta Competition and Consumer Affairs Authority, to kickstart this process. Standards and legislation need to take local conditions into account.' For example, mould and humidity are significant issues for local dwellings. With the right legislation, it is possible to reduce mould by enforcing proper ventilation.

While smart electricity meters have existed for a while, they tend to fall short of their full potential. Yousif mentions how 'one of the energy policy recommendations of the project calls for an increase in people's awareness of energy consumption. Consumers need to know how much energy is being wasted before convincing them to change. By enabling access to one's own smart electricity meter data in real time (either through a mobile app or the internet), consumers will be able to better understand their consumption habits and begin tackling them. The Water Services Corporation has already embarked on a similar initiative for water consumption; the system even sends you an SMS when a sudden change in water consumption pattern is registered, possibly indicating a leakage.' Adopting such an approach to electricity systems is simply the next logical step. After all, what cannot be measured cannot be improved.

Local homeowners are probably already aware of EPCs. Currently, citizens consider EPCs as another form of bureaucratic paperwork when purchasing a dwelling. The real purpose of EPCs is to help consumers make an informed decision on the energy performance of their dwelling. Ironically, a log-book for your vehicle allows you to see a history of the car's services and performance, while a house or an apartment (both significantly larger investments) does not have such records. Besides being used to determine how energy efficient a dwelling is, EPCs could have a much wider impact. 'There are over 80,000 EPCs lying in MITA servers. EPCs could be used to develop benchmarks on energy performance of different building categories. This data would allow the relevant authorities to start renovating the worst polluters first and provide valuable information for potential buyers to opt for more efficient properties – ones that have lower energy consumption than the benchmarks,' explains Yousif.

Finally, a one-stop shop for energy efficiency in buildings would allow both consumers and professionals a centralised point of contact. 'This one-stop shop would help guide consumers through their renovation process, providing unbiased information. It would also help technical staff by providing courses and answers to FAQs on the latest legislation and available relevant studies. France has already adopted a similar approach known as "France Renov",' Rizzo points out. Yousif agrees, 'Malta is already quite adept at one-stop shops, for example BusinessFirst and MyHealth are two very successful one-stop shops for business and health, respectively.' However, Yousif makes an astute observation: 'locally, there is a need for better harmonisation, as building energy performance, renewable energy, and fiscal grants are not dealt with by one entity but by several.'

A BETTER FUTURE?

When an entity such as the University of Malta or any institute embarks upon a research project, there are more than just researchers working on it. In the background, there are several other players that support these projects. The team behind ZEROCO2 would like to acknowledge the support received from the University's Project Support Office, the Research Support Services Directorate, the Finance Office, the Corporate Research and Knowledge Transfer Office, and the Legal Office. The team is also pleased to announce that the University of Malta has just been granted funding for a new Interreg Europe proposal entitled 'Decarbonising the Tourism Industry Post Covid-19 Support' (DETOCS), which builds on the ZEROCO2 project and will be carried out in collaboration with some of its partners and the Ministry for Tourism.

While researchers have laid the groundwork for more energy efficient buildings, it is now up to legislators to implement the appropriate framework. Fundamentally, this research goes beyond energy efficiency. It is about becoming future-proof. The COVID-19 pandemic and, more recently, the invasion of Ukraine have highlighted just how fragile our systems are. We need to be prepared for whatever the future may hold in store.

Further Reading:

Gatt, D., Caruana, C., & Yousif, C. Building Energy Renovation and Smart Integration of Renewables in a Social Housing Block Toward Nearly-Zero Energy Status. doi:https://doi.org/10.3389/fenrg.2020.560892

The Future is Turquoise

Author: **Caroline Curmi**

Now involving nine European universities, SEA-EU is an alliance that pools resources in order to effectively compete with well-equipped universities in China and the USA. But how does an alliance of universities even work? **THINK** *explores the University of Malta's most beneficial alliance yet.*

The European University of the Seas (SEA-EU) owes its conception, in part, to French President Emanuel Macron. Irked by the fragmentation of Europe into many countries, languages, educational traditions, and universities, as well as the competitive superiority of universities within China and the United States, Macron made use of a 2017 policy speech in Brussels to push forward the concept of a 'super university.'

This piqued the interest of the European Commission, who took the concept on board and developed a transnational initiative which would unite European universities into alliance groups: 'It wasn't just about the few, best universities in Europe securing more funding and leaving the rest behind. Rather, it's about many (and not necessarily super) universities getting together, creating a real network supported by the Commission in order to go places we've never been before,' explains Prof. Godfrey Baldacchino, the outgoing SEA-EU Rector's Delegate. By sharing resources, creating joint degree programmes, and fostering collaboration, together the alliance aims to achieve what would be impossible for each individual member to attain alone. 44 such 'European Universities' are now being funded.

Malta's journey was rocky at first. While the university's interest was high, being based in the smallest EU nation state proved detrimental initially. Several top universities in Italy, France, and Germany were contacted, but these had different partnerships and goals in mind, and ultimately no alliance-in-the-making was receptive.

The University of Malta was then approached by the Spanish University of Cádiz, who proposed the idea of a consortium involving coastal universities, each drawing inspiration from the sea. Describing it as a 'great and graspable idea', Prof. Baldacchino highlights the benefits of such an alliance: 'For the first time, University of Malta (UM) finds itself in a network of European universities that comes with funding.' As with any other funding project, a number of deliverables need to be completed in order to achieve success. Happily, most funding criteria could be met in conjunction with the universities' own goals and aspirations: 'We are currently leading a work package under one of the subunits of SEA-EU to advance open science and open research data. It's something that our library wants to do, so we are doing it in collaboration with the other universities of the alliance,' explains Prof. Baldacchino. An open research data policy would allow for unrestricted access to most scientific results, yet there is not one currently in place. The generation of such a policy could lead to its national and international implementation.

By pooling and sharing resources, we are giving quality and value for money to the EU taxpayer who ultimately funds this project.

Corporate Social Responsibility (CSR) is a proactive approach adopted by private business to improve company culture and provide a more sustainable output on all fronts.

The term 'blue economy' refers to the sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystems.

THE INS AND OUTS OF SEA-EU

There are four pillars that support SEA-EU: education, research, identity, and mobility. The latter not only allows for student and staff exchanges to take place but also facilitates the sharing of resources, assets, and facilities amongst partner universities. When it comes to numbers, this alliance affects over 100,000 students and almost 17,000 academic staff and researchers across 68 faculties and 117 research institutes. Speaking in his capacity as Coordinator of the Masters in Oceanography programme, Prof. Alan Deidun (current SEA-EU Rector's Delegate) lends a practical example to highlight the positive impact of SEA-EU in improving the quality of learning and pushing for excellence in student output. Students would benefit from seeing a wave simulator in operation, yet developing one locally would prove too costly. Meanwhile, the University of Split, a SEA-EU partner, has such a resource readily available. 'Why do we need to duplicate the same model in different universities?' he asks rhetorically. 'By pooling and sharing resources, we are giving quality and value for money to the EU taxpayer who ultimately funds this project.'

Stakeholder involvement is high within SEA-EU. While some committees have a purely academic scope – such as developing joint degrees at undergraduate, master's, and Ph.D. level – blue industry representatives, student representatives, and local councils report a high level of involvement: 'It's not just universities speaking amongst themselves within a rarified circle,' confirms Prof. Deidun. Indeed, the concept of outreach and civic engagement is one of the pillars of the European Universities Initiative. Both the European Commission and politicians are concerned that some universities might have lost touch with the grassroots of society, instead directing their focus toward cutting-edge research, innovation, and funding opportunities. Prof. Baldacchino stresses the importance of implementing a community-based approach within academia, a factor which he believes is severely lacking: 'We should be of service to the community, not simply by graduating their kids but by helping them understand, and thus solve, their problems, whatever they may be.'

A NEW TYPE OF MANAGEMENT

This has led to the birth of the TURQUOOOISE project to build, apply for, and sustain an Erasmus Mundus Joint Masters degree in the Sustainable Management of Organisations. Basing itself on the foundations of CSR (Corporate Social Responsibility), the proposed degree aims to introduce a new role within the corporate sphere: that of the Turquoise Manager.

The colour choice in the title is a direct visual representation of what the role represents: 'A Turquoise Manager, or TM, is somebody who understands the need but also the opportunities of transitioning to a preferably zero-carbon economy. This is in line with green growth and sustainable practices while at the same time tapping the blue economy – that's why green and blue,' Prof. Baldacchino explains. The aspiration behind the role highlights the increasing importance of community-focused approaches across public governance, business, and academia, a vision which is supported by SEA-EU and the European Commission. 'When people recruit a manager, an accountant, a technical officer, that person comes on board with an orientation not just for profit but also for people and planning.'

In more technical terms, the course aims to shape students into flexible, resilient, and ever-inquisitive employees who can survive, operate, and thrive in an uncertain, demanding, and ever-changing environment. The impact such a role could have on businesses is projected to be substantial: working together towards collective intelligence and reaching the EU's sustainable development goals.

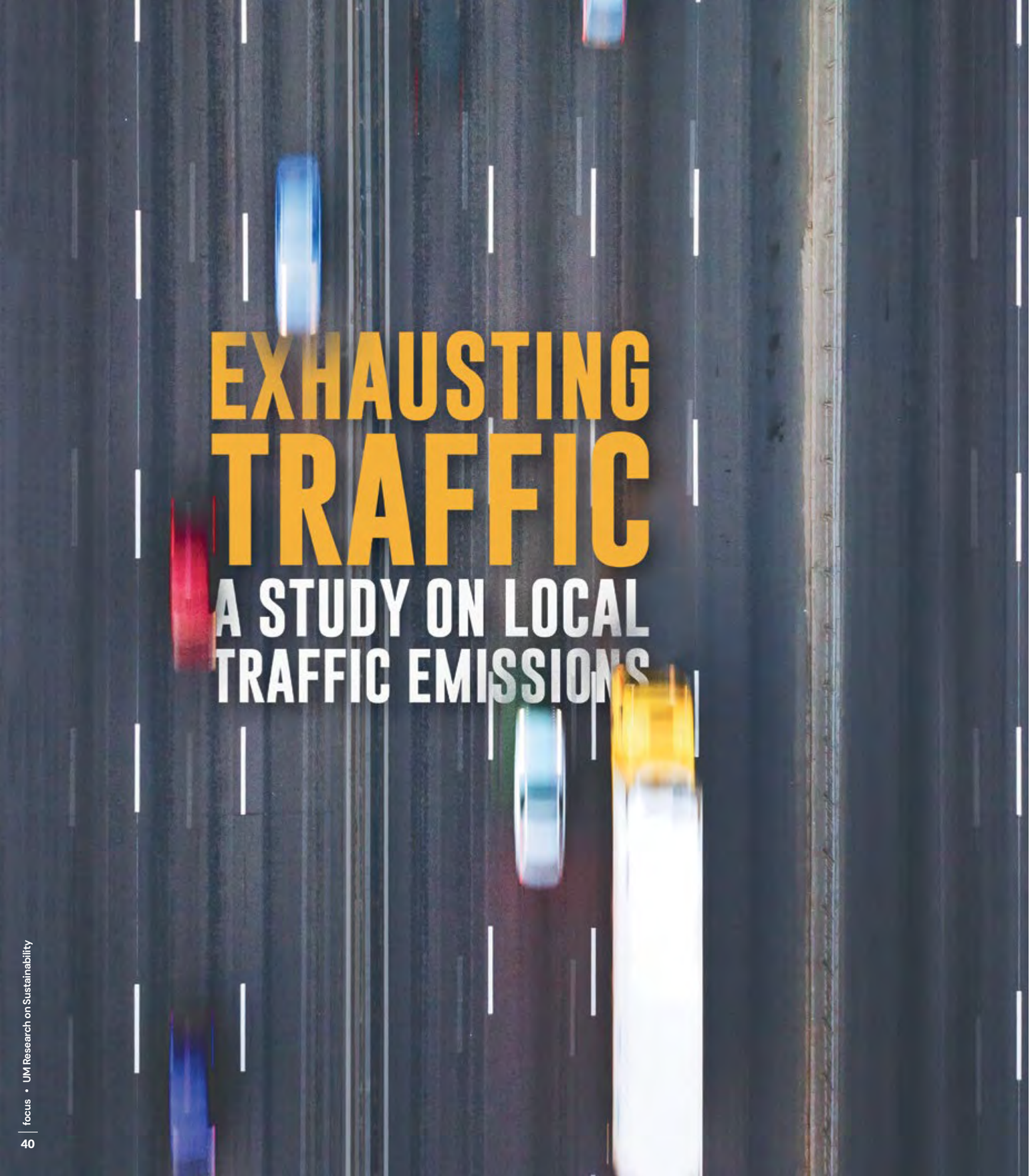
The battle between quality of life and sustainability is still somewhat present in popular public concern, yet Prof. Baldacchino directs the conversation to the opportunities gathering steam in the field. 'We are at a time in history where at least three dozen countries in the world are managing to grow their economy while reducing their carbon emissions. Science is telling us that we don't need to go around barefoot or not have any plastic. It is possible to rationalise people's behaviour in such a way that we continue to enjoy a decent quality of life without harming the planet,' he asserts, concluding that multiple business opportunities in the field are ripe for the taking.

