

MARCH 2022 • ISSUE 37

THINK

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IDEAS • MALTA • RESEARCH • PEOPLE • UNIVERSITY



A vertical poster with a space-themed background. The top half shows a dark starry sky. The bottom half shows the curved horizon of Earth from space, with a bright blue atmosphere and a white rocket trail leading to a bright orange and yellow light source on the horizon. The word 'THINK' is written in large, bold, white, sans-serif capital letters across the upper middle. Below it, the phrase 'like never before' is written in a smaller, white, sans-serif font. In the center, there is a white rounded rectangle containing a magnifying glass icon and the text 'thinkmagazine.mt'.

THINK

like never before



thinkmagazine.mt



editorial

Physical Well-being

Way back in 2011, the University of Malta (UM) launched *Research Matters*, a magazine whose goal, according to the rector at the time, Prof. Juanito Camilleri, was 'to open a window on the research activity underway at our *alma mater*'. Fast forward a couple of months, and in the summer of 2012, *Research Matters* was rebranded as THINK by Dr Edward Duca, Jean Claude Vancell, and the UM's Communications Office. Today, we celebrate 10 years of bringing research to citizens!

Dr Edward Duca has been involved as the Editor, and later on as Editor-in-Chief, since the magazine's inception. He, alongside Cassi Camilleri, Daiva Repeckaite, and myself (David Mizzi; the editors at the time) has helped guide and nurture THINK into the magazine you read before you today. Throughout this time, the magazine has managed to reach close to 2 million readers on issuu.com, hundreds of thousands on Facebook, and tens of thousands locally over its 10-year history. We have received thanks for the magazine from local and international political leaders, industrialists, and most importantly our readers. Duca has now decided to move on from THINK to focus on academia, teaching, and research to discover effective ways to communicate and share research with society. We would like to thank him for his efforts founding and cultivating THINK!

The global pandemic has also cast a glaring spotlight on our physical health and how fragile our bodies really are. Fortunately research is constantly trying to find new ways to improve our health and quality of life. In this edition of THINK, the first in our 10-year anniversary special, we take a look at the research that promises to improve our physical health. Stay tuned for future editions that examine other aspects of our well-being!

Edward Duca

Editor-in-chief

✉ edward.duca@um.edu.mt
🐦 @DwardD

David Mizzi

Editor

✉ david.mizzi@um.edu.mt

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contribute



Are you a student, staff, or researcher at the University of Malta? Would you like to contribute to **THINK** magazine? If interested, please get in touch to discuss your article on think@um.edu.mt or call +356 2340 4438



Physical Well-being

THINK's 10 year anniversary cover uses lenticular animation to create an illusive user experience. The result is a playful cover that reflects the multiple facets of physical well-being.

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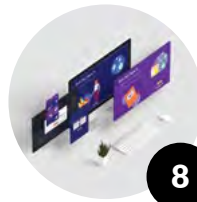
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CONTRIBUTORS

TOOLKIT

Dr Gianmarco Alberti
Inês Ventura

WITHOUT BORDERS

Sara Accettura
Sam Ridgeway

DESIGN

Kirk Grech
Clayton Saliba

OPINION

Malta Union of Teachers

STUDENT SECTION

Kostantinos Sfikas
Natalia Vella

FOCUS

Prof. Maria Attard
Martina Borg
Prof. Ing Joseph Buhagiar
Prof. Jean Calleja Agius
Cassi Camilleri
Prof. Ing. Kenneth Camilleri
Nicola Camilleri
Prof. Patrizia Campolongo
Emma Clarke
Albert Curmi
Dr Sarah Cuschieri
Neil Cutajar
Prof. Giuseppe Di Giovanni
Dr Owen Falzon
Prof. Anthony Fenech
Kimberly Fenech
Jonathan Firbank
Elton Galea
Dr Lucienne Gatt
Ray Gatt

Ryan Giordmaina
Prof. Ing. Maurice Grech
Dr Nicole Grech
Dr Abdelkader Helwan
Prof. Matthew Hill
Becky Jones
Christian Keszthelyi
Prof. Mauro Maccarrone
Prof. Raphael Mechoulam
David Mizzi
Raphael Mizzi
Dr Vanessa Petroni Magri
Prof. Suzanne Piscopo
Dr Arif Rochman
Luke Saliba
Keith Sammut
Prof. Pierre Schembri Wismayer
Dr Stephen Sciberras
Christabelle Tonna
Dr Marion Zammit Mangion

FEATURES

Prof. Joseph Borg
Prof. Vincent Buhagiar
Perit Luca Caruso
Prof. Ing. Pierluigi Mollicone
Prof. Martin Muscat
Sam Shingles
Ahmed Taha

IDEA

Prof. Ing. Kenneth P Camilleri
Dr Tracey Camilleri
Prof. Alexiei Dingli

START UP

Claire Cianco
Zippy Tseng

FICTION

James Moffett

ALUMNI

Daniel Camilleri

LAB TO LIFE

Dr Robert Camilleri

TO-DO LIST

THINK Team

ILLUSTRATIONS

Gabriel Izzo
Nicole Pace

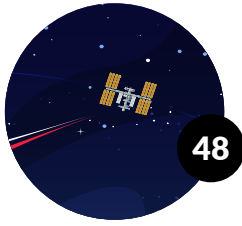
PHOTOGRAPHY

Jason Borg
James Moffett
Michael Seeley
Elisa von Brockdorff
Sarah Zammit

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feature

We chose to go to space - Maleth Program

Find out more about Malta's first space mission!

feature

Concrete solutions towards sustainable construction

Local engineers have developed a new type of concrete block



feature

Power to the people

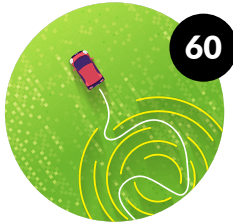
Ever wonder what it's like working on a nuclear fusion reactor?



idea

Transhumanism: A Dangerous Two-Way Street

When the line between human and machine becomes blurred



start up

A greener future from smarter traffic

Improving Malta's road infrastructure through data

lab to life

Flywheels: a 'Goldilocks solution' for aircraft emissions

Is there a way to make airlines more fuel efficient



alumni

Cyberselves 2077

Household robots may become a reality sooner than you think!



fiction

Hunt

Household Horror



to-do list

Sometimes the healthiest thing to do is to relax and unwind!

THINK

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March 2022 – Issue 37

EDITORIAL

Edward Duca EDITOR-IN-CHIEF

David Mizzi EDITOR

DESIGN

Gabriel Izzo DESIGNER

Nicole Pace DESIGNER

COPYEDITING

Edward Duca

David Mizzi

PROOFREADING

Amy Borg

PRINTING

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University of Malta, Msida, Malta

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L-Università ta' Malta

ERRATUM
ISSUE 36

In *Art from Death* (pg. 69), John Paul Azzopardi was incorrectly referred to as alumni. The correct term for male singular is alumnus.

The many dimensions of data

Author: **Inês Ventura**

Do you feel safe walking around after dark? Does the size of the city affect how you feel? How do these feelings compare between men and women? For data analysts, these questions come with unwieldy amounts of data. Luckily, Dr Gianmarco Alberti from the Department of Criminology (Faculty of Social Wellbeing, University of Malta) has authored a free software that visually portrays data patterns in a practical way.

So how does the software work? Going back to our safety in the dark example, the data is plugged into the software. The programme then explores how the feeling of safety relates to the size of the city. In this example, we'll split the variable 'feeling safe after dark' by gender and see if it's influenced by the number of people living in the city ('town size', represented at the top of the first image). The table below is small yet highly complex (see figure 1), finding any obvious pattern of association between categories is hardly an easy task.

Plugging this data into Alberti's software, named 'CAInterprTools', provides a body of facilities that allow users to get the most of those results (see figure 2). With this image, it's easier to understand that the bigger the town (right side along the horizontal axis), the less safe interviewees felt. Both male (identified with a M) and female (identified with a F) have the same perception of their safety in a smaller town (points in the left-hand side of the chart). However, as the size of the town increases, females start to feel less secure than men (points to the right-hand side of the chart). It is clear that this approach can provide insights into data structure and help reveal hidden patterns.

The beauty of Alberti's program is that it increases data analysis efficiency, not only to researchers (e.g. criminologists, political scientists, or biologists) but also to citizens and several entities that work with data (e.g. banks, customers, or companies). The fact that this software was developed under the free R statistical programming language means it is a free resource which can allow for an easier way to interpret data — especially for those who aren't math oriented! Let's hope this leads to safer streets for all! **T**

The programme can be found on <https://cran.r-project.org/package=CAInterprTools>.

FIG. 1

TOWN SIZE

FEEL SAFE AFTER DARK

	-10,000	10,000-50,000	50,000-100,000	100,000-500,000	500,000-1,000,000	1,000,000+	GRAND TOTAL
FEMALE	14628	11792	6139	21334	6609	11426	71928
bit unsafe	2930	3152	1680	5898	2130	3594	19384
very unsafe	968	1171	640	3573	1553	2747	10652
fairly safe	6237	4988	2559	8093	2073	3501	27451
very safe	4277	2376	1206	3634	799	1485	13777
unknown	216	105	54	136	54	99	664
MALE	13041	10755	5099	19044	5480	9742	63161
bit unsafe	1030	1336	817	3677	1367	2504	10731
very unsafe	193	288	165	1529	552	850	3577
fairly safe	4889	4497	2186	8383	2234	3857	26046
very safe	6880	4589	1913	5414	1309	2501	22606
unknown	49	45	18	41	18	30	201
GRAND TOTAL	27669	22547	11238	40378	12089	21168	135089

Figure 1: presents how safe male and female participants feel after dark (column 1) compared to the population size of the city (row 1)

The data used in the table was taken from the International Crime Victim Survey - <https://wp.unil.ch/icvs/>

FIG. 2

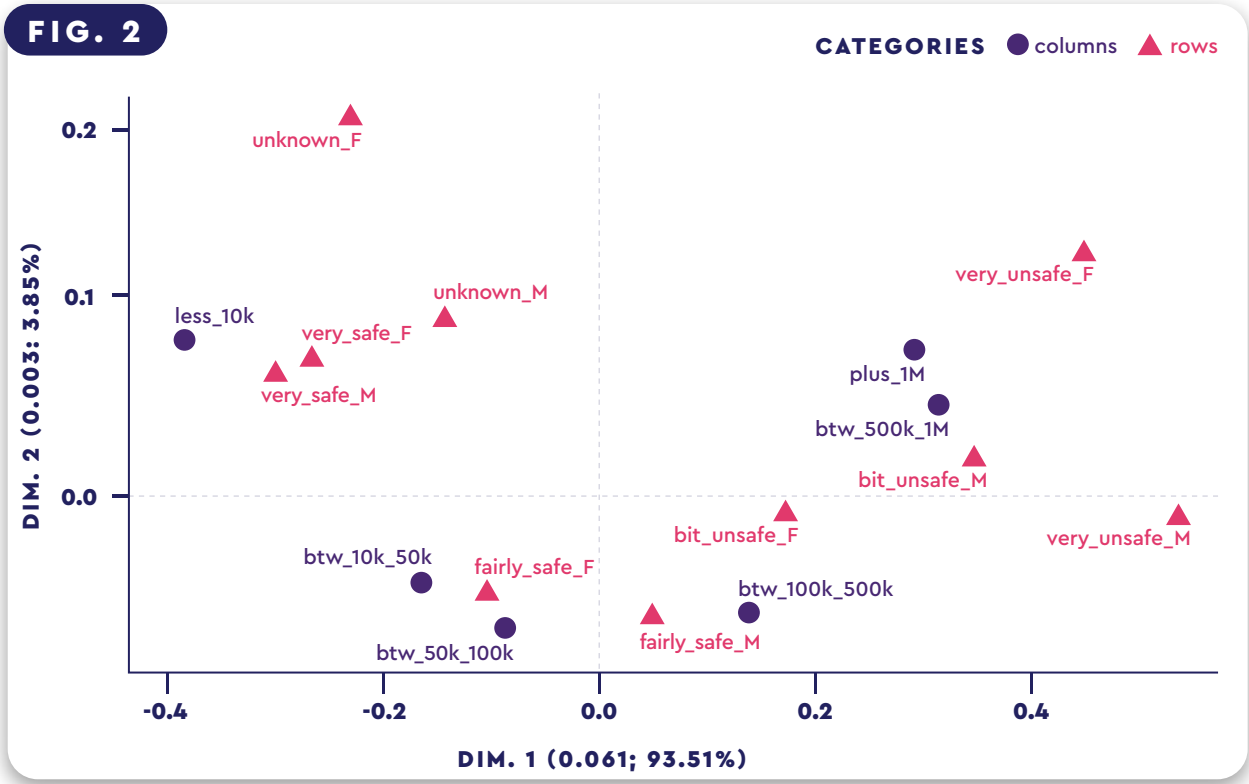
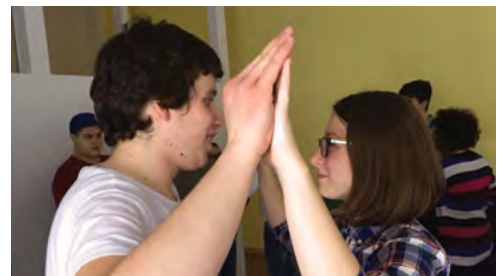


Figure 2: shows a visual representation of the data presented in Table 1. The size of the city is marked with black points, while how safe participants felt is symbolised by the red triangles.