As a pan-university initiative, SEA-EU asserts itself as a network with serious ambitions. A sea of possibilities lies ahead: become a federated university, engaging its own employees and maybe granting its own degrees eventually. A lot is left to be done, but one thing is certain: the future certainly looks turquoise.

Kick-off meeting of the SEA-EU project in Cádiz in 2019 with representatives from our original 6 partners
Photo courtesy of the University of Cádiz

Prof. Godfrey Baldacchino (left) led the University of Malta's participation in SEA-EU until December 2022. He was instrumental in helping to develop the alliance and various sub-programs, as well as securing additional funding for other projects. As SEA-EU continues its steady growth, he has handed the baton to Prof. Alan Deidun (right), who will lead the second iteration of the alliance (2022–26).

At present, SEA-EU has secured EU funding for a further four years to carry the project into its consolidation phase. The original alliance between universities in Malta, Gdansk, Split, Cádiz, Kiel, and Brest has now expanded to welcome universities from Naples, Algarve, and Bodø into fold.



EXHAUSTING TRAFFIC

A STUDY ON LOCAL TRAFFIC EMISSIONS

Author: **Ines Ventura**

We all agree that traffic can be exhausting. But it can also simply be exhaust. Vehicle exhaust emissions originate from their tailpipes and have been strongly regulated to tackle emissions of air pollutants. However, Maltese researchers recently found that this type of emission is not the major contributor to particulate emissions from vehicles. **THINK** *takes a closer look under the hood.*

Transport-related air pollution has an adverse effect on public health. Current policies have been addressing this problem, aiming to improve air quality by decreasing concentrations of transport-related pollution.

To date, only contaminants which originate from vehicles' tailpipes – also known as vehicle exhaust emissions – have been regulated. The increased use of electric cars will lead to decreased emissions of pollutants such as carbon monoxide, benzene, and nitrogen oxides. While we can breathe a collective sigh of relief, exhaust emissions are not the only culprits that need to be tackled, nor are they the worst.

'Shifting to electric cars will only solve the exhaust part of particulate matter from road traffic. We still face a major problem regarding other sources of particulate matter,' highlights Dr Mark Scerri, lecturer at University of Malta's Institute of Earth Systems. In a recent study, local researchers demonstrated that for Msida (a town in the Central Region of Malta), traffic-generated particles are the main pollution source to be considered (38.4% of total emissions). However, only 3.4% of traffic-related particles were due to exhaust emissions. The remaining 35% were due to road dust, tyres, and brakes. These are collectively known as non-exhaust emissions. These non-exhaust emissions constitute 87% of yearly traffic-generated particles and are considered detrimental to public health in particular. But what do we really know about non-exhaust emissions?

NON-EXHAUST EMISSIONS

To understand which sources could be contributing to emissions, the researchers collected data at an Msida traffic site with a sampler over the course of a year. The particles were subsequently analysed chemically in a

lab, allowing researchers to identify the source of these particles. Interestingly enough, a portion of these particles came from natural sources, such as sea salt and Saharan dust. 'A logical contributor since we live on an island near to North Africa,' laughs Scerri. However, the most surprising result was that the bulk of traffic-generated pollution was not released from exhaust pipes, but from non-exhaust emissions.

Non-exhaust emissions are caused by friction between the tyre and the road surface, the resuspension of dust particles previously deposited on the road, and the abrasion between the brake pad and the wheel.

These emissions consist of particles suspended in the air, also known as suspended particulate matter (PM). Particles with a diameter of approximately 10 micrometres (microns) or smaller are referred to as PM_{10}, while particles with a diameter of approximately 2.5 microns or smaller are $PM_{2.5}$. To put this into perspective, a human hair is around 70 microns wide. Both types of particles are small enough to penetrate deep into the respiratory system, aggravating symptoms of asthma or even leading to lung cancer. Contrary to PM_{10}, $PM_{2.5}$ levels in Malta have decreased over time. 'It seems a small detail, but we have to remember that the longer we are exposed to these emissions, the worse the outcome will be,' reinforces Scerri.

IMPACT ON POLICY MAKING

While electric cars do reduce exhaust emissions, they still cause non-exhaust emissions through tyre erosion, road particle resuspensions, and brake-pad abrasion. Since these are not effectively regulated, the change to electric cars will not have a major effect on PM_{10} levels in the environment. In fact, by carrying a rechargeable battery to provide energy, the electric vehicles' additional weight could provoke equal or higher PM_{10} emissions than conventional cars.

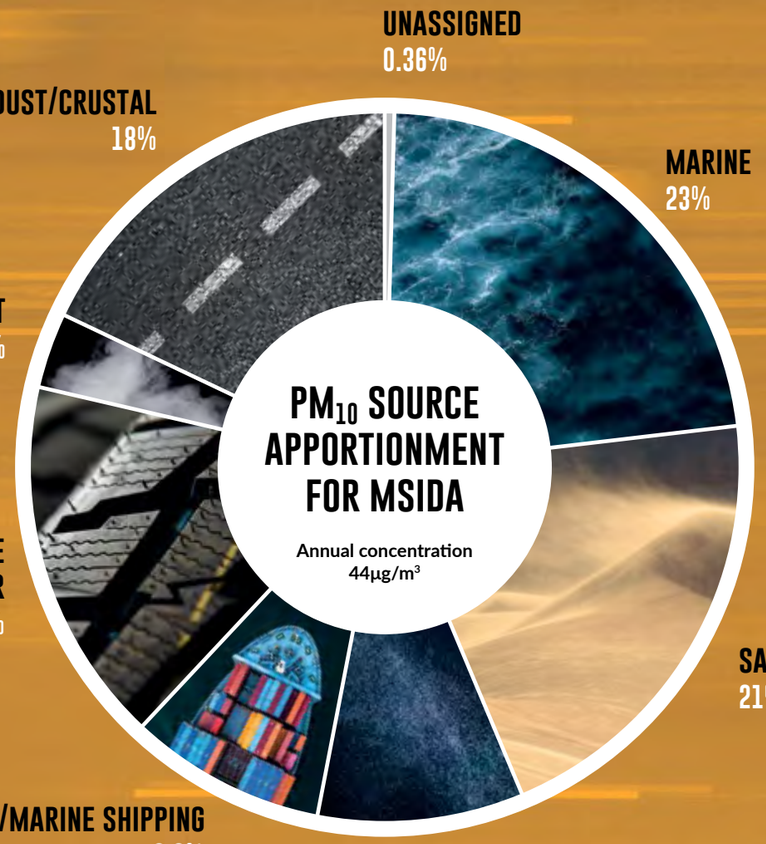
'We are not saying that we shouldn't change to electrical vehicles. We do believe that the use of electric vehicles should be considered, but as part of a basket of measures to control the emission of harmful particles and gases into the atmosphere. However, both electric and non-electric vehicles are impacting our health,' the researcher explains. 'We must invest more in mass mobility – public transportation – and policy making.'

At the European level, discussions addressing non-exhaust emissions and their proper regulation are ongoing. Considering the extreme difficulty in achieving this goal, it is crucial to understand transport demand and traffic activities; ambient air quality, exposure, and effects; as well as urban planning. This requires information from several research areas, often creating transdisciplinary studies and teams.

Decision-makers and risk managers often ask what is the significance of the various components of the pollution emitted by transport that produce adverse health effects? Identifying such components would help risk managers focus their efforts and enable a more forceful reduction of adverse effects on health. The elimination of lead from petrol is an example of this approach; it has resulted in a substantial reduction in exposure to lead and its harmful effects on the neuronal development of children.

As mentioned by the researchers to **THINK** magazine, risk-reduction measures should be extremely calculated, as they may inadvertently have both positive and negative effects. For example, reducing exhaust emissions by increasing the proportion of electric cars may lead to increased PM emissions.

By discovering that the bulk of traffic-generated pollution is due to non-exhaust emissions, local researchers have helped identify one of the main pollution sources related to traffic in Malta. Understanding which pollutants people are involuntarily exposed to is crucial in order to improve the effectiveness of further action. 'That's why science should play an important role in policy-making decisions on – amongst other issues – transport-related matters and in evaluating its benefits and costs to society,' states Scerri.



WE MUST INVEST MORE IN MASS MOBILITY – PUBLIC TRANSPORTATION – AND POLICY MAKING

Adapted from M.M. Scerri et al., 2023

Playing Maltese History

Author: **David Mizzi**

When we study history, we might think of larger-than-life figures such as William the Conqueror and Napoleon or of crucial dates such as the French Revolution of 1789 or the Fall of the Berlin Wall in 1989. But it is also possible to look at history through the lens of microhistory and socio-economic processes, focusing on the daily lives of the people or communities that lived through the time. For the team behind the project Playing Maltese History, this lens was the starting point for their video game, **Valletta: Streets of History**.

Your adventure begins at the National Library of Malta (Bibliotheca), just behind St John's Co-Cathedral. Within its neoclassical, limestone walls lie volumes of scholarly texts and newspaper archives, each clipping providing insights into historical life in Valletta. With your trusty notebook in hand, you have a clue to your next destination…

Valletta: Streets of History puts you in the role of a historian/detective as you piece together stories inspired by historical and archived works. The mobile-supported treasure hunt invites you to explore various locations in Valletta, trying to uncover clues and solving riddles as you connect the dots to resolve a mystery.

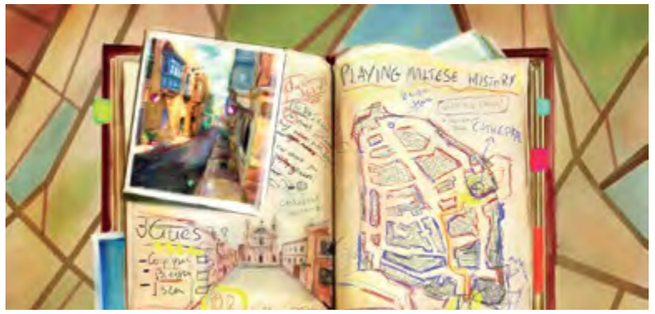
Valletta: Streets of History is a location-based augmented reality (AR) mobile game developed by academics and alumni from the Institute of Digital Games (IDG) and the Department of English at the University of Malta (UM). Dr Renata Ntelia, the project leader behind *Valletta: Streets of History* and a Ph.D. graduate of the IDG, explains to us, 'Think of *Pokemon Go*. That covers the mechanics of the approach, in the sense that it invites the user to go from location to location and interact with certain texts or AR elements. However, the main difference is that, in our case, we've gone for a historical setting and story.'

The game itself consists of three stories, each taken directly from archival research. Drawing from Valletta's rich history, the team wanted to focus 'on the parts of history that aren't so well-known,' explains writer and lead researcher Dr Krista Bonello Rutter Giappone, visiting senior lecturer with the Department of English and research support officer with the Centre for Labour Studies. 'The game centres on marginalised voices from the past.' For example, one of the stories tackles the bubonic plague outbreak of 1813. Another, written by Department of English alumna Ms Naomi Cutajar, follows the story of a young Jewish woman growing up in early 20th century Valletta. However, the game itself has the ability to incorporate a multitude of stories. 'The game itself is very modular. You can play the stories in any order, and it would be very easy to add more stories later on in the future,' explains writer and researcher Dr Daniel Vella, senior lecturer with the IDG.

But how does one go about creating such a game?

IT STARTS WITH RESEARCH…

…and lots of it! 'We started with archival work,' says Bonello Rutter Giappone. 'The Bibliotheca was just one of the places we visited, but we also went to the archives at Santo Spirito, and the National Archives in Mdina. We also



had recourse to private collections such as that of [Judge Emeritus] Giovanni Bonello, as well as consulting people from the Notarial Archives.' While the team started off with an idea in mind, the discovery of new texts in the archives, along with consulting secondary sources, helped to direct them to certain cases. But despite Valletta's rich history, it was important for the team to identify a focus for the game.

'We made a choice early on that the focus should be on the 19th century going on to the early 20th century,' explains Vella. 'Firstly, there's a practical reason: the availability of archives. With the 19th century, there is a lot of archival material to draw from.' The second reason was language. Archives from earlier time periods were often written in Latin, whilst records from the 19th and 20th century were written in Italian and English. This made the process of poring through documents slightly easier for the researchers.

While the stories focus on the historical individuals, the real star is the city of Valletta. 'For me, the city itself is the protagonist,' says Ms Aphrodite Andreou, the game's artist. The game presents clues to the player through a journal. 'I wanted the art in the journal to look like fast, quick sketches to give the game a tactile aesthetic. For example, a sketch of what a particular building looks like now, but without contemporary aspects that could break a player's immersion. However, it was important that the buildings are still recognisable to the player.' Besides the main journal entries, there are also different, smaller images to help illustrate the game's interface, as well as AR models of buildings that don't exist anymore, such as the original main gate of Valletta.

Telling us about her creative process, Andreou explains how, 'every team had their own specific process that they used to follow. For me, after learning about the story and taking the feelings we wanted to convey, I explored how each place looked. Using photographs other people took, seeing different angles from Google Maps, for example, and visiting certain locations before deciding how to portray each one.' For the team's programmers, Ms Emmanuela Marla and Mr Yannis Brellas, the focus instead was on the technical mastery of the game system; accommodating for the designers' creativity while balancing out technical integrity for an error-free end build is no easy task. The game incorporates many different elements that need to be finely tuned for a smooth gameplay experience, particularly when exploring real space in real-time.

GAMEPLAY ELEMENTS

It will take the player more than visiting key locations in Valletta to crack the case, though! There are a number of riddles the player will need to solve, before a clue to the next location is revealed. 'We have a number of riddles and puzzles,' explains Ntelia. 'For example, during one of the stories, the player needs to work through a logic puzzle, reminiscent of games such as *Return of the Obra Dinn*' – as particularly keen super-sleuths might notice. 'The game provides names, addresses, and symptoms (all taken from actual newspapers of the time), and the player needs to figure out who the first victim was.'

Other mini-games are optional. The variety of mini-games creates an element of replayability. 'Each mini-game would represent a unique challenge that would relate to a specific location,' explains Vella.

Digital illustrations created for the game "*Valletta: Streets of History.*" *Images courtesy of Aphrodite Andreou*

The stories selected, design elements, and AR elements all come together to help the player reimagine Valletta. 'Personally, one of my interests is space and place in games,' Vella says. 'I wanted the game to look at the space a bit differently. If you're Maltese, or even if you're a visiting tourist, you're used to seeing Valletta in one way. But the game can turn that city space into something different and even generate new meanings to it.' Certain games set in historical settings, such as *Assassin's Creed* and *Kingdom Come: Deliverance*, allow players to reimagine modern locations as they might have appeared in the past. They help us, as players, cultivate a better understanding of the past.

Building upon this point, Bonello Rutter Giappone refers to psychogeography. Essentially, this idea of urban exploration took form in the 50s and 60s in response to the effect of urban geography on the emotions and behaviour of individuals. 'We have certain frames of perception that are formed out of habit. We almost become desensitised as we follow the same route every day. But by exploring different ways of viewing a space, we can break or bend that habit.'

For Ntelia, it is the historical mystery that makes the project exciting. 'It's about how people lived in this space. We wanted to focus on the parts of history that haven't been exposed yet. So it's not just uncovering new locations in the past, but also experiencing the history of marginalised groups.'

PLAYING HISTORY

'When I was taught Maltese History, it was simply a list of Grandmasters and important dates. We really wanted to look at things that aren't normally part of the historical narrative,' explains Vella. As an educational tool, the game has the potential to foster a love of history. It might inspire players, young and old alike, to find out more about the history that surrounds us.

Bonello Rutter Giappone takes this a step further, 'We're trying to give the player the experience of archival discovery, giving the player some agency in the practice of being a historian. For example, rather than simply presenting history through our writing, we give the player the option to look at the actual manuscripts found in the archives and private collections.'

While games can potentially be used as educational tools, ultimately the true test of a game is how fun it is! If you've always wanted to be a detective or have a penchant for solving riddles, *Valletta: Streets of History* should be right up your alley! Try the game for yourself through either GooglePlay or the Appstore.

The team would like to thank Arts Council Malta, Judge Emeritus Dr Giovanni Bonello, Dr Joan Abela, Mr Noel D'Anastas, Mr Louis Cini, Mr Vince Peresso, the National Archives and Santo Spirito staff, Ms Chanelle Briffa, Dr Sarah Azzopardi-Ljubibratic, Mr Gabriel Farrugia, Dr Evelyn Pullicino, Professor Yosanne Vella, and Aline P'Nina Tayar.

This project is supported by Arts Council Malta.

ALS Discoveries that Help Unlock New Treatments

Author: **Antónia Ribeiro**

Amyotrophic Lateral Sclerosis (ALS) is a rare neurodegenerative disease that 'locks' patients in their own bodies, clear-headed but unable to move or speak. A research group at the University of Malta is looking for therapeutic targets to treat the disease while supporting ALS patients and their families through their condition.

(Top left) Looking through a microscope allows researchers to manipulate flies and understand mechanisms of disease. (Top right) Prof. Ruben J. Cauchi and team members Dr Paul Herrera, Maia Farrugia Wismayer, and Rebecca Cacciottolo. ***Photos by James Moffett***

It is Monday morning, and Ph.D. student Maia Farrugia Wismayer is knocking on a patient's door. The house visit has a double function: first, to collect blood samples for the ALS/MND Lab's biobank at the University of Malta. The second is primarily to assess the patient's neuromuscular health, but also to give advice, answer the family's questions, and offer as much hope as the researcher can in the face of this daunting disease.

ALS is a degenerative motor neuron disease (MND) that leads to the loss of muscle function, including movement, breathing, and speech.

The devastating condition typically occurs in adults, usually between 45 and 75 years of age. For most patients, the disease ultimately leads to respiratory failure and death two to three years after the onset of symptoms. To this day, there is no cure.

ALS, although a rare disease, is a daunting diagnosis, and its incidence in Malta is higher than the rest of Europe. Led by Prof. Ruben J. Cauchi, an associate professor of Neurogenetics at the University of Malta, the ALS/MND Lab is working to better understand this disease, a first step towards finding effective treatments.

CREATING A BIOBANK

Cauchi started his research on ALS using fruit flies. But he soon felt the need to get closer to the local population. To do so, he started a biobank: a repository of blood samples and data from local patients, including their residence, occupation, lifestyle, and environmental exposures.

Farrugia Wismayer visits patients to collect samples for the biobank – samples are the puzzle pieces that create the big picture of ALS in Malta. But a crucial step of the research process is also bringing science closer to the ones who need it. In a frightening period of their lives, patients and their families can discuss their concerns with experts in the comfort of their homes. Farrugia Wismayer recalls, 'It is humbling to see the courage that they have. They put their trust in us. They know that there is no hope for them, but they can help future patients.'

The researchers also collaborate with the patients' neurologists. They advise the clinicians about promising clinical trials that may benefit particular patients.

GENES VS. ENVIRONMENT

Thanks to the analysis of the samples in the biobank, Malta's ALS/MND Lab now understands the context of ALS in the Maltese islands.

The disease can be caused by environmental or genetic factors and, quite often, a mix of both. Familial cases of ALS are caused purely by hereditary (genetic) factors and constitute around 12% of Maltese cases. The remaining percentage are sporadic cases, where a person does not have a family history of ALS but it is still possible to have inherited it from their parents. For example, if a patient's parents died young, they may have possessed the genes related to ALS but did not live long enough for the disease to manifest. Sporadic cases usually result from an interaction between genetic and environmental factors, the latter including lifestyle choices or environmental exposures.

With the blood samples, the ALS/MND team analysed the genetic variations present in Maltese ALS patients. Their results show that Maltese patients have different gene variants to the rest of Europe. There are four typical genes with damaging variants that cause ALS in Europe. These damaging variants are quite rare in Malta. Conversely, there are about five common genes in Malta with damaging variants, which are actually rare in the rest of Europe.

The most recent study of the group found that in Malta, more than in other countries, the balance tilts towards genes as a major determinant of ALS. Findings show that the percentage of genetically explained ALS cases within the Maltese population is one of the highest in the world (around 40% compared to around 20% observed in other populations). This alludes to the effect of genetic insularity on an island population.

LOOKING FOR EFFECTIVE THERAPIES

After figuring out that Maltese patients show a different genetic profile from the rest of Europe, Cauchi wanted to understand how these gene variants lead to ALS. To do so, he went back to fruit flies.

But why would one use flies to study genes that affect humans? Having a 75% genetic overlap with the human genome, but with a genome simple enough to associate a gene with a function, fruit flies are the perfect animal model to study the genetic causes of ALS. Additionally, of all multicellular organisms, flies are the easiest model to manipulate genetically. A win-win situation.

In the fruit flies, the team, headed by Cauchi, is silencing genes they previously saw connected to ALS in Maltese patients. When genes are silenced, they stop executing their function. The researchers can infer the function of the genes by analysing what stops (or starts) working when they silence that gene. Usually, a gene produces a protein that works in particular pathways in a cell. If you silence a gene, the protein is not produced, and the pathway stops working.

If the researchers understand what is happening in a particular pathway, they can tweak it by changing the levels of other proteins. Down the line, they may be able to find proteins that regulate a pathway that is altered in ALS patients. If there are already drugs in the market that target these hypothetical proteins, then these drugs may be beneficial for ALS patients. However, the work does not stop there. The effectiveness of the drugs for ALS will have to be assessed through clinical trials.

Considering that today there is only one medicine for ALS approved in Europe, which only prolongs life by three months, finding new therapeutic options is a priority for the research community.

MOTOR NEURONS

It is Monday afternoon, and Farrugia Wismayer is back in the lab. However, she is not focusing on the blood samples she collected in the morning. She is dissecting fruit flies with ALS and looking at their motor neurons, hoping to find differences between the motor neurons from healthy fruit flies and flies with ALS.

ALS mainly affects one group of cells: motor neurons, the cells that tell our muscles what our brain wants to do. Finding therapeutic targets specifically in these neurons may help to find therapies that only affect these cells, avoiding systematic secondary effects.

Fruit flies with ALS were genetically engineered to express specific sets of genes that are associated with the disease. These genes were identified through an international collaboration known as Project MinE.

BEYOND BORDERS

Cauchi's group is collaborating with an international network to better understand ALS and find new

Fruit flies, the tiny real heroes of ALS research at the University of Malta. *Photo by James Moffett*

treatments. Within Project MinE, the group has access to many more samples and a wide array of expertise. The international project is analysing the genes of at least 30,000 ALS patients from all over the world, and they are comparing this data to 122,000 individuals without the disease to identify genetic differences between healthy individuals and ALS patients.

Scientists working on Project MinE, including those from Malta's ALS/MND Lab, are looking into two different components of our DNA. The first is the genome, the DNA that is stored in our cells. The other is the epigenome, the array of molecules that bind to the DNA and help it be read and expressed. Our cells carry a lot of different genes, but not all genes are used. Different cell types use different genes, and the epigenome regulates which ones are being put to use.

From this work, Project MinE found 15 genes that, when altered, lead to an increased risk of developing ALS. Alone, these altered genes would not cause ALS. However, the risk for developing the disease increases if one of these genes is damaged by variants that one carries in their DNA.

CELL TRANSPORT AND CLEANING THE CELLS

By analysing samples from the Project MinE network, scientists also found more than 40 regions in the genome linked to ALS that can be switched on or off according to lifestyle.

Lifestyle changes alter the epigenome and lead to different genes being expressed. This allows the cells to quickly adapt to their environment. As such, our lifestyle has the power to cause changes to our epigenome, fundamentally affecting the genes expressed and, consequently, the cells' response.

Several genes and epigenetic areas identified through Project MinE have functions related to vesicle-mediated transport and autophagy.

Vesicle-mediated transport is the way cargo is trafficked inside cells. Some cargoes contain waste. Autophagy is the way our cells get rid of this waste through either its destruction or recycling. It is essential for fighting bacterial and viral infections, and it even protects us from cancer. When it is not well-regulated, it stops clearing cell components, including cholesterol, and because of this, high levels of cholesterol can be indicators of a deficient autophagy system and, consequently, ALS.

Curiously, the most common ALS genes damaged in Maltese ALS patients (the rare ones in Europe) are also linked to vesicular trafficking and autophagy, hinting that even though ALS can be caused by different genes, the mechanism behind its onset is somewhat consistent.

Because of the link between ALS and impaired intracellular (inside the cells) transport as well as autophagy, the flies Farrugia Wismayer is analysing have altered genes that function in these pathways. Cauchi's lab is starting to determine how the cell's transport and cleaning system leads to ALS, and by understanding the process, they may identify therapeutic targets.

The next steps for the group will be to understand how the environment and the genome interact, which is complicated to study since everyone has a different lifestyle, thus having different environmental interferences.

Cauchi's lab has already identified that manual workers are twice as likely to be diagnosed with ALS. Research in other populations has shown that Italian football players, American NFL rugby players, and military servicemen have an increased risk of ALS compared to the general population. A long history of strenuous physical exertion therefore appears to trigger ALS. The lab is thus experimenting on different 'lifestyle' exposures that can be toxic to motor neurons in flies.