This graph has been stylised for editorial purposes.

without borders



Images courtesy of Sara Accettura

Dance For All

Author: **Sam Ridgeway**

L *a danza per tutte le età e le abilità* – ‘dance for every age and every ability’ – is the guiding phrase of the aptly named Dance For All programme. The programme, created by Sara Accettura, Assistant Lecturer in Dance Studies at the University of Malta, is an inclusive dance project focusing on people with learning disabilities and autism. By bringing together trained dancers, people with disabilities, and amateurs, the project is able to encourage collaboration, creativity, and communication.

The Dance For All project emerged from Accettura’s international experiences. After studying for an MA in performance in London, she met her collaborators Cedar Dance Studio, who encouraged her to develop inclusive classes. On returning to Italy, Accettura fulfilled her dream to create a youth dance company in Southern Italy – the Junior Dance Company in her hometown of Bari – and linked up with Dalla Luna, professionals specialising in autism care.

The Dance For All programme runs in sets of six workshops with a final performance. Rather than having strict choreography, the dances are developed from tasks, games, and the participants’ own movements. This allows for a more organic approach and facilitates creative collaborations. The end result is a performance that all participants feel invested in. Accettura describes her role as leading rather than teaching: ‘I observe the participants. I’m thinking of every participant, and I’m seeing what their movements are. Then I try to involve that in the choreography.’

True to the inclusive nature of the programme, each participant benefits in their own individual way. Traditionally the focus has been on dance as a way to improve motor skills and socialisation; however, Accettura has recognised that the trained dancers taking part in the programme also benefit. The programme helps them develop their creativity as it is a rare space to freely express and experiment without the pressures of technical, fixed choreography and competition judgement.


The performance element has been very positive with dancers on the autism spectrum who have enjoyed the theatre environment, been motivated to wear costumes,



Sara Accettura
Photo by James Moffett

and even encouraged audience applause – this despite general reports often citing bright lights, unusual clothes, and loud noises as sources of discomfort for those with autism. Accettura believes it is the inclusive and shared responsibility of the dance studio that builds a sense of safety and security. Whilst the overarching goal is to have fun, Accettura highlights the importance of individuals. ‘I don’t have specific goals for everyone, and ideally participants are not aiming to achieve the same results. For some people, it’s about self expression, feeling more confident; for others, it’s more about the movement itself.’

With people always calling for Dance For All to return each year, the programme has been running since 2013. There continue to be international ties. American artists have visited collaborative classes, and Accettura is now completing a Ph.D. supervised by Dr Tamara Ashley from the University of Bedfordshire in the UK that focuses on the programme. In the dance studio though, she continues to adopt a human-first approach. The general workshop structure and the core values of inclusive expression and collaboration have remained the same. She describes scientific literature, such as Applied Behaviour Analysis, as offering a helpful guide to what is being taught internationally and for reflecting on what worked or didn’t work in her own workshops. Next on the horizon is bringing Dance For All across the Mediterranean Sea. ‘I would love to bring this project to Malta. This is in my plans. I would love to bring the sense of being in an inclusive environment because I believe that it helps everyone to learn more.’

Accettura is an Assistant Lecturer, Artistic Director, and Ph.D. student, but above all she is a dancer. Dance For All demonstrates that we all – trained or differently abled, musician or scientist, Maltese, Italian, British, and beyond – are dancers. ‘Movement is our first thing. We first started with movement. We first start expressing ourselves non-verbally as kids, and movement is in everything. Everyone is a mover. Movement is in us.’ 



In the Palm of our Hands

Author: Kirk Grech

How do you help children adjust to living with diabetes? For Clayton Saliba, a Master of Fine Arts in Digital Arts graduate, the solution lies in the palm of our hands. By combining digital arts and medical information Saliba developed Digitus, an app designed to help children better understand diabetes symptoms.

'Ever since I was a child, I always enjoyed doing what I love, all while helping people as well. I feel that that's where my inspiration for Digitus came from,' explains Saliba.

Digitus can be accessed on both desktop and phone. It starts out by asking the user to input their name, age, date of birth, and to choose their avatar, much like a video game would. The choice of avatar also changes some aesthetic details throughout the app, creating a dynamic experience.

As Saliba points out, cartoons and avatars are appealing to children. Besides adding a personal touch, they add a face to a product, especially when they resemble the user's appearance.

The avatar can be personalised to suit how the child perceives themselves. Whether it's the length of their hair, their skin tone, or their eye colour, the customisation helps the child to relate to the app. When the child chooses an avatar, the character in the scenes changes to reflect the child's look. This entices them to engage and participate with the information given to them.

Before settling on the final design, Saliba analysed several popular cartoons and illustrations such as

Invader Zim, *Teen Titans Go*, and *Dexter's Lab*. Saliba noted that they all use vibrant colours, and have a flat character and environmental design. Dark, yet colourful, background block colours create a contrast with the light and vivid characters. These types of design elements help children focus on the characters.

The creation of the avatars was easy for Saliba. The challenge was gathering information on diabetes. Originally, he wanted to ask people who had the condition. Due to data protection and ethical issues, he was advised to ask caregivers and healthcare workers rather than people diagnosed with the condition.

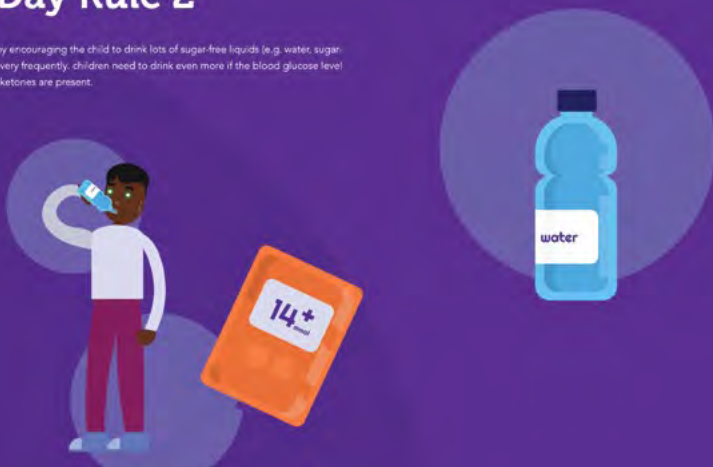
Another hurdle Saliba needs to overcome is language accessibility. Digitus is currently in Maltese and English. Saliba wishes to make Digitus available in even more languages; he also wants his project to be a part of something bigger. Not just for diabetes, but also for other diseases such as asthma or cholesterol, as well as for psychological conditions such as depression and anxiety.

Apps like Digitus are trying to help people become more aware about their bodies and the signs they give us. These apps are trying to help us better understand our body's warnings, raising awareness in both the individual and their friends and family to help tens of thousands of people in Malta who have diabetes. **T**



Sick Day Rule 2

Avoid dehydration by encouraging the child to drink lots of sugar-free liquids (e.g. water, sugar-free lemonade, etc) very frequently. Children need to drink even more if the Blood glucose level is high and/or urine ketones are present.



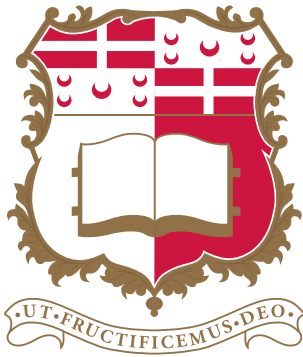
DIGITUS

Choose your Avatar



Images courtesy of Clayton Saliba





Ph.D. GRADUATION CEREMONY

Monday 21 March 2022
Church of the University, Valletta

On 21 March 2022, the University of Malta will be awarding its highest academic award – the Doctor of Philosophy Degree (Ph.D.) – to 87 students who represent a mix of research areas and disciplinary domains. In addition, 25 students will be obtaining their professional doctorate in Pharmacy (Pharm.D.). This year's in-person ceremony will bring together the graduands of 2020 and 2021, with just over a quarter of them hailing from overseas.

Prof. Nicholas Vella, Director of the Doctoral School, said: "After the challenges we have faced over the last eighteen months, it is wonderful to celebrate our graduates' successes together. Moreover, this year marks the 47 year anniversary since the University of Malta awarded its first Ph.D. degree. Since then the Ph.D. has opened up the University to a changing world of research and mobility. With its current cohort of 450 researchers working towards a Ph.D., the University is living up to its mission of serving scholarship and society in a meaningful way."

L-Università ta' Malta





Marco Bonnici, MUT President
Photo courtesy of MUT

Teaching at the seams

Author: **Marco Bonnici**

The term 'seamless,' adopted from fabric or surface production, refers to non-visible gaps or spaces between materials. In education, 'seamless' is quite analogous as it refers to smoothed transitions in a student's educational voyage.

But are these seams strong enough?

The first transition of a child following the entry to childcare (which is itself a transition) is from childcare to kindergarten, but strategies to link the two are non-existent. We tend to undervalue the 'education' that is provided in childcare, possibly due to the name of the service, which in no way refers to education. Even the fact that childcare provision falls under a separate entity within the ministry may portray it as a separate institution without an educational focus.

The second transition in school life is between the kindergarten and the primary school years. Here we can speak more favourably about a seamless transition, as very often the student will not change school, having the kindergarten and primary classes housed in the same building. Educators in kindergarten and primary are colleagues, and ongoing communication enables them to compare programmes and smoothen the transition.

The most difficult transition comes at the end of the primary cycle with the benchmark of final exams, followed by entry into secondary schools. The most significant aspect is the change in school. Very few state schools (as well as non-state schools) house primary and secondary classes in the same building. A change in school, a change

in management, and a change in educators may have a considerable effect on students. Schools which house both primary and secondary education within the same building or within the same school community provide a better transition. Communication between primary and secondary schools needs strengthening. Having a file transferred from a school to another is beneficial, but having communication between primary and secondary school educators will bridge the gap towards a smoother transition.

The recent introduction of middle schools within state schools faces the same problem. Students have to change school premises, management, and educators in a similar transition to the previous one. Yet given that there is a continuation in the educational programme, the gap is less severe.

A seamless educational transition builds upon the achievements of the previous cycle through a strategy which sees all cycles synchronised to provide ongoing education to students without gaps. Ensuring a seamless educational transition requires dialogue and coordination, and this is where we may be lacking in some areas more than in others. **T**

Marco Bonnici is President of the Malta Union of Teachers (MUT)

The second part of the article, which can be found online, looks at the gaps between secondary school, higher education, and employment.



Does teleworking reduce traffic?

Natalia Vella


Gridlock has become a daily part of our morning commute. Teleworking could solve Malta's traffic troubles by reducing cars on the road, but little research exists to prove the idea. While reading for a bachelor's degree in Geography, I (Natalia Vella) explored teleworking as a means of reducing car traffic. Essentially, is teleworking an effective solution to minimise travelling distance in Malta?

In Malta, the private car is the most popular daily mode of transportation used by commuters. Average commuting distance by car has grown year on year. In 2017, this was 2,976 million km (by all licensed cars) which increased to 3,196 million km by 2019. Maltese people get around.

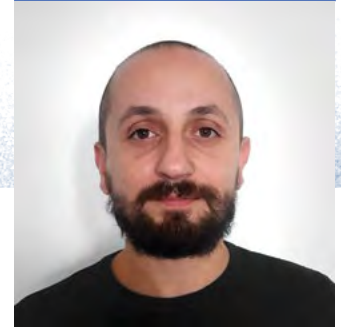
While many studies imply that telework reduces overall travel, new studies also suggest the opposite. In my research, questionnaires were distributed to University of Malta employees who have been or are now teleworking. My study looked into their work from home experience and travel behaviour during teleworking days.