SCIENCE AT THE SERVICE OF SOCIETY

It is late on this Monday afternoon, and the researchers should be heading home, but the group has one more task to complete, one that goes beyond their research responsibilities. While working hard to push forward the research on ALS, the group is also trying to spread the existing knowledge to the communities that need it. Annually, they organise seminars for patients, families, researchers, clinicians, and anyone interested in learning more about ALS. Here they reveal new findings based on the latest research of the lab and current advances in the development of treatments.

Their direct work with patients and their efforts to collaborate with clinicians and other researchers show that the University of Malta's ALS/MND group does not lose focus on the bigger picture: the impact of its research on the life of patients. A true example of science at the service of society.

Research at the University of Malta's ALS/MND Lab is presently funded by the Malta Council for Science & Technology Research Excellence Programme and the Internationalisation Partnership Award, the Anthony Rizzo Memorial ALS Research Fund facilitated by the University of Malta's Research Trust (RIDT), and an Endeavour Scholarship (part-financed by the European Social Fund).

A full list of references will be available on the digital version of the article at thinkmagazine.mt

Can You Enhance That?

Author: **Timothy Alden**

Cop shows have taught us that grainy photos of a crime scene usually contain clues to a killer in action. By zooming in or running a program, investigators are able to catch critical clues to help in their investigation. In reality, if one zooms in on a poor-quality image, one simply gets pixels. A team of researchers at the University of Malta (UM) are developing software which can enhance images to extract critical details and clues using artificial intelligence. ***Dr Ing. Christian Galea****, one of the researchers in the Deep-FIR project, talks us through his journey.*

One can look at the challenge of reading low-quality images captured from CCTV, mobile phones, and other means as a puzzle. Hidden in those pixels could be clues to solving a crime. However, if one is not cautious, image enhancement software could implicate the wrong person. To understand why this is the case, one has to understand how Dr Ing. Christian Galea (Research Support Officer, Faculty of ICT) and the team at UM tried to solve these puzzles. What is the artificial intelligence software they programmed trying to do?

The Deep-FIR software works by feeding a large dataset of images through an artificial intelligence, training it to recognise patterns and to thus make an incredibly accurate guess wherever there is information missing. In other words, the software makes an educated guess about what *should* be in an image, based on different examples it has been exposed to. In reality, the Deep-FIR project does not simply enhance an image or zoom in. Instead, it increases the image's resolution by filling in the gaps wherever there is missing information. Of course, therein lies the risk and the need for ever greater accuracy. Galea elaborates:

'If certain details in an image are very small, it is very difficult to get a true prediction. Eye colour is one example. I had an image of David Beckham. I degraded the quality and then super resolved it using the software. The result I got was a David Beckham with blue eyes. In reality, his eyes are green. However, because in the publicly available datasets we use celebrities tend to have blue eyes, then the software used probability to estimate that his eyes would be blue based on the information left in the degraded image.'

WHAT CAN IT BE USED FOR?

Fighting crime is not the only application of Deep-FIR. There are many applications for this sort of software, even in the entertainment industry. Historical footage can be improved and made suitable for the higher definition screens we have today. This is significantly easier for the software to do, as there is already a lot of information to work with. In some cases, all that

From left to right: Prof. John Abela, Prof. Ing. Reuben A Farrugia, Prof. Ing. Kenneth P Camilleri, Mr Keith George Ciantar, Dr Ing. Christian Galea, and Mr Matthew Aquilina
Photo by Prof. Ing. Carl James Debono

is needed is to make the images sharper and remove blurriness or any visible compression artefacts.

In deciding the focus of the project, however, the team decided to address a major research gap. While software had been designed before to improve poor-quality images, the novelty of the project lies in the ability to apply it to the real world. Currently, software applied to real images such as CCTV snapshots do not work very well because the software is not trained on sufficiently realistic images. Deep-FIR takes the technology a few steps further and uses supplementary information to train the artificial intelligence models.

The software is not limited to faces. Even when a face is not visible due to a mask, for example, there could still be things to note such as tattoos or other identifiable features. By gathering feedback from the local police force, the project team was able to help focus on certain applications and decide which data to feed the software to train it accordingly.

'We spoke to the police to see what their actual requirements are and how we could make the software as useful as possible. It was then that we realised the scope of the challenge. One of the results of this feedback was to work on making number plates more visible. It can be difficult to distinguish between a 0 and a 9 in images, for example. We can also make the model of a vehicle more recognisable. The goal then is not to get all of the information on the spot, but to help the police to narrow down the possibilities,' Galea explains.

ETHICAL CONSIDERATIONS?

Facial recognition software is a tool to be used with caution. The project team kept the need for accuracy at the forefront to reduce the risk of misidentifying someone or mistaking crucial details. By its nature, however, the software is not meant to be used to prosecute suspects. In a court of law, the uncertainty around software which works on probability means that the evidence might not be admissible. However, the point of the software is to help police with their investigation before prosecution. It is there to help them gather crucial data in their investigation, directing them towards potential new leads, for example. It is from these subsequent leads that they would get what they need to prosecute.

In developing Deep-FIR, Galea and the team worked only with publicly available datasets. In other words, no private images of people were used to train the software. Generally, they would use images of celebrities. However, there are still risks that this choice of dataset will skew the data. For example, racial and gender biases are problems which currently affect face-recognition systems. While the team has conducted limited research on what is called 'face super-resolution', Galea expresses the importance of tackling this and other demographic considerations in any follow up to the project:

'Celebrities do not tend to represent the majority of the population. Furthermore, they wear makeup and are always dressed in a certain glamorous way. So the software models must be tuned accordingly, and we have to be very careful in how we choose the models. If most people in the dataset are of a particular demographic, then the algorithm will likely work well on that demographic at the expense of other demographics. To counteract this, the available data is not used solely for training but is split into a validation set and a test set so that the tuning of certain parameters and evaluation can be made on data that is not seen during training. This helps to provide a better picture of what would happen when the algorithm is used in the real world.'

WHAT DOES THE FUTURE HOLD?

Asking Galea what might be next, he points to a number of ways in which the software might be improved: 'There are still a lot of things that could be explored. We want to work on videos, for example, instead of just images. Currently, we can super resolve and enhance videos frame by frame, but that is not quite the same thing.'

Asking Galea what he is most excited about regarding Deep-FIR, he highlights the fact that it can be applied in the real world unlike other research in the field. Furthermore, the software could be provided with additional information in future, such as the contents in a scene itself. In the case of face super-resolution, information about, say, race and gender could be provided to help guide the software into producing more faithful and less biased results that are tuned to the characteristics of the person. This information could be derived from eyewitnesses' or victims' descriptions of criminals when interviewed by law enforcement agents.

Here is facial recognition software for the real world based on upscaling poor quality images – technology from fiction which is no longer just sci-fi. The future, it seems, is finally just around the corner, and Galea and the rest of the Deep-FIR team have made sure that it has been programmed in an ethical way.

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feature

A Revolution of Enlightenment
The Redemptive Rise of Manwel Dimech

Author: **James Moffett**

During the 1880s, while incarcerated in a Maltese prison, a young man's desperate thoughts slowly but surely transformed into a series of radical and progressive concepts that would both condemn him and turn him into one of the most overshadowed and pivotal historical figures in Malta's history.

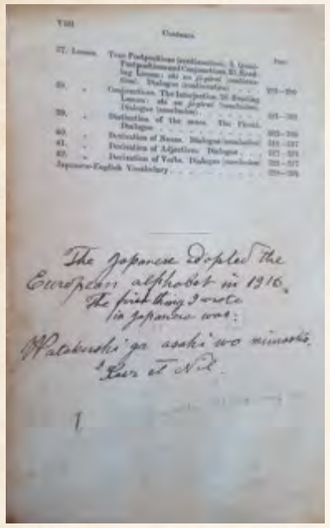
Manwel Dimech was born in Valletta in 1860. The son of a sculptor, his early childhood was plagued by the harsh living conditions prevalent at the time. Malta was a colony of the British Empire and a crucial naval base in the Mediterranean. Meanwhile, many of the island's inhabitants were at the mercy of disease and poverty, afflictions which also affected the Dimech family. With the death of his father and worsening hardships, the 14-year-old boy found himself involved in thievery that would cause repercussions for years to come, until his death.

'His whole life was a terrible tragedy. He suffered much from poverty and religious persecution, exile, and prison.' Mandy Cassar Conti, a postgraduate ethics student reading for a Master's in Teaching and Learning at the University of Malta, said to **THINK** about her dissertation on the life of Manwel Dimech. 'The only option for him to survive was through the criminal world. He therefore used to steal to make a living. He had a rebellious character, and he ended up in bad company.'

At just 17, Manwel Dimech committed involuntary murder together with a friend, following a scuffle with an individual who owed them money. He was sentenced to 20 years in prison, and whilst he himself avoided the gallows, his companion was not so fortunate and was eventually hanged in public. This led to a strong sense of guilt in Dimech. Yet, amid the bleak and dreary existence of prison life, a kindling light shone upon the young convict. It was here that he met his first mentor and teacher, Dun Pietru Pawl Borg. The presence of the prison chaplain, educating and teaching the illiterate Dimech to read and write, proved critical in the young man's subsequent formative years, which ultimately led to the recognition we know him by today. Cassar Conti explains, 'Manwel Dimech had found a father figure that was missing in his life at that point. He felt betrayed by his biological father, deeming him a traitor for letting him and his family live in poverty.'

REDEMPTION THROUGH EDUCATION

Unlike his father, Dimech had a very good relationship with his own mother – who visited him on a regular basis and encouraged him to read and study literature.



Top: A book on Japanese grammar where Manwel Dimech wrote down his notes.
The book was provided by Tony Nelson, son of Albert Nelson, whom originally transcribed the same book.

Left: *Dimech 1* – An illustration which will be included in Mandy Cassar Conti's dissertation

Photos courtesy of Mandy Cassar Conti

He was exposed to Italian newspapers and began writing several poems in that language, which ended up being published with the assistance of Dun Borg.

Dimech became literate whilst serving his prison sentence. Despite his early uneducated background, he quickly became a prolific writer and a voracious reader. This helped propel the formation of his radical ideas, which began to simmer at that time. Reading took over his life, and one particular account reveals how he convinced prison authorities that he was suffering from hypochondria – a chronic anxiety about one's health. He was granted a light in his prison cell, which enabled him to keep reading late into the night. Light was a crucial concept in Dimech's thoughts. The symbolic use of illumination, filling the darkness of the mind with knowledge and awareness, signified independence from social shackles or political restrictions; this was attained through education. Only educated individuals were able to comprehend their rights and resist any oppression imposed upon them.

After his release in 1897, Dimech made his way to Italy – a country that had started witnessing the rise of the socialist party: the Partito Socialista Italiano (PSI). 'Few know that Dimech's profession was that of an educator,' explains Cassar Conti. 'He was a teacher. That's how he made a living in Italy: by teaching French and English. His pedagogy, the way he used to teach, really interests me.' This enabled Dimech to reach out to people as a public figure, and it was at this time that he became politically active and began to harbour thoughts of an independent Malta – a Republic free from the chains of colonialism. 'That's what he's best known for. He fought against the British.'

Dimech's thought was influenced by pragmatism (a philosophy that focuses on practical approaches and solutions rather than the theoretical) and this is also reflected in his pedagogy. Instead of, for example, studying the conjugation of verbs by heart or memorising words, which is the traditional method for teaching languages, he contextualised knowledge. 'In my opinion, learning a phrase in a context is more effective, both in understanding the meaning and also in using it. The traditional method of learning verbs by heart is not apt, because in practice if you are speaking, you are not going to express anything about yourself by reciting the verbs or singular words,' explains Cassar Conti.

Dimech was also one of the first to strive for Malta's language. Maltese was largely spoken at that time, especially among the lower classes, but lacked any concrete use in writing. It was Dimech's belief that this language could unite the people as a nation. Individuals could identify themselves as Maltese, whilst the language could also serve as a political tool, rather than being limited to the exigencies of literature. Dimech wanted his words and messages to reach the working classes. As a result,

Mandy Cassar Conti and Tony Nelson

Photo courtesy of Mandy Cassar Conti

he began publishing a weekly newspaper, *Il-Bandiera tal-Maltin (The Flag of the Maltese)*, to disseminate and advocate the importance of education to the masses.

With his growth into a fluent speaker, his mastery of various languages, and as the author of several published works, he was able to spread these concepts throughout Malta. Yet, his views of a free and independent Malta did not sit well with the British authorities or the Church. Both of these factions still wielded considerable power over the local population. As a consequence, he was exiled to Egypt, where his presence and radical ideas could be stamped out and removed from the heart of the island.

Despite the terrible conditions he found himself in once again, he persevered in his studies, education, and attainment of knowledge. Already accomplished in four languages as well as some Russian, he spent his exiled years studying Japanese, among other scholarly pursuits.

'It was a terrible period in his life, and he remained there till his death.' Despite numerous attempts from family members and friends to bring him back to Malta, such pursuits proved futile, and Dimech eventually died in exile – buried in an unmarked grave.

'This is why his story really affects me.' Cassar Conti explains the motivations behind her research: 'He went through a lot but he kept fighting for social justice. He had this flame and this mission for social justice; he did not just become a cynical individual. He wanted to give back to the people. He wanted to see people rid themselves of that terrible situation they were in.'

PRISON EDUCATION AS REFORMATION

Rehabilitation is a concept that has often been associated with the prison system and with prisoners themselves. Can an individual become a better, more knowledgeable person than when they were incarcerated? Dimech's story seems to offer a glimmer of hope in this aspect. As Cassar Conti has discovered in her research, education proved the crucial turning point that provided Dimech with rehabilitative benefits. 'The fact that he had tutors and someone who cared for him, a mentor, was also crucial in these environments.'

Later on during his prison years, Dimech met his second tutor, Rev. George Wisely, who instilled in the young man a sense of purpose in life. Rev. Wisley believed in pragmatic philosophy, which he passed on to Dimech, who was then able to unify this with his political activism. Cassar Conti believes that 'the closer prisons can reflect the society out there, the more it can provide rehabilitative properties.' While Dimech's incarceration introduced him to father figures and paved the way for a distinguished education, the prison system was unsuccessful in providing him with core social values and behavioural norms. Dimech was not ready to face life, and soon after his release for murder, he was sent back to prison after committing money fraud.

LOOKING AHEAD

Manwel Dimech's life is both tragic and inspiring. Though failed by the justice system, he is a clear example of the redeeming qualities that a good education and a quest for knowledge can provide. His story has also paved the way for prison reforms in Malta in the years since. The death penalty, which was in existence back then, is now no more.

Depending on the angle through which one chooses to tackle the issue, Dimech's trials through life may be deemed a success story. He has undoubtedly left an indelible mark on Malta's history, demonstrating how reforming oneself through sheer determination and with guidance from others enables an individual to strengthen their resolve and contribute beneficially to society. While Dimech was unable to physically free himself from his oppressors and the situations he was forced into, in the end, he found himself liberated and prevalent through his voice and the written word.

idea

Must There Be Winners and Losers as We Go Green?

Author: **Timothy Alden**

Climate change is a growing problem. The longer we go without making sacrifices, the greater the price that must ultimately be paid. The problem is made worse, however, because when it comes to phasing out fossil fuels, some people must automatically pay a higher price than others. So who would the winners and losers be if we suddenly drove forward to significantly lower emissions by 2030, as the European Union intends?

One of the greatest problems with climate change is that everybody seems to think that somebody else should be making bigger sacrifices. The United Nations Framework Convention on Climate Change (UNFCCC) was established in 1994 as a vehicle to tackle climate change and has been the basis for discussions to lower emissions ever since. The problem is that the benefits of reducing emissions today are spread out among all inhabitants of the planet and are often not immediate, while the costs of reducing emissions are concentrated on the individual or country making the reduction. This creates a situation where each actor has an incentive to free-ride on the efforts of others rather than take action themselves. How much should one sacrifice for it to be fair?

Before the Paris Climate Accord in 2015, there was the failed Copenhagen Accord. Christiana Figueres, executive secretary of the UNFCCC from 2010 to 2016, said that the Copenhagen Accord in 2009 was a free-for-all of political frustration, outrage, and disagreement, in which the global north and global south were set against each other over the issue of climate justice. The perspective of poorer countries was that richer countries have benefited from industrial revolutions, emitting carbon for over a century, and therefore, they should be paying to help poorer countries go green instead of just blocking them from using fossil fuels. This notion of climate justice has taken centre stage ever since.

Answering the question of who should be paying the most to address climate change is challenging. However, the need for drastic reform is undeniable. This begs the question: what are the strategies of those preventing climate action from happening?

THE CHURCH OF OIL

Unsurprisingly, fossil fuel companies stand to lose from the transition to green energy. What is surprising, however, is that fossil fuel companies such as ExxonMobil have been accurately predicting the devastating effects of climate change as early as 1977. In 2021, American environmental sociologist Robert Brulle pointed to new evidence that has come to light of the 'deliberate and organised effort to misdirect the public understanding of this issue through the promotion of

uncertainty over mainstream climate science,' utilising phoney think tanks as weapons to delay action and confuse the science and the public debate around it. Therefore, part of the tension between science and politics, including on the global stage, is manufactured by interest groups to protect their advantage. This is done at the expense of the common good and by rigging the rules of the game against the outcomes most beneficial to the global community as a whole.

Upon discovering the damage they were causing, fossil fuel companies reacted by indulging in unprecedented propaganda operations. The objective has been to transform the consumption of fossil fuels into more than just an economic choice, but also into a culture war. In the United States, aversion to renewables and defence of oil is the result of extensive lobbying by fossil fuel companies over generations. The capture of politicians by moneyed interests has also led to an ideological addiction to fossil fuels. Prof. Jean-Daniel Collomb (Grenoble Alpes University) observes that climate scepticism in the US emerged in part because the challenge which climate change poses significantly damages the soundness of the ideological pro-market position which the American conservative movement has been embracing since the Reagan era. Essentially, the reality of climate change harms capitalist ideology. One of the most popular answers to it, therefore, is to deny that it is even happening or that mankind is influencing it.

One can even imagine that if a technology like nuclear fusion were to become commercially viable in the next few years, fossil fuel companies would hardly welcome it. They would most likely do everything in their power to slow the successful adoption of nuclear fusion in spite of the solutions it could offer to the climate crisis and even to global poverty. Even though fossil fuel companies might slow the roll-out of that new technology, they would also realise that in the long term, it may be a losing battle. They would likely consolidate their hold over third-world markets, who would initially not have the money to invest in nuclear fusion reactors or infrastructure. Furthermore, developing countries may not have the expertise or skills to immediately adapt the technology. Inequality, therefore, would not go anywhere anytime soon, even despite the promise of limitless energy. Fossil fuel companies promise to invest in renewables today, but in reality, they dedicate very few resources to actually doing so and employ similar strategies to get away with it.

NATION STATES

Certain countries that are heavily dependent on fossil fuels, such as India and China, are busy making the argument that they should be allowed to do so for the sake of catching up with first-world countries. They agree to rolling out renewables, but also argue in favour of having more distant carbon neutrality targets. However, while those countries consume fossil fuels, there are others such as Saudi Arabia, Venezuela, and Russia who are famous for selling them. These countries face an even more daunting challenge. They must not only pay for renewable or nuclear infrastructure, but they must give up a competitive advantage from resources they possess in abundance. Such countries participate in the likes of the Paris Agreement, but unsurprisingly, their actions speak louder than words. Like fossil fuel companies, they face the temptation of maintaining their advantage by watering down international agreements.

While it is hard to sympathise with such governments, especially when elites seem to grow richer on such wealth while the poor remain poor, it is also important to note that fossil fuel producing countries also exist in the First World. While the United States is known for its wealth of fossil fuels, and its politics are reluctant to address climate change as a result, there are also countries such as the United Kingdom and Norway who have vast fossil fuel industries. There, political battles rage as to what extent these resources should be kept in the ground in times of economic hardship. The United Kingdom's briefly sitting Prime Minister, Liz Truss, received much criticism for proposing that fracking be allowed once again, inciting the ire of environmentalists both outside the Conservative Party and within it.

Norway has an even more complex attitude towards fossil fuels. On one hand, Norway is a major producer of oil and gas, and the industry represents a significant part of its economy. The country's offshore oil and gas reserves have made it one of the world's wealthiest nations and a major exporter of fossil fuels. On the other hand, Norway has also been at the forefront of efforts to combat climate change and transition to renewable energy. The country has set ambitious targets to reduce greenhouse gas emissions and increase the share of renewable energy in its energy mix. Norway has also invested heavily in research and development of renewable energy technologies such as wind and hydropower. Additionally, Norway has implemented several policies to reduce its carbon emissions, such as a carbon tax, and has committed to being carbon neutral by 2030. The government has also divested from coal and invested in reforestation and afforestation projects to sequester carbon.

EFFORTS OF INDIVIDUALS

With everybody pointing fingers at everyone else as to who should shoulder the burden of lowering emissions, political scientist and economist Elinor Ostrom warns that 'given the severity of the threat, simply waiting for resolution of these issues at a global level without trying out policies at multiple scales because they lack a global scale, is not a reasonable stance.' In other words, we cannot sit pretty and expect these problems to sort themselves out in the highest levels of government. Ostrom studied the tragedy of the commons, challenging the notion that when communities govern common and shared resources, they must automatically be governed poorly. By identifying case studies of communities who managed their common resources successfully, she was able to draw lessons as to what informal and formal rules worked best to conserve those resources. This theory falls under the umbrella of the 'governance of the commons'.

To address climate change, therefore, Ostrom has proposed a polycentric approach – action taken at all levels, from top to bottom. However, one of the clearest take-aways from her studies is that to resolve problems such as the Tragedy of the Commons and the inability to cooperate in regards to shared resources, trust is a fundamental requirement. Without trust, enforcement of rules, and clear communication, communities on whatever level cannot successfully govern shared resources. We should not, therefore, let bad faith actors or 'free-riders' such as fossil fuel companies destroy our ability to cooperate with one another or encourage us to give up. There are no easy answers to determine who should be the winners and losers of the green energy transition, but Ostrom shows us how we might at least best organise ourselves in the meanwhile. The starting point must certainly be building the trust which inspires action.

A full list of references will be available on the digital version of the article at thinkmagazine.mt

An advertisement for Humble Oil, Life Magazine*, June 1962*

The Tragedy of the Commons

The tragedy of the commons refers to a phenomenon where individuals or groups overuse a shared resource by choosing to act in their own self-interest instead of moderating their behaviour. This can occur in situations where there is no mechanism in place to regulate usage or ensure preservation of the resource. Climate change is an example of a tragedy of the commons, as the emission of greenhouse gases by individuals, businesses, and governments contributes to the warming of the planet, but there is little incentive for any one actor to reduce emissions without a coordinated global effort. The negative impacts of climate change, such as desertification and more frequent natural disasters, are shared by everyone, but the benefits of reducing emissions are not equally distributed. Therefore, people are not incentivised to shoulder the responsibility of fixing the problem, especially if few people around them are doing so. This creates a situation where the costs of inaction are high, but the incentives for action are weak.

Modl.ai: Creating the Ultimate AI Game Testers

Author: **Christian Keszthelyi**

A spin-out from the University of Malta's Institute of Digital Games is working on artificial intelligence-run game testing software. The engine would run thousands of low-level testing rounds before humans engage in high-level testing of a game prior to market release. Modl.ai co-founder ***Georgios N. Yannakakis*** *tells* **THINK** *how his team aspires to change the game.*

Playtesting video games is essential in game development as it ensures ridding games of bugs and glitches to avoid hindering gamers' experiences while playing. However, the game tester labour shortage (and the repetitive and tedious nature of the job) makes it hard for developers to find suitable gamers to vet video games. Modl.ai, which raised an investment of €8.5mil from Microsoft's M12 Venture Fund and Griffin Gaming Partners in late 2022, allows developers to use artificial intelligence (AI) to extensively test the nooks and crannies of a game.

Prof. Georgios N. Yannakakis, co-founder of modl.ai, was a professor at the IT University of Copenhagen (ITU) and met Christopher Holmgård, now CEO of modl.ai, as his Ph.D. student interested in human-computer interaction in 2012. Holmgård was co-supervised by Julian Togelius, co-founder of modl.ai and now research director. The three of them envisioned the use of AI for testing games in an autonomous fashion. Their ad-hoc Copenhagen club disbanded when Togelius moved to New York to teach at New York University, Yannakakis came to the University of Malta, and Holmgård stayed in Denmark. Some years passed before the trio met in Athens at a conference in 2018 and realised that Holmgård's early research had become extremely relevant to the market. This prompted the birth of modl.ai. The co-founder team included Prof. Sebastian Risi from ITU, Lars Henriksen, and Benedikte Mikkelsen. But how does it work?

PLAYTESTING: DREAM JOB OR LOGISTICAL NIGHTMARE?

'The idea is to have artificial intelligence automatically testing games, any game,' Yannakakis tells **THINK**. But why is this so important? Nowadays, almost a third of a game's budget is dedicated to quality assurance and testing. Playtesting, however, is a time and fund-consuming feat. Human players must spend ample time playing a game to uncover a selection of bugs in graphics, soundtrack and effects, and mechanics. The bigger the game's world, the more impossible it is to manually uncover every single bug before the game is released. The current shortage of qualified game testers, coupled with hiring and contracting costs, quickly crank up expenditures, which makes the financial development tally thicker.