Most teleworkers (76.1%) responded that they would have made these trips regardless of if they were teleworking or not. When comparing the participants' trips before and during teleworking days, it was discovered that they travelled more during teleworking days than they did when they were not teleworking. The trips were mostly done by car (53.8%) and used for grocery shopping and everyday necessities. Most participants (87.4%) said that the main factor behind teleworking was COVID-19, while only 15.1% mentioned eliminating the daily commute.

Participants' daily routines had not changed, because they stated that trips such as grocery shopping and other errands were still necessary regardless of whether they were teleworking or not. In addition, teleworking allowed them to have more free time by eliminating the need to go to and from work, which created time for other additional activities.

My study examined whether the concept of teleworking can or cannot be used to limit commuting and change travel behaviour. It found that teleworking did not reduce daily travel. The more teleworking individuals did, the more they travelled for reasons other than work – the addiction to car travel remains. 





Playing with AI

Konstantinos Sfikas

By 2017, AI had advanced far enough for AlphaGo, a specialised AI that can play the highly complex board game Go, to beat the major Go players in the world and be awarded professional 9-dan by the Chinese Weiqi Association. Go, however, is a fully deterministic game like Chess, with no random elements. Probabilistic games like *Pandemic*, on the other hand, are even trickier for AI to play efficiently, as the randomness of dice rolls or shuffled cards makes it much harder for computers to crack them. This problem inspired me (Konstantinos Sfikas) to attempt to create an AI that can play the *Pandemic* board game.

In the summer of 2018, I started working on this problem as part of my thesis for the M.Sc. in Digital Games (Institute of Digital Games, University of Malta), under the supervision of Dr Antonios Liapis.

At the core of our methodology lies Rolling Horizon Evolution (RHE), a planning algorithm that makes decisions by optimising action sequences through artificial evolution (introduced by University of Essex researchers in 2013). In order to make a single decision, RHE initially composes a population of random action sequences and evaluates them by simulating their potential result. Then an iterative process of optimisation takes place: the action sequences are randomly mutated, generating a set of offspring. The offspring will either replace their parents or be discarded based on a quality comparison. While this process repeats, the overall quality of the population tends to increase. After a predefined number of iterations, the agent simply selects the first action of the best-found sequence and applies it to the actual game.

Based on RHE, we designed the Policy-Based Rolling Horizon Evolution Agent (PB-RHEA), which operates on a higher level of abstraction, using a set of 'policies' (artificial behaviours) as an indirect encoding of action sequences. When composing or mutating sequences, PB-RHEA does not consider the full amount of potential single actions (as

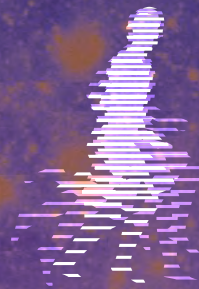
RHE does), but rather selects among a much smaller set of possible behaviours that translate into specific actions and approximates their probable outcome through repeated randomised simulations. Through this technique, the agent's operation was greatly enhanced in terms of computational efficiency and overall performance.

During my thesis and the two publications that followed (both co-authored with my supervisor Dr Antonios Liapis), we performed a large number of computational experiments, analysing the agent's behaviour and optimising its performance. One of the most challenging aspects of our research was to design a set of heuristics that approximate the quality of any given game state, thus allowing the agent to evaluate the outcome of an action-sequence. Another challenge was to define the set of policies that the agent would use as building blocks in such a way that they are both efficient and expressive. Finally, fine-tuning the algorithm's parameters through trial and error was another critical aspect of the agent's degree of success. The results overall showcase that our proposed methodology exhibits a good performance against a hard problem and leaves clear avenues for further improvement.

From an academic perspective, the main contribution of our research is that it clearly expanded the knowledge on planning algorithms like RHE and, more precisely, their applicability on complex problems like *Pandemic*. Agents like the PB-RHEA can be used to play alongside human players in the digital versions of board games or even be used in the context of automated playtesting during the development phase of board games. Although gamers have been playing alongside AI for a long time, will game developers also adopt AI as a partner when designing their games? **T**

This research was carried out as part of an M.Sc. in Digital Games at the Institute of Digital Games, University of Malta, under the supervision of Dr Antonios Liapis.





Physical Well-being

From the food you eat to the exercise you do (or should do) to the miniature universe of your cells — they all affect your physical well-being.

How can we improve our bodies, and how does the latest research suggest we become healthier, and perhaps stronger versions of ourselves?



Turning the lens on lung cancer

Local scientists are looking at novel ways to treat this deadly cancer

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Identifying novel leukemia treatment from nature

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Can Malta actively move away from its car culture?

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Turning the lens on **LUNG** **CANCER**





Author: **Emma Clarke**


A lung cancer research team at the University of Malta, jointly led by **Prof. Anthony Fenech** and **Dr Vanessa Petroni Magri**, is exploring a new approach to target lung cancer. **Kimberly Fenech**, who has just started her Ph.D. with the team, will be learning techniques at the very forefront of cell biology to investigate the world's deadliest cancer.

Gently, Ph.D. student Kimberly Fenech slides the flat plastic plate in her hands under the microscope. Turning the dials with gloved hands, she adjusts the focus until she can see distinct shapes through the red liquid: a layer of living, human cells. They look completely still, though they are actually replicating and growing on the plastic base, and their curved bodies stretch out in different shapes to touch each other.

Your body contains trillions of cells just like these, each a tiny factory adapted to a specific purpose. Cells are the living building blocks of tissues, which fold together to make the organs that keep us functioning. Given the right conditions, however, cells can happily grow on a plastic plate, allowing researchers such as Fenech to find out more about how they function and respond to disease. Fenech is studying lung cancer, and so most of the cells she cultures grow aggressively. Mutations in their genetic code mean that these cells do not die easily, and they divide much more rapidly than normal. When the human body is exposed to carcinogens (such as tobacco smoke), such cells might build up to form a dense mass called a tumour, which left untreated, could spread to other parts of the body and become life-threatening.

A LIFESTYLE RELATED DISEASE?

Lung cancer is the deadliest form of cancer worldwide. Highly aggressive and often difficult to detect in the early stages, the disease has a lower survival rate than most other cancers – only about 18% of patients survive more than 5 years post-diagnosis. Recent research shows that in Maltese males, lung cancer was the second most frequently diagnosed cancer (14.7%) after prostate cancer, while it was the fourth among Maltese women (5.1%). It killed more than any other cancer in both sexes.

The figures are sobering, and even more so when we consider that it took just half a century for lung cancer to go from one of the rarest diseases on the planet to one of mankind's biggest killers. In the 40s, researchers began to notice that lung cancer rates were going through the roof. The reason for the change was not initially obvious, though after World War II, smoking was at an all time-high in the United States and Europe. Companies such as Lucky Strike and Philip Morris were paying doctors to promote cigarettes in medical journals. A seminal paper, published in 1950 by Richard Doll and Austin Hill in the British Medical Journal, changed everything. Doll and Hill had successfully confirmed the suspicions that many researchers were having: the fact 



Kimberly Fenech (right) and Nathan Vella (left), Ph.D. students working on the LCeNT Project
Photo by James Moffett

that lung cancer was linked to smoking. Further evidence followed, and in 1965, the US Surgeon General officially advised that tobacco was a leading risk factor for lung cancer.

Unfortunately, it is difficult to assign every case of cancer to a specific initiating cause. Each person's genetics are unique, and how our genes interact with our environment is a crucial element of whether a given disease will develop. Smoking is not responsible for every single case of lung cancer, but research shows it drives around 80% of specific lung cancer cases. Another potential cause is regular inhalation of carcinogens, which could arise from some occupational hazards or air pollution. Nonetheless, 20% of lung cancer cases have no evident lifestyle risk factor.

While current therapies can be initially effective, lung cancer patients may relapse with a tumour that is resistant to treatment. Scientists are urgently searching for new treatment options and a means of detecting the cancer early, before it spreads to other

parts of the body and becomes difficult to treat. The team at the University of Malta headed by Dr Vanessa Petroni Magri and Prof. Anthony Fenech is working on the LCeNT Project (Lung Cancer enhanced Novel Therapy), researching new strategies for treating the disease. The team, including Ph.D. students Kimberly Fenech and Nathan Vella, as well as M.Sc. students Rachel Scicluna, Marija Galdes, and Marlene Muscat, have a new idea to target lung cancer. To understand their approach, though, we have to circle back to the contents of those plastic plates: the human cell.

THE SECRET LIFE OF CELLS

In a healthy system, a cell's life cycle is strictly regulated. They are 'born' by division, they grow, they divide, and they die. If we zoom in, each cell is like a miniature factory, bustling with activity from tiny molecular machines which make products or send signals to each other. The cell's 'head office' is the nucleus, a compartment which contains a person's genetic material, which in

turn holds all the instructions for life. When everything is ticking along, these instructions provide all the information that keeps those molecular machines, known to biologists as 'proteins', functioning correctly. It is when these instructions become damaged that problems arise. Carcinogens in tobacco smoke or air pollutants can lead to 'typos' in DNA – small mistakes in the instruction manual called mutations. Some people may already have a certain number of these mistakes which they inherited from their parents – a phenomenon known as 'genetic predisposition'.

These errors can happen in any part of the DNA, and if left unchecked or unrepaired, such mistakes will propagate further as the cell continues to divide. Furthermore, if such errors happen in critical genes, they can go into overdrive. A cell might begin to divide much more rapidly than it should, birthing more and more cells with the same faulty DNA. This high-speed build-up of mutant cells eventually develops into a tumour.



Kimberly Fenech
Photo by James Moffett

As a safeguard against this, cells have several checkpoint mechanisms to repair such occurrences, as well as an 'emergency brake'. This triggers them to commit a programmed suicide if they detect enough DNA damage which goes beyond repair. In many cancer cases, however, scientists investigating the tumour will see that these repair mechanisms or the emergency brake itself is often also damaged.


ARE THREE DRUGS BETTER THAN ONE?

To stop the tumour in its tracks, cancer treatments are often agents that are intended to selectively cause the death of cancer cells. This prevents rapid cell growth, but can also be damaging to the healthy cells in the rest of the body. A major problem in cancer treatment is the toxicity of the drugs to normal, non-cancerous cells. The LCeNT team believe that by using a novel combination of carefully selected drugs, they can target specific, cancerous cells while minimising the effects on healthy cells. The team is

currently collaborating with a CNRS research team, headed by Prof. Palma Rocchi, to study the outcome of such drugs, while simultaneously also modifying the function of specific genes in order to enhance the result.

The LCeNT team are studying each of the drugs individually and also together, to see how well they kill the cancer cells and how toxic they are to healthy, normal body cells. To carry out these experiments, Fenech will also be obtaining training from collaborators in Nottingham to learn how to culture human lung cells in a new way. Studies have shown that, in the right conditions, lung cells can be coaxed into forming more complex structures that closely resemble lung tissue in the human body. The opportunity is exciting because the drugs can be studied on a model that's much more similar to the microenvironment of lung tissue than a single layer of cells. This approach enables study outcomes which better reflect the real-life situation, producing results which are therefore more relevant.

By working together with Mater Dei Hospital, the team will study patient cancer cells taken from lung cancer surgeries. This allows them to study how actual patient tumour tissue responds to treatment. Through experimentation, the team will see how the drugs' combined effects will impact the malfunctioning proteins. By combining different approaches, they hope to increase the likelihood of success while keeping within parameters which will hopefully not increase the risk of side-effects.