Yet playtesting is essential. 'When a game is released without proper testing, it can destroy not only a game release, which in itself is a huge investment, but also the credibility of the developer and the publishing companies,' Yannakakis says. The stakes are high, while time and money are finite. Modl.ai aims to fill the gap between early development and the point when human testers try their fingers at a game pre-release.

AI solutions are changing the job market, but Yannakakis believes that, in their case, both AI and human testing will remain relevant. 'Modl.ai strives to become the ultimate testing tool that any game should have. Our AI game engine is a component that sits on top of any game engine, automatically testing various aspects of the game,' Yannakakis says. Modl.ai's solution would run thousands of bots (non-human gamers) across the game to test for the nitty gritty before human testers are unleashed on a pre-release game.

The AI engine modl.ai is working on aspires to become a game-agnostic tool, which would allow the software to sit on any game engine currently running or emerging in the future, from small-scale mobile games to triple-A behemoths. 'We need to find ways to make sure our final product can interact with any game development engine. Obviously, we are looking at the most popular game engines for now, as a case study. But in the next iteration of our engine, we would want to be able to build a game-agnostic AI engine,' Yannakakis says.

GAMER ARCHETYPES

Modl.ai's bots are able to play a game using a variety of play styles, mimicking various player types. These 'gamer archetypes' are possible thanks to procedural personas, a concept that comes from interaction design and human-computer interaction. For example, you might have players who try to 'brute force' a solution by trying all possible

The modl.ai team
Image courtesy of modl.ai

combinations and others who might try an indirect approach. 'It is essentially a theoretical model of how a particular group of people will behave when they are faced with an interaction, for instance, in a game or a web application,' Yannakakis says. This modelling helps establish archetypes of gamers' behaviours, based on cues of how humans interact with technology, computers, and games.

Bots deliver rapid feedback to developers before testers would even get a glimpse of the game. 'You can iteratively improve your game with our AI game engine, and once you're happy, you can send it to humans for further polishing and further testing,' Yannakakis says.

EXPANDING THE TEAM

Malta plays a crucial role in modl.ai's development. Yannakakis, who is also the Director of the Institute of Digital Games at the University of Malta, oversees the company's subsidiary in Malta, which is hosted at the university's TAKE OFF Business Incubator. There are Institute of Digital Games alumni on their team, who work on automating game development procedures like debugging and quality assurance testing.

'We have four people in Malta working in the spin-out of the start-up. We are firm supporters of remote working, and the recent funding we have received has enabled us to hire aggressively. In the next few years, we plan to expand up to 70-80 people around the world from the current over-30 in Malta and Copenhagen,' Yannakakis says. Modl.ai needs hard-working talent as they aim to finalise their AI game engine, which has a strong research component, in the next two years, with activity picking up in 2023.

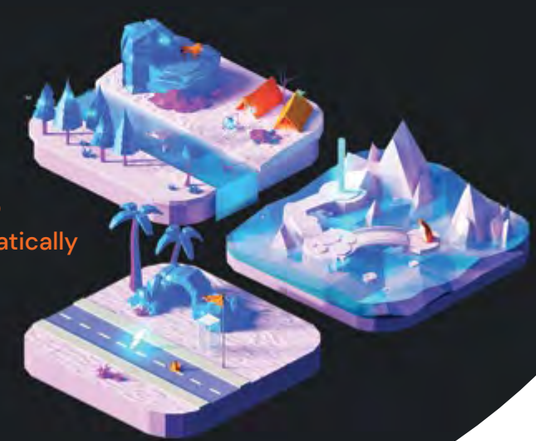
Beyond the university serving as a crucial location for the development of the game-testing AI solution, modl.ai recently managed to secure a grant from the Ministry for Education, Sport, Youth, Research and Innovation's Postdoctoral Fellowship Scheme 2022 to fund a researcher for the development of their project. Yannakakis tells **THINK** that modl.ai seeks to find further synergies between their company and the Malta Chamber, and the start-up looks to expand its Maltese branch.

'We want more and more people to come to Malta to work with us and modl.ai. When it comes to AI and games, this is one of the most creative lines of work you may be able to find in Malta,' Yannakakis adds. The foundations are in place for growth. In a recent collaboration with Malta Enterprise, the local economic development agency, modl.ai announced the expansion of its local presence and recruitment of new talent at its centre in Malta.

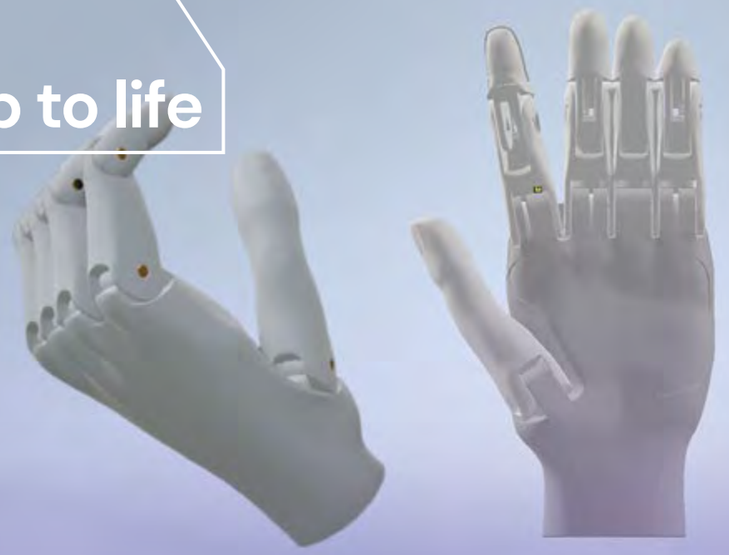
For gamers and game developers, a bug can quickly ruin the experience. Unfortunately, expecting human playtesters to comb through the expansive worlds of modern games is unrealistic. Perhaps through the combined powers of AI research and innovation, it might soon be possible to have bug-free new releases! 'It is also entirely possible we will reach a point where AI could design, play, and test its own games before it releases them for us to play!' Yannakakis notes.

Modl.ai strives to become the ultimate testing tool that any game should have. Our AI game engine is a component that sits on top of any game engine, automatically testing various aspects of the game.

Image courtesy of modl.ai



(bottom right)
Gameplay from *Forge and Fight*. The game's team-play dynamic added extra complexity to the challenge of adding bots to the game since they needed to be both interesting opponents and reliable and useful teammates.
Image courtesy of modl.ai



Prosthetic hand design, developed by the MAProHand team, and aesthetically refined by Mr Fabrizio Cali from the Faculty of Media & Knowledge Sciences

How Less Is More in Prosthetic Hands

Current hand prosthetics are expensive, heavy, and hard to control. Researchers from the University of Malta (UM), in collaboration with Orthopaedic Centre Malta, are addressing these problems by simplifying the design of prosthetic hands. The project MAProHand, led by ***Prof. Ing. Michael Saliba****, creates a novel hand prosthetic that concentrates on the key functions of the hand.*

Author: **Josse Schubert**

Imagine you have an accident that cuts off your right hand. While hand prostheses might seem like an obvious solution, you quickly find signficant challenges. There are either aesthetic artificial hands that don't do anything, or motorised hands that are highly expensive, very heavy, and counterintuitive to control. You ask yourself why there isn't a motorised hand that is affordable, easy to control but nonetheless able to perform most of the tasks you need. The prosthetic hand you are looking for is what the UM project MAProHand – Minimal Anthropomorphic Prosthetic Hand – is developing.

Prof. Ing. Michael Saliba, professor in the UM's Department of Mechanical Engineering, has been researching robotic hands for more than 20 years. Together with Prof. Ing. Kenneth Camilleri from the UM's Department of Systems and Control Engineering, Saliba started the MAProHand project to apply his knowledge about artificial hands to the area of prosthetics. In this field, the researchers faced new challenges as a hand prosthesis needs to be small, lightweight, and easy to use. In 2017, the project team, led by Saliba as principal investigator, started to take on the challenge of improving the shortcomings of current hand prostheses.

HAND PROSTHETICS

If someone wants a hand prosthesis that can take over some of the tasks of human hands, they need to get a motorised hand. The design of such hands, based on natural human hands, usually has five fingers with two or three joints each. Many of the joints can be controlled independently from the others. As obvious as this design may seem at first glance, it has some major deficits. Every independent joint needs a motor on its own, so the more such joints there are in a prosthetic hand, the heavier the hand gets and the more costly it becomes. Moreover, the more joints that need to be controlled individually, the harder it gets for the user to coordinate movements and make the hand operate as intended. The solution to these problems is to determine the key functions a prosthesis needs to perform and streamline the design to achieve those.

No artificial hand is as sophisticated as a natural hand. As soon as someone loses their dominant hand, the other hand takes over the role, no matter what kind of prosthesis they use. Therefore, the task of a hand prosthesis should be to replace the non-dominant hand, which doesn't need to be as dexterous as the main hand.

Most of the movements we perform with our non-dominant hand can be attributed to **motion-patterns: reoccurring movements we perform with the entire hand**. If the prosthesis is able to perform these motion-patterns as a whole, it doesn't need to move every joint individually. One example of a motion-pattern is the movement of closing the hand. It is used most of the time when the hand grabs something. Depending on the size of the object, the same movement stops in a more open or more closed position.

'By moving the entire hand instead of every joint individually, the prosthesis can be designed simpler than the ones that try to exactly replicate a human hand,' Saliba points out. 'The artificial hand loses some dexterity, but compensates by being easier to control.' In a set of experiments, MAProHand determined motion-patterns, hand design, and prosthesis control.

MAPROHAND

The MAProHand project benefited from the participation of many researchers from different fields. Under the coordination of Saliba, all of them contributed their expertise to the common goal.

Yesina Aquilina, doctoral student at the Department of Mechanical Engineering, performed experiments on human subjects to investigate the required hand structure. She determined the minimum features a hand needs to perform most of the tasks a non-dominant hand usually does, and the specific motion-patterns that such a minimal hand would need. Together with Saliba, she confirmed that the ring finger and little finger are not essential for those tasks. Therefore, the resulting hand structure merged the two fingers with the middle finger to avoid unnecessary complexity. A hand designed this way is easier to control and needs fewer motors, thereby becoming lighter and cheaper.

Developing such a sophisticated hand required extensive simulations. For this part of the project, MAProHand was helped by Prof. Alexiei Dingli from the UM's Department of Artificial Intelligence. Together, the researchers determined the best values for the various hand dimensions, as well as the best way to orient and couple the various joints.

The prosthesis' movements are controlled by the muscles in the arm of the amputee. The muscles' movements trigger electrical signals on the arm's skin, which can be measured. Camilleri and master's student Rachel Cauchi implemented an existing tool that does exactly that. Using this technology in the form of an armband with appropriate sensors, the researchers set up the system to control the hand. In an intact hand, every motion-pattern is triggered by movements in the arm that are individual to each pattern. When someone loses a hand, if their arm muscles remain intact, they can activate those muscles with electrical signals as if they still had a hand. The armband detects such activation signals and recognises which motion-pattern it is trying to induce. According to that information, the signals collected in the armband tell the prosthesis which gesture to make.

Translating the muscles' electrical signals to hand movements is a tricky computational challenge. Measuring the signals and the corresponding hand movements of test subjects with limbs intact, the researchers collected data to train a neural network to recognise which electrical signals at the skin link to which hand gestures. They then confirmed experimentally that the same neural network can be used on persons missing their hand, either from birth or through amputation, to determine the motion that they wish to impart to the prosthetic hand in an intuitive manner.

After the hand design was completed, Engineering graduate and Orthopaedic Centre Malta researcher Christian Von Brockdorff helped complete the control system of the 3D-printed prototype and fit the motors. He also managed the prosthesis' feedback system. Sensors located in the finger gear trains sense if the prosthesis touches something and how much strength the prosthetic hand applies. This information is fed back to the amputee via a vibration signal at the armband.

To keep the device close to amputees' needs, the project benefited from their field consultant Dr Jesmond Attard, RSO with the Department of Mechanical Engineering. As a professional working closely with amputees, he was able to provide valuable information on the real-world applicability of the project.

Fitting all these parts together, the research team managed to design and build a hand prosthesis that masters the vast majority of the tasks it needs to do, is easy to control via arm muscle movements, and can be produced more cheaply on a large scale than more complicated prostheses.