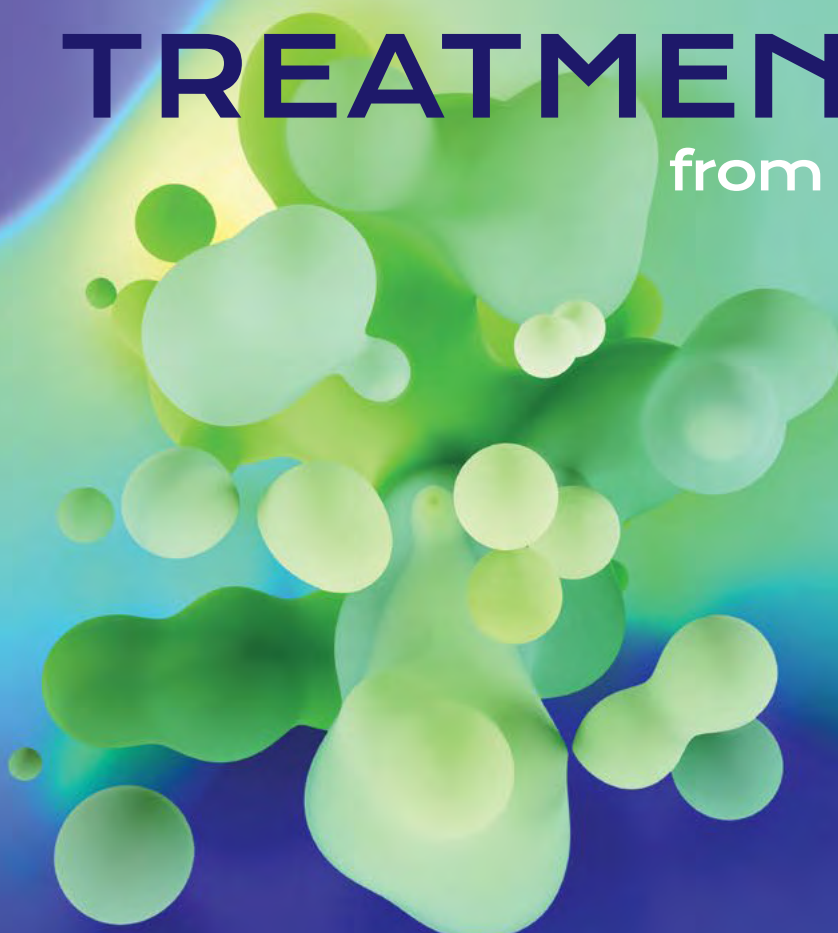
The project is still in its early stages, and it will take a lot of time and experimentation to know if the strategy shows promise. We can take inspiration from the creative approach that the team is taking and the collaborative spirit that is supporting the project. It will surely be needed to challenge the world's deadliest cancer. 

Project LCeNT is funded by the Fusion TDP Programme of 2019 of the Malta Council for Science and Technology.

Identifying novel

LEUKAEMIA TREATMENTS

from nature



Author: **Christian Keszthelyi**

*University of Malta research has shown that polyphenols, chemical compounds naturally found in plant foods such as fruits, legumes, and olive oil, exhibit anti-leukaemia activity. Can these compounds give us insight into better leukaemia treatments? **THINK** talks to **Prof. Marion Zammit Mangion** and **Neil Cutajar** to find out more about the Agent NovoBio Project.*

The human body is a complex structure composed of many different types of cells with specialised functions. As most cells have only a relatively short lifespan, they must replicate continuously to replace themselves before they die. This requires each cell to form exact copies of itself. Unfortunately this replicating process is not perfect, and the resulting cells may not carry out the exact functions required. When this happens, it may lead to dysfunction of the cell, which in turn may ultimately result in a malignant cancerous growth. In cancer treatments, scientists try to find molecules that affect the malignant cells while limiting the harm to healthy cells. Professors Marion Zammit Mangion and Pierre Schembri Wismayer (Associate Professor, Faculty of Medicine & Surgery, University of Malta), research support officer Neil Cutajar, and Dr Lucienne Vassallo Gatt are working on the NovoBio Project, which examines natural bioactive agents from Maltese endemic plants for the treatment of leukaemia. But before we jump into that, we need to understand some basic biology — cellular differentiation.

BIOLOGY 101: CELLULAR DIFFERENTIATION

Cellular differentiation refers to a process during which a cell changes from one type to another. Think of foetal

development. As the cells divide, they gradually become more specific (hence differentiation) with new daughter cells taking on more specialised roles. A similar process occurs within our blood-forming tissue. Special cells called stem cells will divide and mature into the different cells that make up our blood in a process referred to as haematopoiesis or 'blood cell formation'. Leukaemia or blood cancer occurs when this complex differentiation process is halted or blocked at an early stage of the differentiation cycle. When this happens, new unspecialised cells that lack the specialised structures of healthy cells form. These new, malignant cells may be described as 'out of control' in terms of their behaviour, cell division, and appearance.

TREATING LEUKAEMIA

Project Agent NovoBio studies the use of bioactive agents from Maltese endemic plants, specifically how these may be used to treat leukaemia. The project builds upon previous work performed by the team in the laboratories at the University of Malta, who noted that on addition of a crudely purified plant extract, differentiating activity was observed, and the leukaemia cells reverted back to healthy blood cells and died naturally. This is a very interesting scenario, where the malignant cells were induced to develop some of their lost structures and to slow down the rampant cell division. ➤



From left to right: Prof. Pierre Schembri Wismayer, Dr Lucienne Vassallo Gatt, Neil Cutajar, Prof. Marion Zammit Mangion
 Photo by Sarah Zammit

Logically, there had to be a specific molecule or molecules within the extract that was responsible for this. This is where the first challenge to separate this mixture of compounds into single components was encountered. For this, the researchers, primarily Dr Vassallo Gatt, used a preparative high-pressure liquid chromatography (prepHPLC), the only one of its kind on the island. By separating the extract into its singular components, the team could test each one individually to see which would trigger differentiation.

In a painstakingly long process, the team behind the Agent NovoBio research managed to identify a single component out of the ten different compounds that showed marked differentiation on specific leukaemia cell lines. The next step is to see whether the component can be used on other types of leukaemia as well as other cancer cell lines and explore the molecular pathways by which the bioactive component acts.

Cutajar explains how this chemical component may help fight off leukaemia cells. 'What we would like to do with this bioactive molecule is to help encourage the process of differentiation – this component would be introduced to the differentiation process at the early stage of maturation and cause malignant cells to stop dividing and die off naturally.' Essentially, leukaemia cells do not usually fully differentiate and are immortal. However, when exposed to the treatment, these cells would differentiate and then die off.

Cutajar explains his current research phase: 'I am now testing the different components of the extract on different leukaemia cell lines. Once I have investigated whether differentiation is also occurring in these cells,

I will do more precise tests to establish how far along the maturation process differentiation occurs in practice.'

Prof. Zammit Mangion underlines the importance of Cutajar's work, who is not only testing these agents to see their reaction with malignant cells but also working on characterising these components. 'If you want commercialisation of your research results, you have to showcase a highly purified, preferably single component that is fully characterised. You need to fully understand how it behaves in different types of leukaemia and cancer models to ensure it can be further developed as a pharmaceutical with follow-up investment,' the lead researcher says.

The next phase of the research will be to see what changes the molecule induces in leukaemia cells on a micro-molecular level, which is indispensable for commercial development. In fact, Zammit Mangion emphasises how MCST funding is critically important to act as a bridge between downstream research and the commercialisation of scientific discoveries.

The research is in its early stages and still far from being available to patients, as like all treatments, a very long process of rigorous experimentation and testing is needed. However, the team sounds optimistic about the results they have achieved so far. **T**

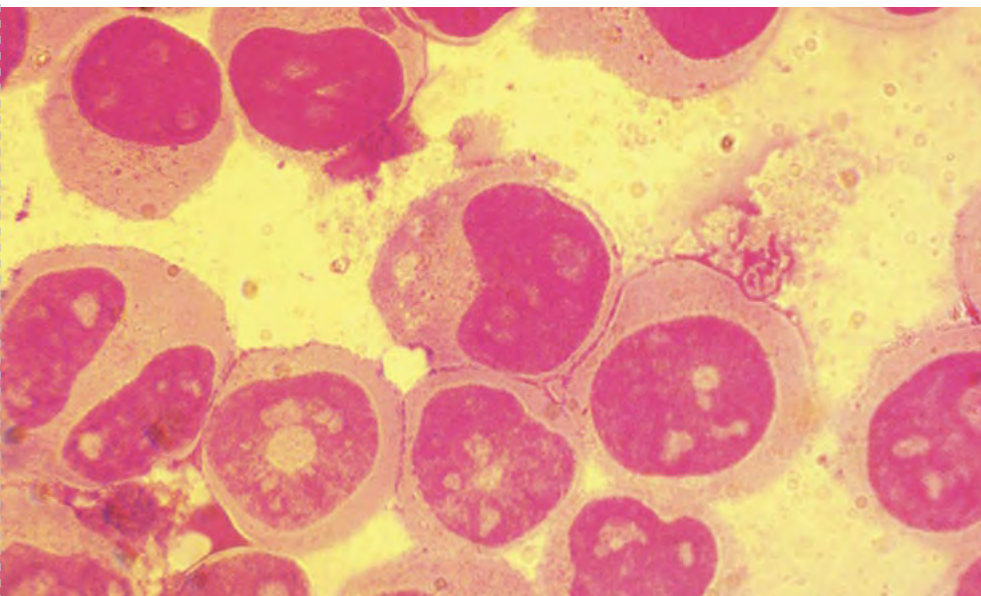
Project Agent NovoBio is financed by the Malta Council for Science & Technology (MCST) through FUSION: The R&I Technology Development Programme 2019



Neil Cutajar
Photo by Sarah Zammit

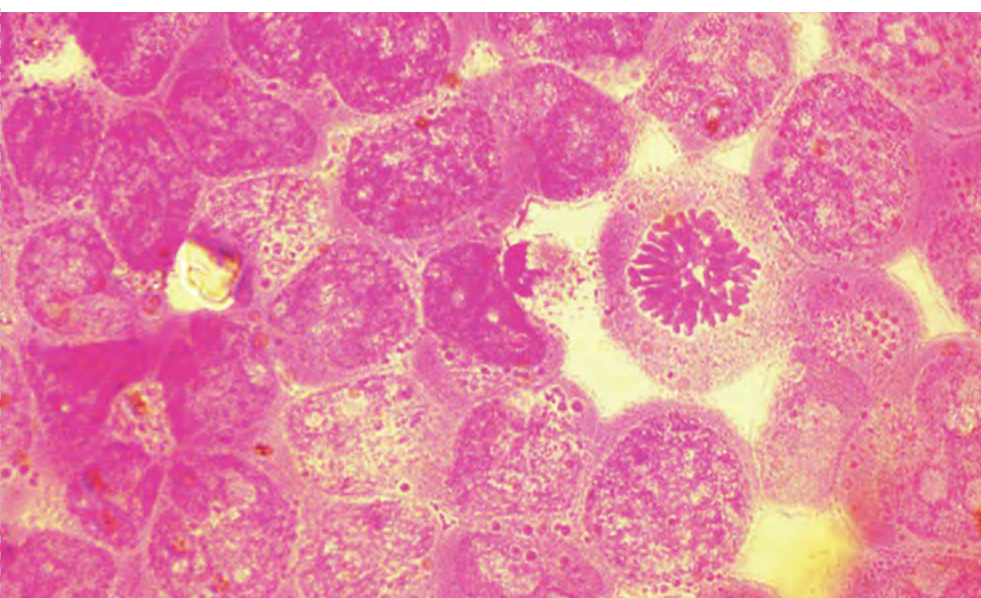


Dr Lucienne Vassallo Gatt
Photo by Sarah Zammit



On addition of a crudely purified plant extract, differentiating activity was observed, and the leukaemia cells reverted back to healthy blood cells and died naturally

Treated (differentiated cells) showing kidney-shaped nucleus and large irregular cytoplasm, showing monocyte-like appearance

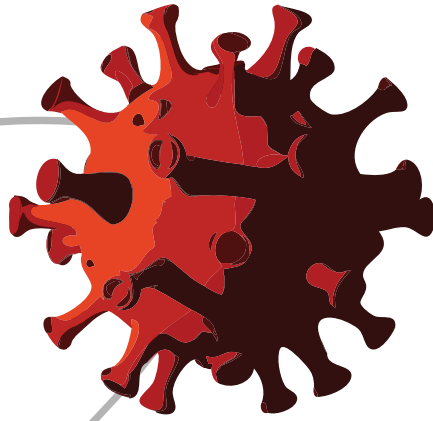


Untreated (undifferentiated cells) showing large nucleus with very small cytoplasm in the border, showing immature blast-like appearance

Images courtesy of Neil Cutajar

The COVID-19 impact on the Maltese population's well-being





Author: **Becky Catrin Jones**

*As the COVID-19 pandemic took over Europe, there was no question that the disease had a profound effect on public health in Malta. But as cases were rising, **Dr Sarah Cuschieri** noticed that nobody was reporting the impact on people's lives. Here she tells **Becky Catrin Jones** how doing the maths could help us face challenges in public health.*

Nearly two years into the pandemic, it's almost impossible to remember a time when COVID-19 wasn't in the news. Since March 2020, the Maltese population has had to adapt to life with an unwelcome visitor on its shores – a virus causing a respiratory illness, fatal in the most extreme cases. The newly identified coronavirus, SARS-CoV-2, spurred the scientific community into action as more details, symptoms, and variants were revealed.

Wishful thinking that the virus might just disappear by itself seemed more and more unlikely, and the impact of the virus on long-term public health was called into question. While some who contracted the virus appeared to recover with no symptoms at all, others were far less lucky. Particularly distressing for a subset of COVID-19 sufferers was the talk of so-called 'long-COVID', where some symptoms of the infection could persist for weeks or even months. A growing number of reports told tales of patients who, although no longer needing

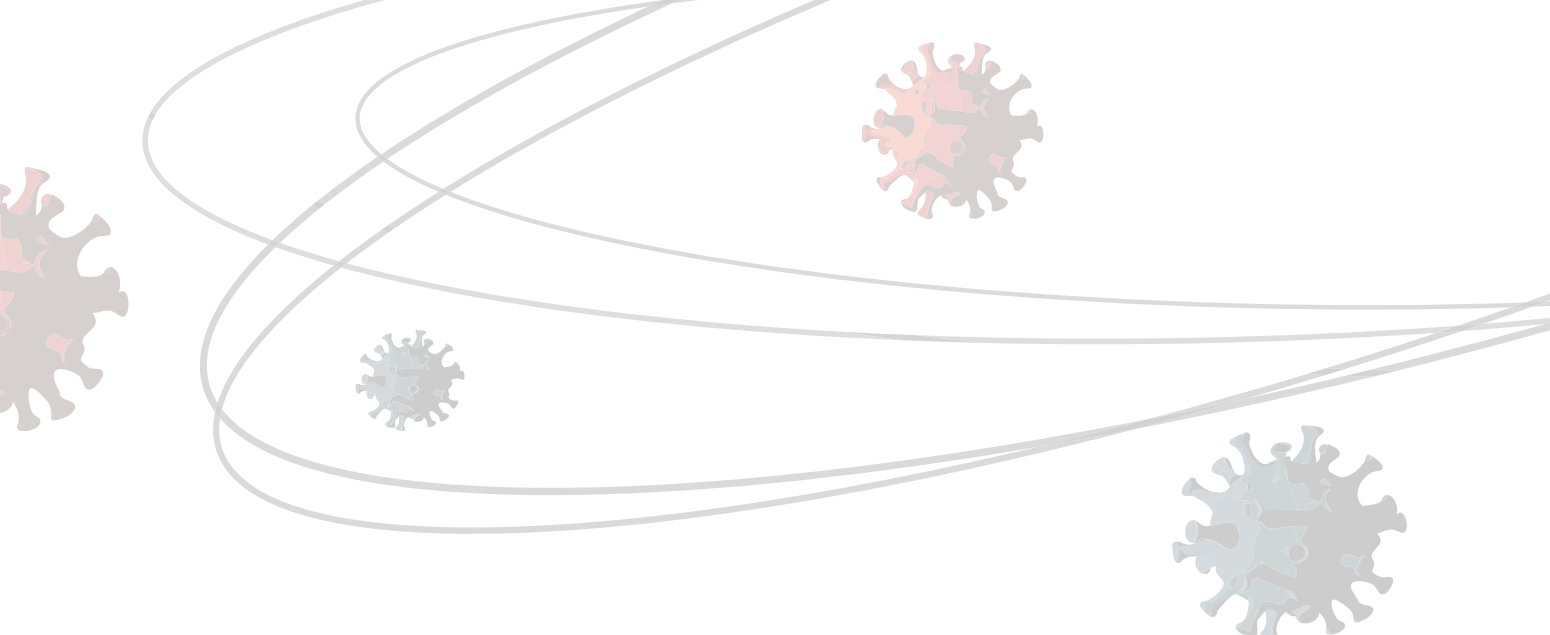
treatment at a hospital, were still struggling to complete everyday tasks without becoming very short of breath. Others had lingering fatigue, headaches, or loss of smell and taste.

The numbers of infected or hospitalised COVID-19 patients were being published weekly by the Ministry for Health, but there was no real sense of what these numbers meant for the Maltese population. For Dr Sarah Cuschieri, this was a question far too important to ignore.

PUBLIC HEALTH

Cuschieri's background in epidemiology and public health had given her plenty of experience in mapping the impact of disease on our health. With a particular interest in diabetes, Cuschieri had begun studying the burden of particular diseases on society.

By only considering the mortality rate of a disease, we miss the impact that it has on the day-to-day life of a patient. For example, someone with Type II diabetes might have a lower life expectancy than average. But poorly managed >



Dr Sarah Cuschieri

diabetes might mean that the patient suffers with pain in their fingers and toes, loses their eyesight, or has to inject insulin, all of which affects their quality of life compared to a healthy individual. To get a real understanding of a disease, there needs to be a way to measure how much of a burden living with a particular condition is to an individual life.

'We call these Disability Adjusted Life Years, or DALYs,' Cuschieri says. DALYs are a measure of time lost – either through premature death due to disease (mortality), or what an individual might miss out on due to pain or disability related to their condition (morbidity).

WHAT IS DALY?

Mortality, or Years of Life Lost to premature death (YLL), can be calculated relatively simply by comparing the age at which the patient died to the average life expectancy. Morbidity, however, takes a little more thought. To assess this, symptoms are further divided into severity categories: moderate, severe, or critical. These are used to give weighting to each of the symptoms that an individual might experience, producing a number for Years Lived with Disability (YLD).


Working alongside epidemiologists, the YLL and YLD are combined to produce a single number, which can be used to compare the impact of different diseases on a population. This can be an incredibly useful tool for determining priorities in healthcare research and funding.

Such studies are uncommon in Malta. In fact, there had only been one such epidemiological study in Malta before COVID-19 – led and conducted by Cuschieri herself.

But the growing impact of COVID-19 required further action. Although the first wave of COVID-19 infections had been relatively low and controlled, summer of 2020 brought much greater numbers and more stress on healthcare systems. Cuschieri and her colleague, Prof. Neville Calleja, began documenting the numbers of COVID-19 infections and hospitalised patients reported by the government in their weekly updates, along with any reports on mortality of patients.

THE IMPACT OF COVID-19

In the year between March 2020–2021, over 70,000 people were reported as testing positive for COVID-19 in Malta, of whom 331 sadly died. Using these figures alongside data on the average life expectancy, Cuschieri calculated that on average the disease robbed patients of 16 whole years of life. Across all patients, that brought the YLL (which represents the impact of a disease over



a year) to a huge 5,229. The virus had a huge impact. To put this into perspective, according to the Global Burden of Disease 2019 study, the YLL of Type 2 diabetes was 1,776 while for ischemic heart disease (heart problems caused by narrowed heart arteries) the YLL was 12,998.

Calculating the YLD proved more difficult. Of the 70,000 cases, around 20% were asymptomatic. The other 80% with symptoms could be divided into mild (no hospital stay), moderate (hospitalisation but no intensive treatment), and severe (intensive care stay needed) categories. Assuming that the average COVID-19 infection lasted 14 days, Cuschieri and team used these figures to calculate the YLD for each category.

But those long-COVID sufferers made the story more complicated. Reports of breathlessness and fatigue couldn't be ignored when considering the impact that COVID-19 was having on Maltese lives. To account for this, the team adapted the calculation to include an extra 14 days of infection, bringing the total to 28 days. Altogether, these long-COVID patients accounted for more YLD than all the other groups combined.

Combining the YLD and YLL gave COVID-19 a total DALY figure of 5,478 – the fourth leading disability in Malta behind heart disease, lower back pain, and diabetes. The impact is massive, especially when considering that the vast majority of this big number comes from the number of people who died from the disease or who suffered the effects for longer than two weeks.

It's difficult to know if some of these long-COVID symptoms are purely caused by lingering effects of the virus, or whether the side effects of being in lockdown have had some impact too. In another study, Cuschieri used a prediction methodology to examine the burden that COVID-19 has put on those with pre-existing health conditions, such as diabetes or obesity. 'We're finding that those with chronic disease had worse COVID, and when they recovered, their chronic disease was worse or responded less well to medication,' she said.

Combining the YLD and YLL gave COVID-19 a total DALY figure of 5,478 – the fourth leading disability in Malta behind heart disease, lower back pain, and diabetes.

A lack of available data at the beginning of the pandemic and other compounding factors such as existing health conditions made the DALYs modelling more challenging. But Cuschieri is confident of the overall conclusions. 'We had to adapt the maths to make sure we had a clear picture,' she said, but she stresses that she would like to work more closely with healthcare providers on other follow-up projects to model the burden of disease.

LONG-TERM EFFECTS

It's undeniable that COVID-19 has had a profound effect on our lives, but having the numbers down in black and white to compare with other diseases has helped many realise the extent of COVID's impact. Since publishing this research, lessons are already being learnt. The Maltese Parliament was offered the paper to prove the need for continued testing, and Cuschieri has been invited on various platforms to share her work.

What next? Cuschieri has already worked on a number of related projects examining the effect of COVID on other diseases – those with chronic illnesses who have then caught COVID, or those with undiagnosed conditions that have slipped unnoticed in the midst of lockdowns and full hospitals.

'The health and socioeconomic repercussions of the pandemic could be huge,' Cuschieri says. 'There is a lot more that we need to understand.' 📌

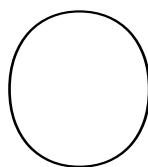
CANNABIS:

Legalise it or criticise it?



Author: **David Mizzi**

*Is cannabis a dangerous drug, or is it just a medical plant? Science cuts through the political rhetoric and can provide us with empirical answers. **David Mizzi** from **THINK** gets in touch with a number of scientific experts to look past the smoke and better understand cannabis.*



On 14th December 2021, Malta legalised the cultivation and personal use of cannabis. While some hailed this landmark legislation as long overdue, others felt it would do more harm than good.

But are these fears well-founded, or are they the result of uninformed opinions? What's the evidence out there? We asked these questions and others to Prof. Giuseppe Di Giovanni (Faculty of Medicine and Surgery, University of Malta [UM]) and some of his international collaborators working on the therapeutic benefits of cannabis. 'First of all, I believe that marijuana and research on cannabinoids will give rise to the discovery of new potential treatments for many disorders, especially epilepsy, pain, and cancer,' clarified Di Giovanni. 'This idea is also shared by many neuroscientists, including Prof. Mechoulam, who discovered THC in the 60s,' continues Di Giovanni.

'Regarding the legalisation of the recreational use of cannabis, science does not need to take a position. This is more a political issue and after, a personal choice,' according to Di Giovanni. While science does not need to take a stand, it does give us the tools to make rational and well-informed decisions.

WHAT IS CANNABIS?

Weed, marijuana, ganja, devil's lettuce, hashish — these are all different terms for cannabis, a plant which has been used medicinally and recreationally for centuries. However, just like alcohol is an umbrella term for different types of booze (beer, whiskey, wine), Prof. Mauro Maccarrone (University of L'Aquila, Italy) points out that 'cannabis is just one word for many different formulations, each with a potential benefit or threat for health.'

Di Giovanni explains how the consumption of cannabis produces a wide range of psychotropic (mental) effects such as mild euphoria, relaxation, time distortion, sensory alterations, and a generally pleasant feeling. When compared to other psychoactive substances (such as alcohol and nicotine), cannabis has a low toxicity. In fact, the doses needed to induce a fatal effect are well beyond that consumed by humans. It has been calculated that a delta 9-THC lethal dose in a 70 kg human would be approximately 4g. Such a dose could not be realistically achieved in a human following oral consumption, smoking, or vaporising the substance, as delta 9-THC has a large margin of safety.



Left, Prof. Raphael Mechoulam (Hebrew University of Jerusalem, Israel), right, Prof. Giuseppe Di Giovanni (University of Malta, Malta) at the MNS2017 in Malta. Image courtesy of Giuseppe Di Giovanni



From left to right: Prof. Mauro Maccarrone (University of L'Aquila, Italy), Prof. Patrizia Campolongo (Sapienza University, Italy), Prof. Matthew Hill (Calgary, Canada) Images courtesy of Giuseppe Di Giovanni

While many report pleasant experiences with cannabis, these are not universal. Some people report feeling anxious, fearful, or panicked. This can occur when a person smokes too much, the plant has a high potency, or if the person is inexperienced with the drug. Large doses can also result in acute psychosis such as hallucinations or delusions. While unpleasant, these temporary reactions are distinct from longer-lasting psychotic disorders such as schizophrenia, which we will discuss later on.