THE FUTURE OF MAPROHAND

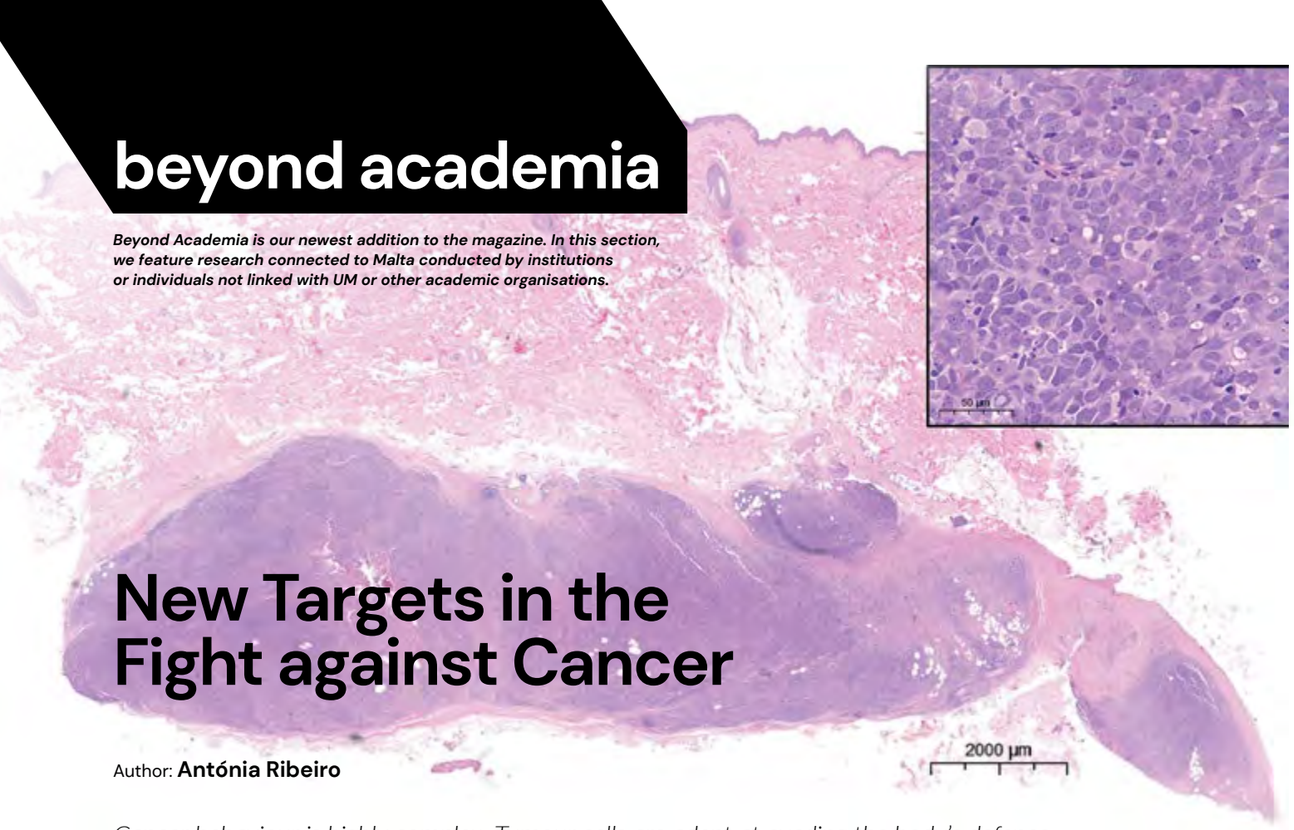
Before the new prosthesis can be produced, some issues still need to be resolved. 'For now, the applicability is limited to the laboratory because the prosthesis still needs a desktop computer for the data processing. Finally, the translation of the data collected in the arm band into hand movements will be done by an integrated chip. Developing that chip is part of the project's next stage,' Saliba explains.

Another aspect is the physical stability of the 3D-printed hand structure. The challenge here is to build a light design that is nonetheless resistant to everyday stress. Future research will focus on making the prosthesis even lighter and more durable.

Even with the work that still needs to be done, MAProHand has already demonstrated that the principle of a minimal anthropomorphic hand is one that holds several advantages over current prostheses: it is easier to control, cheaper, and lighter. Having shown this, the research team will go on improving their model until it can finally be used by amputees who wish their functional hand back.

The project MAProHand is funded by the Malta council for science and technology under fusion research and innovation programme with the Contract R&I-2017-028T

Beyond Academia is our newest addition to the magazine. In this section, we feature research connected to Malta conducted by institutions or individuals not linked with UM or other academic organisations.



New Targets in the Fight against Cancer

Author: **Antónia Ribeiro**

Cancer behaviour is highly complex. Tumour cells are adept at evading the body's defence mechanisms and therapeutic drugs over time. At Mater Dei Hospital, a multidisciplinary team of health professionals is analysing a rare case of cancer cell transformation that may uncover new therapeutic approaches for patients with this cancer type.

For anyone in the biomedical field, cancer is scary and fascinating in equal measure. It shows the wonders of life and how a cell can modify itself to survive the most inauspicious conditions. A cancerous cell is, in its most basic form, an unparalleled survivor – destroying the very ecosystem that enables its existence.

A big part of cancer research tries to understand how cancer cells mutate and adapt to continue to proliferate: how a tumour evolves to keep growing, camouflages itself from the immune system, and at times persists after therapy. In some cases, one cancer type even transforms into another. In fact, researchers at Mater Dei Hospital are studying how a particular cancer has metamorphosed.

A METAMORPHOSIS

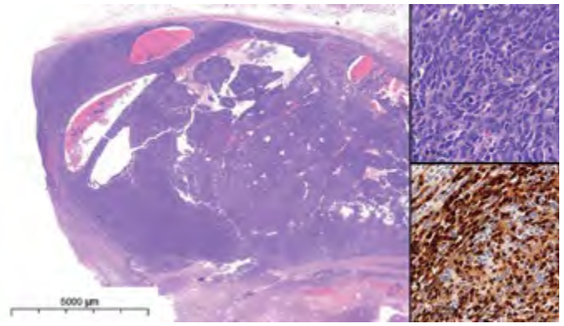
Melanoma (skin cancer) is an aggressive cancer that can form metastases (cancer cells migrating from the initial tissue to a new location) in nearby skin or even distant organs. A team of pathologists and biomedical scientists from the Cellular Pathology and Molecular Pathology & Genetics Laboratories within the Department of Pathology at Mater Dei Hospital (MDH), are studying a particular case of melanoma. A few years after presentation and treatment, the melanoma migrated to a lymph node and transformed into a neuroendocrine tumour. This type of cancer, unlike melanoma, is more like the cells that are found in glands, rather than in skin.

This process, **in which one cell type becomes another**, is called **transdifferentiation**. Although neuroendocrine transdifferentiation is known to occur in certain types of cancers, it very rarely occurs in cases of skin cancer. Transdifferentiated neuroendocrine tumours are usually highly aggressive and easily evade current therapies.

As such, this research team is committed to understanding the molecular process that led to the transformation of a melanoma into a neuroendocrine cell. By doing so, they want to know how melanoma turns into a neuroendocrine tumour and use this information to develop new targeted therapies.

THE GENETICS OF CANCER

Cancer cells multiply uncontrollably, as their growth signals are forced to remain 'ON' through mutations in what we refer to as driver genes. Genes form the code for proteins that a cell produces to be able to survive and perform its functions. In the case of cancer cells, researchers refer to gene defects that cause the cell to become cancerous as **driver genes**. By identifying the possible driver genes of the neuroendocrine tumours, the researchers may understand which proteins to target in order to kill the cancerous cells. This can then be tested in cell experiments where cancer cells can be treated with candidate drugs to observe the effects.



Images courtesy of MOLNET team

Using cancer tissue biopsies along the progression of the cancer, the group is looking for driver gene mutations that may cause gene upregulation, downregulation, or inactivation. An upregulated gene is used more times, so the cell will have a higher concentration of the protein it encodes, while downregulation is the opposite, and inactivation switches the gene off entirely. These changes alter the cell's activities, which led to the transformation into neuroendocrine tumour cells.

This targeted approach may decrease secondary effects as opposed to general treatments such as chemotherapy, which disrupts both healthy and malignant cells. If a drug targets proteins that are primarily expressed in the cancerous cells, the drug won't cause such strong systemic effects typically encountered in traditional chemotherapy, but cancer cells will be more adversely affected.

To find the driver genes, the researchers used whole-genome sequencing of the tissues from the original melanoma, the metastases, and the neuroendocrine tumour to find mutations exclusive to the neuroendocrine cells. The exclusively mutated genes will then be compared to data for other neuroendocrine tumours available through online databases to help identify potential drivers of this cancer type.

RESEARCH FOR BETTER HEALTHCARE

Securing funding was essential to carry out this analysis, and the project has been funded through a research excellence grant by MCST. With the funding, the Cellular Pathology Laboratory at MDH recruited laboratory scientists from the hospital to perform research work and gain valuable experience in research methods and also bioinformatic analysis of genomes.

The research group outsourced the bioinformaticians to process and analyse the data obtained from whole-genome sequencing and the comparisons with the online databases. This research project required a multidisciplinary team of healthcare professionals, including dermatologists, biomedical scientists in the fields of molecular pathology (those who analyse genetic changes during life that led to cancer) and cellular pathology (those who analyse the tissues and morphological alterations to the cells), as well as bioinformaticians.

The collaboration between healthcare fields is enabling a better understanding of cancer behaviour for the development of personalised therapies for an aggressive cancer type and allowing a better understanding of cancer, highlighting the importance of investing in healthcare-driven research.

The Project: "Molecular switch underpinning Neuroendocrine Transdifferentiation in malignant neoplasms – MOLNET" (REP-2021-021) is supported by the Research Excellence Programme (REP) funded by the Malta Council for Science & Technology (MCST).

glossary

Metastasis: When cancer cells migrate from the initial tissue to a new location.
Neuroendocrine tumour: A rare type of tumour that affects cells that release hormones into the bloodstream.
Transdifferentiation: A process in which one cell type transforms into another.
Upregulated: The process by which a cell increases its response to a substance or signal from outside the cell to carry out a specific function.


Warren James Borg Ebejer

A Journey into Spirituality

Author: **Caroline Curmi**

Spirituality refers to one's connection with the divine. ***Caroline Curmi*** *sits with* ***Warren James Borg Ebejer*** *to discuss his faith and the motivations that have fuelled his successful academic pursuits, specifically, his study on the Carmelite friar, Fr Avertan Fenech.*

Warren James Borg Ebejer's academic journey has been fruitful, to say the least. He has spent nine successive years at the University of Malta. While the first four were dedicated to reading for an undergraduate programme in English and a one-year English PGCE, the latter five saw him achieve two master's degrees: one in English with a focus on Modern and Contemporary Literature and Criticism and another in Spirituality (Carmelite Stream) through the Faculty of Theology. Illustrated below is how it started, progressed, and continues to develop.

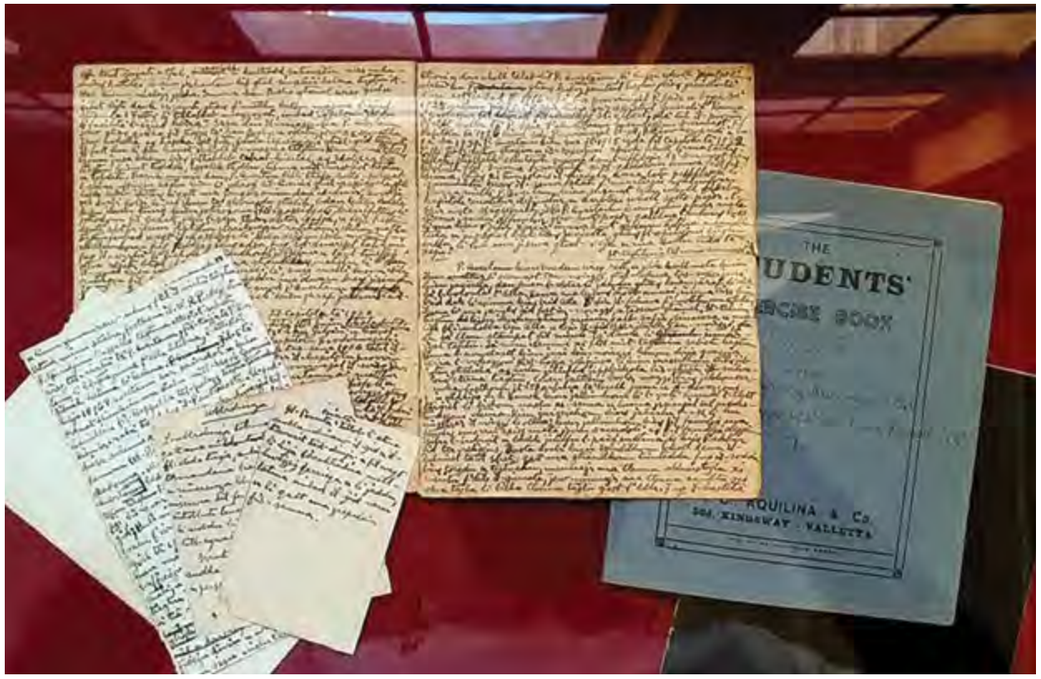
A THEOLOGICAL TRAIL

Borg Ebejer's inclination towards theology was ever-present. His undergraduate dissertation revolved around the supernatural present in Shakespeare's *Hamlet*, specifically the Ghost's challenge to Elizabethan beliefs about the afterlife. Interestingly, this research highlighted a possibility of Shakespeare having been a crypto-Catholic, that is, a Catholic in disguise.