This wide spectrum of effects occurs due to plant variability (each plant has different concentrations) and human variability (the way a person reacts). Di Giovanni explains how even if two people smoke from the same joint, there is no guarantee they will be affected the same way due to their unique genetic makeup.

Di Giovanni points out that 'abusing cannabis, just like other drugs of addiction such as alcohol and nicotine, produces detrimental effects on brain function. Consequently, there is no scientific reason why legal drugs of abuse are sold by governments, while others are banned by society. This highlights a major paradox in international drug laws.'

HOW DOES IT WORK? THC AND CBD

All drugs have an active effect on the brain because they act similarly to chemical compounds that the body naturally produces. For example, heroin acts similarly to endorphins. Cannabinoids produce their effects by interacting with specific receptors that are part of the endocannabinoid system, located within different parts of the central nervous system and the body. Simply put, our brain and body produce endocannabinoids (similar to delta 9-THC) that regulate

how cells communicate: how they send, receive, or process messages. The endocannabinoids regulate our brain and body functions as a conductor directs an orchestra, creating a beautiful symphony.

Cannabidiol (CBD) and tetrahydrocannabinol (THC) are the two main compounds found in cannabis. The psychotropic effects of cannabis are caused by THC, while CBD does not induce the 'high' and seems to have beneficial effects such as reducing anxiety and antipsychotic properties. It is believed that CBD has the ability to moderate the psychotropic effects of THC; this is known as the entourage effect. However, a 2020 study by Peter Cogan has cast doubt on this idea.

THC and CBD have a number of effects on the body's systems. For example, THC works primarily on the brain's CB1 receptors, while CBD acts on the CB2 receptors and several other targets. When it comes to the central nervous system, THC acts as a muscle relaxant and psychotropic (inducing a high) but can also cause short-term memory problems and distort the perception of time. CBD on the other hand, has anticonvulsant (prevents seizures) properties, as well as anxiolytic and antipsychotic properties.

IS CANNABIS DANGEROUS?

While cannabis' dangers are significantly milder when compared to other substances, this does not mean it is harmless. For Prof. Patrizia Campolongo (Sapienza University, Rome, Italy), long-term dangers include 'addiction, altered brain development in adolescents, chronic bronchitis, as well as increased risk of chronic psychosis disorders (including schizophrenia) in persons with a predisposition to such disorders.' Di Giovanni expounds on this point: 'marijuana

should definitely be forbidden to adolescents up to 21 years old. The prefrontal cortex (think of it as the CEO of the body; it understands what is good, bad, and possible consequences), is the last part of the brain to mature.' Consumption of cannabis during this stage can negatively affect a person.

One of the major issues with cannabis is its association with the development of schizophrenia. However, Prof. Matthew Hill (Calgary, Canada) is quick to point out that the nature of this association is still a debate within the academic community. While the risk of developing schizophrenia is terrifying, the bulk of human research conducted is observational, yielding correlations but not proving causation. This has left researchers debating whether cannabis can directly cause schizophrenia, or if it triggers schizophrenia in people already predisposed to developing the disorder. Di Giovanni advises, 'adults with a family history of schizophrenia and other mental disorders should avoid cannabis or any other drug of abuse, including those that can be legally bought, such as cigarettes, caffeine, and alcohol,' as these may also trigger certain conditions.

HOW WILL CANNABIS LEGISLATION IMPACT SOCIETY?

While science can give us a detailed explanation of what cannabis is, determining how legislation impacts society is a different matter. Taking a look across the Atlantic towards Canada, which legalised recreational marijuana in 2018, we can see how legislation impacted society there.

According to Hill, 'based on my experience in Canada, legalisation literally had no discernible impact on society. There has been no change in things like fatal motor vehicle accidents; cannabis use by teenagers has not changed at all since legalisation; and in general, there has been no notable change in any aspect of society following legalisation.'


For Campolongo, while there is a consensus in the academic community of the strong therapeutic potential of cannabis, when it comes to recreational use, the issue is less clear cut. For one thing, 'recreational cannabis would be subjected to totally different production methods, with different (not controlled or known) percentages of the various psychoactive and non-psychoactive substances.'

This sentiment is echoed by Maccarrone, given that there are hundreds of cannabinoids, 'it is not yet clear how different combinations interact with each other and how they can impact on human health. Different formulations can have very different effects (from highly beneficial to highly dangerous) on human health and disease.'

Looking beyond the chemical composition, Hill believes that the majority of academics in North America view the prohibition model as being detrimental, particularly on

marginalised and racialised populations. For example, 'despite comparable levels of cannabis use between black and indigenous populations, and white populations, the former were up to five times more likely to be arrested and charged.'

Prof. Raphael Mechoulam (Hebrew University of Jerusalem, Israel), arguably the father of cannabis research, is best known for his discovery of THC and endocannabinoids. He believes that if a country decides to legalise recreational cannabis, there should be a few safeguards. These include, 'an age limit of over 21, the percent of THC in cannabis should be limited, similarly to alcohol – driving should be prohibited until a number of hours have passed, and hospitals should have staff that are experienced with cannabis medical problems.'

While cannabis is arguably less dangerous than other drugs of abuse and has an extremely bright future for therapeutic applications, it is not a miracle drug. It certainly does not deserve the stigma associated with it, and people who use it should not automatically be considered criminals. But as with any drug on the legal market, including nicotine and alcohol, consumers need to know about the potential side effects. Cannabis is not the root of all evil, nor is it the cure for all diseases. 'More research on cannabinoids is warranted. Once we understand the mechanisms by which cannabis affects the body, its benefits can reach more patients and also consumers,' Di Giovanni concluded. 

More information about current preclinical and clinical research on cannabinoids, collaborations, and student opportunities can be directed to Prof. Giuseppe Di Giovanni.

Further Reading

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EFFECTS OF TETRAHYDROCANNABINOL (THC) AND CANNABIDIOL (CBD)



Receptor/non-receptor effects

Effect	THC	CBD
CB1 Receptors	++	±
CB2 Receptors	+	±
Anti inflammatory	+	+
Immunomodulatory	+	+



Central Nervous System effects

Effect	THC	CBD
Anticonvulsant (prevents seizures)	+	++
Muscle relaxant	++	+
Anxiolytic (decrease anxiety)	±	++
Psychotropic (induce a high)	++	-
Antipsychotic	-	++
Short-term memory problems	+	-
Distortion of perception of time	++	-
Neuroprotective antioxidant	+	++
Antiemetic (stop vomiting)	++	++
Sedation	+	-



Cardiovascular effects

Effect	THC	CBD
Bradycardia	-	+
Tachycardia	+	-
Hypertension	+	-
Hypotension	-	+



Anti Carcinogenesis (Preventing or Delaying the Development of Cancer)

Effect	THC	CBD
Glioma (apoptosis)	+	+
Lung cancer (Note: this only applied if eaten. Smoking any substance damages the lungs)	+	++



Metabolic effects

Effect	THC	CBD
Appetite	+	-
Gastrointestinal motility (slowed)	++	+
Metabolic/diabetes	+	-



Ophthalmological effects

Effect	THC	CBD
Intraocular pressure (reduced)/Glaucoma	++	+

CBD Cannabidiol
CNS Central nervous system
GI Gastrointestinal
THC Tetrahydrocan

Full list of references available on **THINK** website

Taking the lead with patient monitoring

Author: **Martina Borg**

Patients are currently monitored using wired leads (electrocardiographic cables). This decreases patient mobility and comfort. Studies have shown that it can also lead (pun not intended) to long-term skin damage, especially with newborns. A team of researchers from the University of Malta (UM) are examining whether some of this data can be extracted through digital cameras, removing the need for cables.

While monitoring patients wirelessly sounds like an almost futuristic idea,

it's precisely the line of research being investigated by an interdisciplinary team of six scientists and medical professionals at the University of Malta and Mater Dei Hospital. The formidable team, consisting of Dr Owen Falzon, Prof. Ing. Kenneth Camilleri, Dr Abdelkader Helwan, Prof. Jean Calleja Agius, Dr Nicole Grech and Dr Stephen Sciberras, is currently spearheading what they call the NIVS Project: Non-Invasive Vital Signs monitoring project.

'Monitoring vital signs like heart and respiratory rates is essential for various reasons,' explains anaesthesia trainee Dr Nicole Grech over a coffee

one morning. 'It's particularly important in wards like the Intensive Care Unit (ICU) where patients are more likely to be unstable, so continuous monitoring can be a matter of life and death.'

Grech explains that heart and respiratory rates can often show that all is not well with a patient even when they are feeling fine; a situation that was quite common with COVID-19 patients over the past months for instance.

'ECG monitor leads are considered the gold standard in terms of providing that data in real time, but they also come with a lot of issues,' she explains. 'First of all, there is a practicality issue, in that they tend to fall off patients and hamper their movement when they are trying to move about or even sleep. There are also issues when

patients have hairy or moist skin, not to mention diseased skin that can become irritated or prevent the leads from adhering effectively.'

Grech goes on to explain that the leads can sometimes cause significant damage to the skin, particularly in premature babies, whose delicate skin could actually slough off when the adhesive leads are removed.

'There is also a higher likelihood of infections spreading from one patient to another, regardless of how well these leads are disinfected. Hospital-transmitted infections are actually incredibly common, and they can lead to higher mortality rates, particularly in places like the ICU where patients are already vulnerable,' Grech says.

The World Health Organisation has prioritised research to find alternatives to contact-based devices such as



monitoring leads. It wants to reduce antimicrobial resistance, which is a global and health development threat.

FINDING NEW SOLUTIONS

The spike in global interest and the recent focus on social distancing led project lead investigator Dr Owen Falzon to set up the multidisciplinary team and attack the issue with technical and clinical solutions.

'The inter-faculty collaboration between UM and Mater Dei Hospital allowed us access to a full suite of equipment and resources, as well as the possibility to run tests in controlled conditions and clinical settings, to give us a much deeper understanding of the systems needed,' Falzon explains.

Falzon, together with the Director of the UM's Centre for Biomedical Cybernetics, Prof. Ing. Kenneth

Camilleri, worked to synergise medical and scientific research, a step which has so far been uncommon in Malta. The team of researchers decided to dive into the concept of photoplethysmography (PPG), which operates on the idea that changes in someone's heart rate can be detected through skin colour changes.

'The basic idea is that every time the heart beats, it pumps freshly oxygenated blood – which is redder in colour – to the surface of the skin,' explains Grech. 'This gives the patient a pinker hue. The process is invisible to the naked eye, but a basic camera can pick up the subtle change.'

Grech goes on to explain that using a camera, known as remote PPG, would be non-invasive and would ultimately enhance patient wellbeing. 'The absence of leads would

mean that patients can move around in their beds without fear of getting disconnected or tangled. The risk of contamination and skin damage would be lowered, and the remote data collection would also allow for more effective physiotherapy sessions as patients need not be concerned about getting disconnected from monitors during these important sessions.'

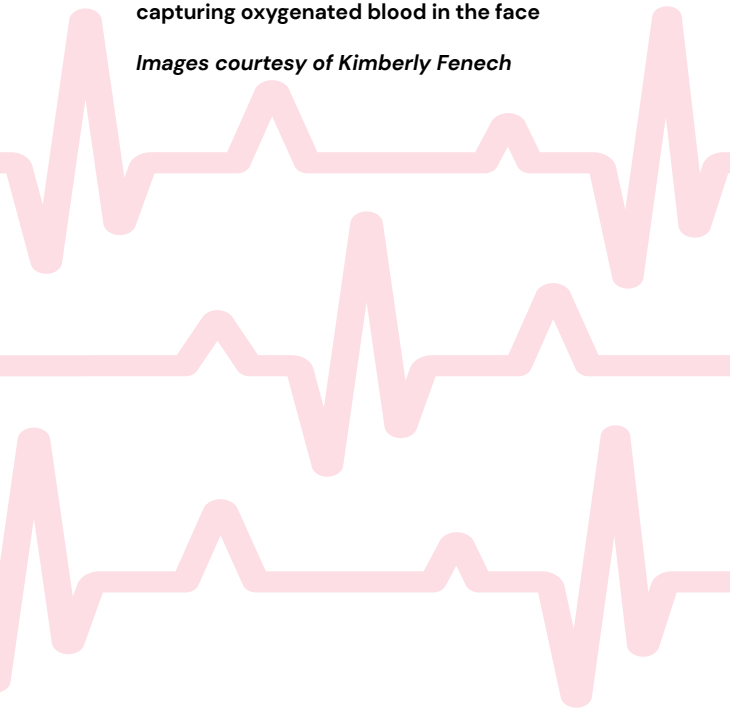
WHAT HAPPENS TO THE FOOTAGE?

In the interest of this project, the team has already gathered around 44 hours of footage in total; first from healthy volunteers (approximately 31.5 hours) and then from ICU patients (approximately 12 hours). But how does that translate into medical data that health professionals can interpret? ➔

Left: Non-invasive monitoring of a patient through multiple imaging devices

Right: Photoplethysmographic imaging capturing oxygenated blood in the face

Images courtesy of Kimberly Fenech



Data analyst Dr Abdelkader Helwan explains that the data and videos are being fed into a convolutional neural network – a form of Artificial Intelligence (AI) that can learn how to carry out complicated tasks based on the data it is fed. Helwan will then work on creating an algorithm that allows the machine to recognise anomalies and irregularities in patient heart rates, in the same way an ECG monitor would.

Helwan explains that AI is becoming increasingly important in the health sector, with models successfully detecting and classifying diseases like skin cancer and beating experts at determining the malignancy of tumours.

'Our work in this particular project is very robust as we are using various video scenarios, including a variety of poses, illuminations, and distances from the camera,' he adds. 'Filming

patients in a hospital environment will allow our AI to better overcome common issues identified in this method of data collection.'

Some of the most common challenges to remote PPG have been highlighted in medical and research journals. From the placement of the equipment to data privacy issues, this research project is trying to overcome several challenges.

'The camera itself can be a little cumbersome, so we need to think of where we can place the equipment to effectively monitor patients without disrupting the staff if we are to use this method in a real world setting,' Grech explains.

'Clinical tests have also thrown up issues like light changes causing a disruption to the data collected. If there are lights flashing from various monitors or pumps around the patient, the data may become

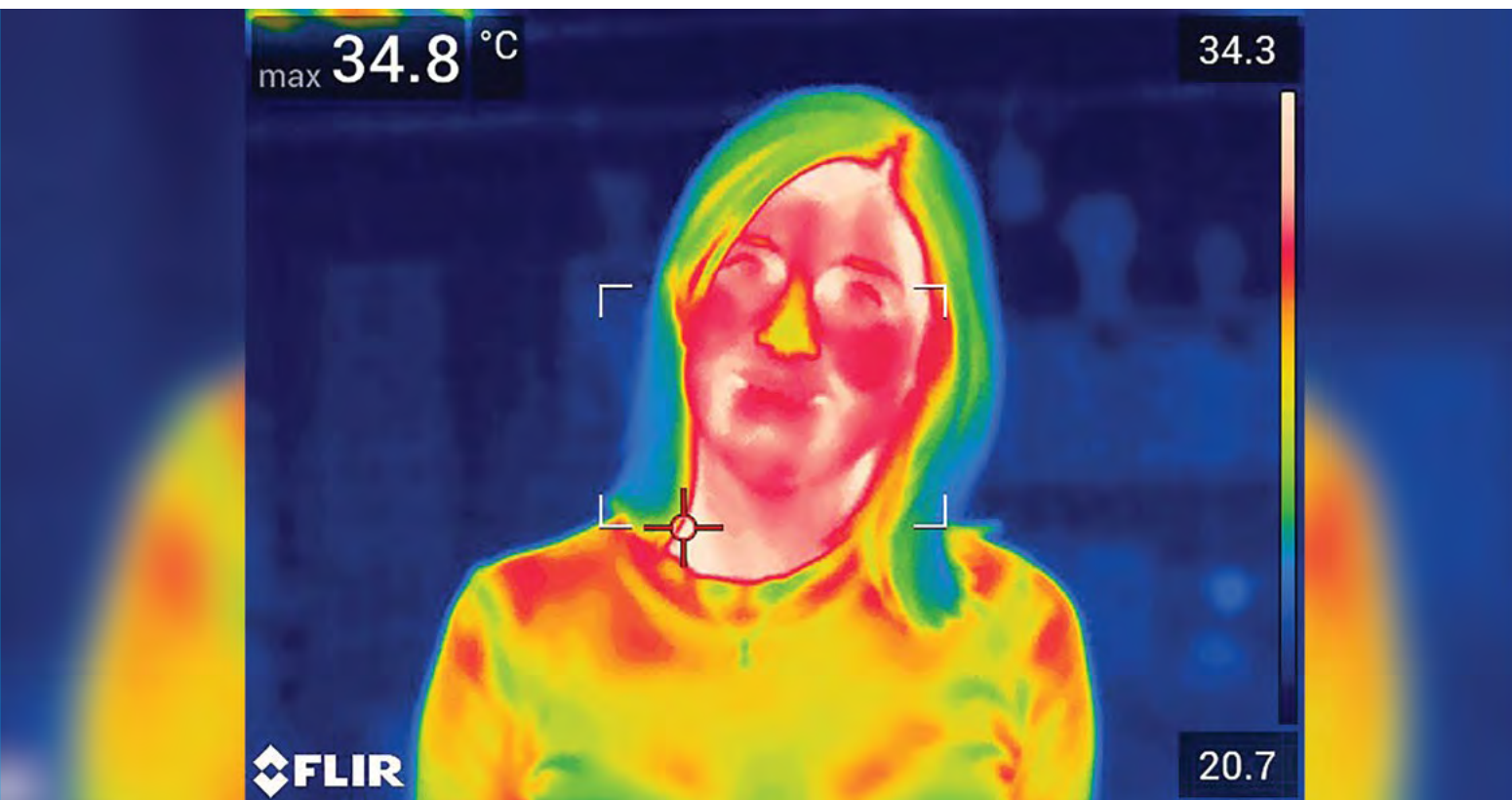
muddled,' explains Helwan. 'Movements of hospital staff around the patient can also cause disruption to the data collection.'

Echoing Helwan, Grech explains that this research project collected data in dim light, bright light, and even darkness to train the AI to interpret data in as varied conditions as possible. The idea was to simulate real use.

NEXT STEPS

'Beyond the practical aspects,' says Grech, 'our clinical tests have shown that we need to have a wider data set to compare to. The data collected from healthy patients often does not match up to the conditions of patients in wards like the ICU.'

'The algorithm won't be able to recognise patients whose heart rates are perhaps outside the normal zones, so we are currently applying for ethical approval to



collect data from healthy patients doing exercise. This will allow the algorithm to develop an understanding of more elevated heart rates, for instance,' she adds.

Data privacy is another key issue. Given that this data relates to patients with severe health issues, the team had to seek approval from Mater Dei Hospital and UM Ethical Committees to ensure that the data is secure, with only the clinical and research team having access.

A further hurdle the team came up against is the expensive nature of the equipment in question, with some of the machines costing thousands of euros. To this end, the team successfully applied for funding from the Malta Council for Science and Technology for the NIVS Project.

'As mentioned earlier, we have already identified the need to analyse more elevated heart rates and feed it

into the system, but the aim is to use all this data to assess the accuracy of the system and finally test it in a real-world setting,' Grech adds.

The hope is for the research to ultimately become widely used in hospitals. The team have opted for a broader data set than has been attempted so far in any international study. Most studies around the subject have employed exclusionary criteria and focused on specific issues like patients undergoing haemodialysis treatment or preterm infants, but the local research team has chosen to have a broader variety of patients to properly test this form of data collection.

Intensive Care Consultant Dr Stephen Sciberras and the Head of UM's Anatomy Department Prof. Jean Calleja Agius explains that the ambitiously wide data collection will allow the team to build an

estimation model that should work seamlessly in a busy hospital setting.

'The ICU offers the best opportunity to collect as much data as possible in a clinical situation, as it incorporates a wide variety of conditions,' Sciberras explains. 'Patients here can be awake or asleep, some could be breathing normally while others use ventilators, and so on... This ultimately means that the system will be better calibrated for everyday use, rather than only a specific type of patient.'

With infectious energy and optimism, the team has largely completed their data collection and are now well into the data analysis stage. Should these results be favourable, the project would likely change the image of hospitals as we know them and push them into a more contact-free future, a feeling that is entirely on-brand in our post-Covid world. **T**

We are what we eat

Author: **Martina Borg**

*Calorie-counting and crash diets may seem like the most accessible ways to get in shape, but a focus on what's actually in the food we eat might reveal that staying healthy doesn't need to be as difficult as we think... **THINK** speaks to University of Malta experts to find out the real deal.*

As the sparkle of our 'new year, new me' resolutions begins to fade, it might be tempting to fall back into old habits. When it comes to food, we might think it's enough to just eat less and exercise, but there's more to it than that. THINK had a sit-down with University of Malta Associate Professor Suzanne Piscopo (Faculty of Education) to discuss just how people can get the best out of the foods they eat by focusing on nutrient density.

MAKING SENSE OF NUTRIENT DENSITY

Piscopo first came across the term and concept of nutrient density when she attended a nutrition conference in the US whilst reading for her master's degree in Canada in the early 90s.

'At the time, there was a focus on creating new food-based dietary guidelines, so researchers were placing foods into different food groups,' she said, adding that each food item within the group was then rated with a star system rating.

'For instance, salami and beef both fall into the same group, but the star rating they are given largely depends on the benefits they present. Put simply, beef contains protein,

vitamins, iron, and some fats, whereas salami contains more fats as well as elevated levels of sodium. This means that beef will have a better star rating than salami, essentially.'

Nowadays, nutritionists have moved on from talking about star ratings, but it's easy to see how the system has formed the backbone of modern nutrition profiles.

'Now, we are essentially talking about creating profiles and ratings based on desirable vs undesirable nutrients in the foods we eat, and that's what we mean when we talk about nutrient density. It is essentially the practice of looking at the number and variety of nutrients in a particular food: the nutrient quality.'

Piscopo explained that 'nutrient-dense foods' are determined by the presence of favourable nutrients like vitamins, minerals, proteins, so-called healthy fats, and fibre, as opposed to less favourable ones like saturated fats, sugars, and salt. At the same time, the lower the calorie count the better.

'The comparisons and calculations take place in terms of nutrients per calorie or nutrients per weight. For instance, you could have two pieces of bread weighing the same, but one is wholemeal, and the other is white bread. Basically, the wholemeal piece contains more nutrients than the white, so



Prof. Suzanne Piscopo
Photo courtesy of Michael Piscopo

it will be the more nutrient-dense food item. Similarly, the calculation and comparison can be made on a calorie basis. So for instance, you can have two slices of pizza adding up to two hundred calories each, but one contains cheese and vegetable toppings, and the other has only cheese and ham. Naturally, the vegetable pizza has more beneficial nutrients than the other one, so it would be more nutrient dense.'

Piscopo explained that some foods or food groups are naturally more nutrient dense than others (namely vegetables, fruits, lean meats, seafood, low-fat dairy products, pulses, eggs, and nuts) but also added that nutrient density could be handy to decide which foods to choose from within the same group.

'Fruits are all nutrient dense, for example, but apricots would be more so than watermelon, purely because of their higher vitamins, minerals, and fibre content.'

WHY SHOULD PEOPLE CARE?

Perhaps one of the first things the more sceptical of us will wonder is: why does all this matter? And how is this different from dieting fads such as calorie counting? Piscopo maintains that there are actually three aspects where nutrient density can impact us: health-wise, economically, and ecologically.

'People are recommended a certain amount of food or calories every day based on their age, gender, and level of physical activity, so really we should try to get the best nutrition out of that allowance. Ultimately, this will simply allow us to get better bang for our buck,' Piscopo clarifies.

She explains that nutrient density is superior to calorie density because calorie-dense foods can eat up our calorie budgets quite quickly, whereas focusing on nutrient density might allow us to eat more satisfying quantities of healthier food in the long run. Calorie-dense foods tend to be packed with fats and sugars, so ultimately, they end up being nutrient-poor, which means that calorie counting alone might not be the best option for health. Interestingly, the US's latest dietary guidelines (published in 2020) have shifted focus onto promoting more nutrient-dense foods (whilst staying within calorie limits) as opposed to highlighting calorie dense ones.