For his Master's in English dissertation, Borg Ebejer analysed the Madonna's presence in early 20th and 21st century literature. While T.S. Eliot's poetry purifies the image of womankind by revealing a silent yet active Virgin Mary, James Joyce focuses more on mother wounds and dethroning oppressive nurturers in *A Portrait of the Artist as a Young Man* and *Ulysses*. Unconscious juxtapositions of motherhood and myth come out in Virginia Woolf's *Mrs Dalloway* and *To the Lighthouse*, while Colm Tóibin dares to portray an unbelieving Mother of Christ in *The Testament of Mary*.

It was during this point in his studies that Borg Ebejer, having seen a Facebook post about Bible study at the Carmelite Institute of Malta, came into direct contact with the Carmelite Order and its spirituality. There he met two friars – also lecturers at the University of Malta, who introduced him to the Master's in Spirituality course they were running. 'I took it exactly after I finished the English one,' Borg Ebejer says.

Speaking about Carmelite spirituality's Marian nature, he explains how the Madonna is the model upon which the Carmelite Order is based: 'Mary is considered to be the first true disciple of Jesus, and Carmelites model their life upon her values and virtues.' Once hermits in the mountain range of Carmel in the Holy Land, the Carmelites moved into Europe during the Crusades due to persecution.

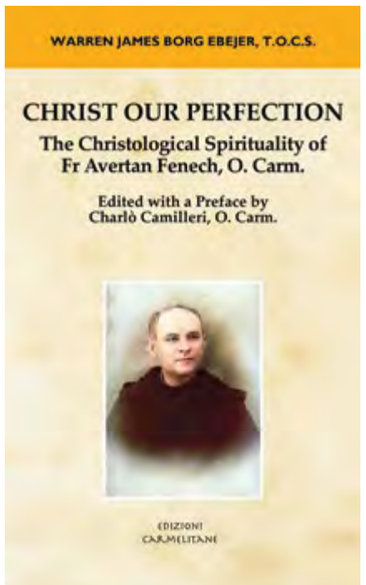

A manuscript detailing the life of Fr Avertan Fenech by his biographer Fr Lawrenz Sammut

There, they were formally recognised by the Church, people got to know them better, and monasteries were built; the first Carmelite monastery in Malta was built around 1418. A noteworthy Carmelite in the early 20th century was Fr Avertan Fenech, a friar, priest, and novice master whom Borg Ebejer has based his research upon. 'His writings on spiritual theology are in old Maltese, but once you start reading a few words, you get the gist of what they're spelling out,' he explains. The texts in question were highly oratory in fashion, making for easier reading: 'These notes would be read in conferences he would hold for his students and novices,' Borg Ebejer reveals.

Borg Ebejer credits his studies in English for his academic success in theology: 'In English, you have to study texts, draw comparisons and contrasts, read between the lines, analyse the author's inspiration, and investigate connections to other works,' he explains. By adopting tools and methodologies learnt there and applying them to his Master's in Spirituality, Borg Ebejer not only managed to achieve a distinction in his thesis but was also able to gather a Dean's List accolade for his work. 'It really was all there. It was a stepping stone for me,' he says.

Delving deeper into his analysis of Fr Avertan, Borg Ebejer illustrates the different stages of his research; his first focus was on the biographical context: reading about the socio-politico-historical context of the time and how religious life was carried out. This was followed by the literary aspect: 'I'm currently in the friary where he lived and died. We actually have his books in the library, so I could see where he would get his inspiration from or things he would leave out,' Borg Ebejer reveals. Some interesting findings were made here: 'Fr Avertan subscribed to paying money to help an orphanage – id-Dar ta' San Ġuzepp. I also found a new manuscript of a friar who knew Fr Avertan well and documented his life,' Borg Ebejer enthuses. At another time, he uncovered a new photo while leafing through a book on the 1913 Eucharistic Congress at the university library: 'I was looking through the photos and recognised one small figure in it,' Borg Ebejer says. Once Fr Avertan's identity was confirmed with the book's publisher, Borg Ebejer was able to determine the friar's interest and attendance in the Congress.

The third and core part of the thesis was focused on Fr Avertan's Christology and the image of Jesus in his writings. Borg Ebejer identified



Top left: Photos of a middle-aged and elderly Fr Avertan Fenech

Bottom left: Fr Avertan's notes and prayer books

Right: Borg Ebejer's thesis published through Edizioni Carmelitane

All images courtesy of Warren James Borg Ebejer

He couldn't speak very much, he couldn't write, and he couldn't participate much with the community because he had to stay in bed.

four of these: Christ the Master, Christ the Healer, Christ the Poor and Meek Lord, and Christ the Eternal Priest and Victim. Fr Avertan conformed to these images, and Borg Ebejer draws on his knowledge to highlight the personal traits of Fr Avertan: 'He was meek, humble, and obedient, a sought-after spiritual director and confessor.' An inquiry into the mention of victimhood reveals a tragic turn: at the age of 61, Fr Avertan suffered a stroke which paralysed half his body, leaving him bedbound for the last 11 and a half years of his life. Borg Ebejer highlights Avertan's personal sacrifice: 'He couldn't speak very much, he couldn't write, and he couldn't participate much with the community because he had to stay in bed.' This period coincided with the Second World War, and Fr Avertan was especially fearful of air raids. He had to rely on others to put him in a wheelchair and carry him down into the shelter. An added layer of trauma formed through the abuse suffered under his carer. 'The nurse who was meant to be taking care of him would admonish and threaten him despite his condition, refusing to change his dressings and causing maggots to fester,' Borg Ebejer reveals. Once the superior found out about this, the nurse was kicked out. 'It really was a painful time for him,' Borg Ebejer admits.

THE NEXT STAGE

Due to the discovery of various new findings, Borg Ebejer was able to publish his thesis through Edizioni Carmelitane – the Carmelite Order's publishing house. Becoming a published author is an achievement that brings Borg Ebejer joy, but the attainment of this goal does not mark the end of his journey. Rather, he is gathering steam for the next step in his academic journey: a doctorate. Admitting that Carmelite spirituality has left a positive impact on his faith and identity, Borg Ebejer now hopes to broaden his research to explore beyond the remits of Carmelite faith, looking at how various faiths connect to one another: 'It's like me and English, connecting it to theology. I'm thinking of something a bit more inter-religious for my Ph.D.,' he maintains.

Rounding up his experiences at the University of Malta, Borg Ebejer comments that it was very positive, with the highlight being the Master's in Spirituality. Having a relatable, person-centred approach, the post-graduate course helped Borg Ebejer deepen his spiritual dimension and allowed him to recognise himself more as a person. 'It highlighted the common journey that society has everywhere in all of history, moving towards a divine,' he concludes.

to-do list

podcast

Science Quickly
by **Scientific American**

Leading science and tech journalists dive into a rich world of scientific discovery in this bite-size science variety show. Check out their episodes at **www.scientificamerican.com/podcast**

book

The Trial
by **Franz Kafka**

One of the best known works of Franz Kafka – a bank clerk, Josef K, is arrested one day and searches through the absurd machinations of the legal system to discover the nature of the charges.

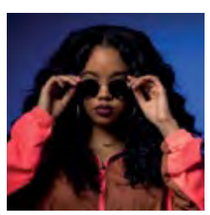
youtube channel

Babish Culinary Universe

Binging with Babish is the realisation of a young(ish) man's dream to combine his love of film and cooking and to have some fun in the process. Join him each week as he recreates the foods you've always wanted to try from movies and television – and if you're not careful, you just might learn a thing or two.

music

H.E.R.



Gabriella Sarmiento Wilson, known professionally as H.E.R., is an R&B musical artist. Her songs have been described as 'downcast post-breakup material that sounded vulnerable and assured at once.'

movie

Ant-Man and the Wasp: Quantumania (2023)

Ant-Man and the Wasp find themselves exploring the Quantum Realm, interacting with strange new creatures and embarking on an adventure that pushes them beyond the limits of what they thought was possible.

tv

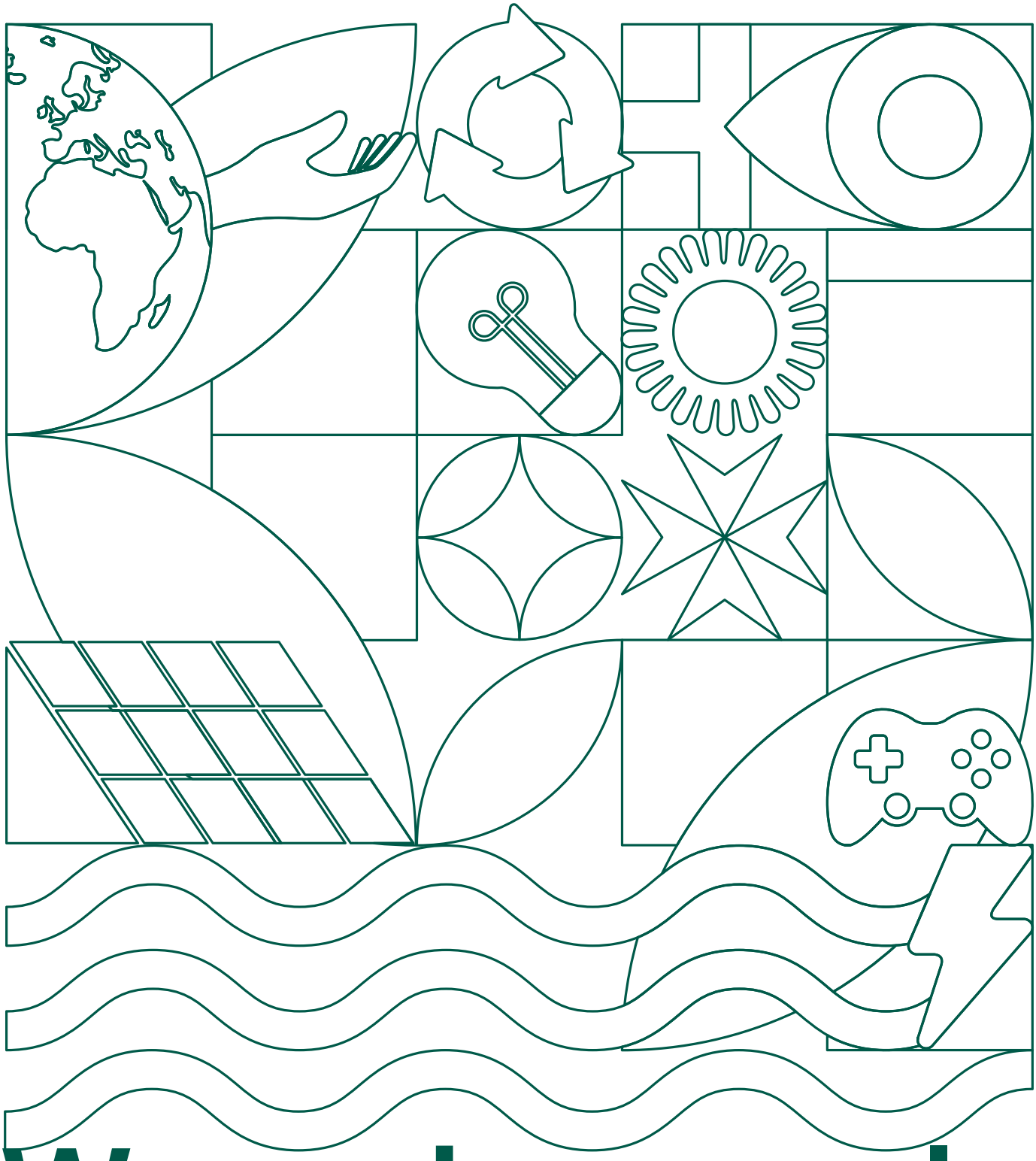
The Fabelmans

Young Sammy Fabelman falls in love with movies after his parents take him to see The Greatest Show on Earth. Armed with a camera, Sammy starts to make his own films at home, much to the delight of his supportive mother.

instagram

The Unbiased Science Podcast

No nonsense, just science! Join immunologist, Dr Andrea Love, and public health scientist, Dr Jess Steier, as they debunk science and health-related misconceptions!



We make people THINK