'I often get asked for advice and meal plans by people who are trying to lose weight for whatever health or aesthetic reason. My interest in the subject was first piqued precisely because I needed to understand how to best advise people to get the best nutrition from the limited bank of calories they were allowed to achieve their goals.' ➡

Piscopo also goes on to explain that her interest intensified and has taken a slightly different slant recently, as she has grown more interested in the financial aspect of nutrition.

'I've become increasingly interested in facilitating the nutritional needs of low-income families and individuals. It's far too easy and cheap to access the not-so-healthy foods, but making people more aware of nutrient density will ultimately ensure better nutrition for less money. It will ensure that people spend their limited money on foods that will be good for them, rather than foods rich in sugars, salt, and fats,' she clarifies.

Piscopo explains how nutrient density can affect the environment. Researchers are now analysing the greenhouse gas emissions of foods along the supply chain.

'You can look at similar products, like a jar of tomatoes, for instance, and compare that to tinned tomatoes to decide which one is best both in terms of its nutritional value and in terms of the carbon footprint of its production, transport, storage, and use.'

She adds that there are also studies looking into the water consumption of specific food products, as well as land use to make certain comparisons.

'These studies will look into how much water you need to raise livestock or to water plants, as well as how much nutrition you can gain from a designated area of land. For example, if you use one hundred square metres of land to raise a few cattle, you can get a certain amount of protein, vitamins, and minerals from their meat, whereas if you use that land to grow beans, the yield of food and nutrients will be higher.'

For Piscopo, these calculations can allow the agriculture industry to make better choices in terms of nutritional value and how best to use the land available to feed people with less harm to the planet.

MAKING NUTRIENTS MORE VISIBLE

As Piscopo's research has already shown, a focus on nutrient-dense foods can be beneficial in various aspects. Indeed many countries already use nutrition density as

one of the main recommendations to manage weight loss and access lower-cost foods. In fact, Piscopo hopes that nutrient profiling will become more mainstream and even become present locally on product labelling and packaging.

'France, for instance, has introduced a nutriscore label on food products in the past three years, and this has allowed consumers to make more informed choices. The score basically gives foods a rating between A and E (with A being the healthiest) depending on the nutritional value. There are currently talks about whether this should be an EU-wide scheme, as it has had fairly positive results.'

Piscopo points out that the scheme would not just allow consumers to make more informed decisions, but it would also prompt food production companies to improve their recipes and aim for better nutrient profiles for labelling purposes.

'I think having some sort of labelling would put consumers in a much better position, as I believe a lot of issues come from the public simply not knowing how to maximise nutrients and minimise calories,' she says.

Piscopo highlights her point by pointing out a few simple and healthy swaps that could lead towards a more nutritious lifestyle. She goes on to add that as part of her teaching, she shares a tasty and healthy muffin recipe featuring the humble red kidney bean as its main ingredient with her students. As I clearly can't hide my intrigue and slight skepticism, she assures me they're surprisingly good, and I can't wait to test them myself...

I am left to wonder how such labelling might impact my determination for new year resolutions, which often slowly fizzles away come spring. As the call of nutrient-poor take-outs beckons me ever more enticingly, Piscopo reassures me that following a nutritious, plant-forward diet is often easier than it seems. She suggests a series of simple swaps from less nutrient-dense food items to more dense ones. The gist is that focusing on plant-based foods and wholegrain products can have a deep impact, simple advice that can change our health and lives. **T**

Suzanne Piscopo's go-to list of nutrient-dense foods

Whole grains – oats and oatmeal, quinoa (technically a pseudo grain), barley, bulgur, wholegrain/brown rice, and whole-wheat pastas and breads

Legumes – all kinds of beans, lentils, chickpeas, split peas, black-eyed peas

Vegetables – leafy green vegetables (ex spinach, chard, beet greens, kale, endive, rucola, leaf or romaine lettuce), red pepper, kohlrabi, scallions, broccoli, cauliflower, cabbage, carrot, pumpkin, sweet potatoes, parsley, chives

Useful swaps

WHAT IS NUTRIENT DENSITY?

Food that is high in nutrients but relatively low in calories, nutrient-dense foods contain vitamins, minerals, complex carbohydrates, lean protein, and healthy fats. Examples of nutrient-dense foods include fruits and vegetables, whole grains, low-fat or fat-free milk products, seafood, lean meats, eggs, peas, beans, and nuts." (US National Cancer Institute <https://www.cancer.gov/publications/dictionaries/cancer-terms/def/nutrient-dense-food>)

BREAKFAST

Chocolate cereal with whole milk
(Approx. 30g serving + 200ml milk)

8g

14.5g

0.4g

1.1g

250

Wholegrain cereal with low-fat milk
(Approx. 38g serving + 200ml milk)

0.8g

9.15g

0.2g

2.9g

163.3

Leaves room for some fruit if desired

LUNCH

White wrap with bacon, mayonnaise, and lettuce

22.5g

1.5g

2.3g

2.7g

401

Wholegrain wrap with lean chicken breast and low-fat yoghurt dressing

9.6g

3.9g

0.78g

5.4g

380

Leaves room for more veggies like lettuce, mushrooms, and tomatoes if desired

DINNER

Fried chicken drumstick and fries
(one 140g piece - weight including the bone)

38g

1.3g

0.4g

1.7g

573

Roasted chicken breast and roast potatoes
(one fillet -140g)

2.78g

0.19g

0.19g

1.72g

188

This allows you to add more vegetables on your plate, which is more filling, and according to science, it is more satisfying to see various colours on your plate

SNACK

Slice of white bread toasted with jam

1.3g

9g

0.2g

1.1g

135

Wholegrain toast with low-fat cream cheese

3g

1.4g

0.2g

1.8g

85

This allows you to have more snacks like fruit during the day

Meats and Dairy – lean chicken, rabbit, (sustainably sourced) oily or local fish, eggs, ricotta, low fat milk and yoghurt

Fruit – all kinds of berries, kiwis, avocado, cantaloupe melon, apricots, peaches, nectarines, tangerines, oranges, pomegranate, starfruit, papaya, mango, apples, banana

Nuts – peanuts (technically a legume), almonds, pistachios, cashews, walnuts, hazelnuts

Plant oils – particularly virgin olive oil

BRIDGING THE GAP: BONE GRAFTS OF THE FUTURE

Author: **Cassi Camilleri**

*Better recovery for patients, reduced need for revision surgeries, and many hundreds of thousands of euros saved for public health and industry. That could be the outcome of four years' intense work by engineers and medical professionals at the University of Malta and Mater Dei Hospital in developing biodegradable metal-based tailor-made bone scaffolds. **Cassi Camilleri** writes.*

Healthy bones matter. They carry us through life, literally. But we all know that journey can be fraught with difficulties. Cancer, a bad fall, even the simple passage of time, all of it impacts our bones. And not in a good way.

As a result, more and more people are visiting their orthopedic department at hospital, and more and more people are needing corrective procedures that involve bone implants or grafts. According to research published in 2017 by Wang and Yeung, that number lies at around 2.2 million procedures worldwide.

THE STATUS QUO, ITS FLAWS, AND THE NEED IT HARBOURS

'If we need to repair bone, the first option is an autologous bone graft,' explains orthopedic surgeon Ray Gatt. With these autografts, surgeons fix the damaged area by harvesting bone from another part of the patient's own body. While this method has obvious pros in biocompatibility, it also has cons.

'For the patient, it means you're giving them one incision where the primary operation is and then another incision where you're taking bone from. So they're

effectively having two surgeries. Occasionally, that second incision is much more painful than the first.'

The extent of the damage in question is another limitation to the autograft. 'You can only harvest so much bone from a patient's own body. It's a finite resource,' explains Gatt. If a bone has multiple fractures from a car accident, for example, surgeons would then turn to a combination of bone graft substitutes and permanent implants.

These require weeks of downtime from the patient until the grafts consolidate and can bear weight on them. However, there are other issues that Gatt's colleague Ryan Giordmaina highlights: 'In big defects, you want to give the bone strength and support; however, when you're doing this, you're also taking away the bone's ability to regrow and reform.'

Bone has a funny way of regenerating. Researcher Prof. Pierre Schembri Wismayer explains it this way, 'When you break a leg, surgeons put a cast on and ask you to rest for a while, then when the bone has formed a bit, you progress to weight bearing, and it's time to start walking. The reason is that bones can feel stress passing through them and rebuild themselves according to that stress. It's an amazing capability.'



Top: The BioSA team (Front row, left to right); Dr Arif Rochman; Prof. Ing. Maurice Grech; Prof. Ing. Joseph Buhagiar; Christabelle Tonna; and Mr Keith Sammut (Back row, left to right); Mr Ray Gatt; Mr Luke Saliba; Prof. Pierre Schembri Wismayer; Mr Ryan Giordmaina and Elton Galea; and Albert Curmi



Bottom: The stages of scaffold preparation – 3D printed polymer template, metal coating the template and sintered scaffold (from left to right)

Photos by Elisa von Brockdorff

Plates and other hardware that are implanted pose the same issue. ‘Plates carry a lot of their weight themselves,’ continues Giordmaina. ‘So the force isn’t passing through the bone, and to some extent, there can be some loss of function. This is why the current drive in revision surgery is to have more bone biology. You want the bone to grow back as much as possible.’

To make this happen, the medical world needs an implant that ticks a number of boxes. It has to be strong and mechanically sound. But it also needs to be porous to allow for vascularisation and nutrients to pass through. It needs to be biodegradable so the patient’s own bone could grow back, but the implant and the degradation material both need to be biocompatible and non-toxic to the patient.

It’s a tall order, with a lot of conflicting needs at the outset. But that was the brief. And that was what the engineers needed.

With that, and continued support from Schembri Wismayer, Gatt, Giordmaina, and many others at the University of Malta, Knowledge Transfer Office, Project Support Office, and Mater Dei Hospital, as well as the Malta Council for Science and Technology, Prof. Joseph Buhagiar kicked off the BioSA project.

EARLY DAYS AND LEAVING THE KNOWN BEHIND

This particularly complicated problem-solving process started with Buhagiar and his then-student, now collaborator Christabelle Tonna experimenting with powdered metals. They wanted to replicate the net-like structure of spongy

bone, and this is why they use actual, off-the-shelf washing up sponges as a way to create metal templates.

Using different powdered metals and a slurry liquid to bind it together, they covered the sponges and then applied heat. This fuses the powdered metals together in a process called sintering, while burning the sponge off at the same time. This is what’s called the replication method, and it worked. ‘In the end, we were left with a scaffold of sorts,’ Buhagiar confirms.

As expected from first drafts, it wasn’t perfect. ‘Among other things, the scaffold wasn’t reticulated like real bone is,’ Buhagiar explains. ‘There was a network, sure, but there were too many dead ends. Real bone isn’t like that, so we needed to find another way. But it was a start. A proof of concept we would continue to build upon.’

And build they did.

In fact, the first few months of the project were dedicated to making leaps. The team wanted the scaffolds to be tailor-made to the patient, so the ready-made sponges had to be left behind. With Dr Arif Rochman’s help, the team looked into 3D printing solutions.

Together, they decided to use a stereolithography 3D printer. Unlike standard filament printers, its advanced resolution would allow them to print a plastic scaffold template with small enough gaps to allow the patient’s blood supply to flow through the implant. It would even allow them to create a gyroid structure for the template instead of the straight lines we usually see in scaffolds.

In another part of the engineering lab, collaborator Prof. Ing. Maurice Grech was helping Buhagiar run a project in parallel to find the right powdered metal recipe for the scaffolds. ➔

Yes, metals are the best for giving the scaffold the strength it needs to bear the body's weight, but iron can also be toxic.

'Iron is present in the body, but iron isn't easily got rid of by the body,' explains Schembri Wismayer. 'It stays stored, but the body can get overwhelmed. And if it does, iron damages the kidneys, heart, and liver and causes them to stop functioning. So we had to find a balance.'

This balance is the key to the whole project.

'In engineering, we're usually working on corrosion resistance, coatings for resistance. In real life, you want to protect the item from corrosion. All our knowledge is built around that. But with BioSA, it was about increasing the rate of corrosion. The work needed us to flip all our knowledge as engineers on its head,' Tonna explains.

'It was a massive paradigm shift,' nods Buhagiar.

This mindset saw the team making more jumps as they went. Though the initial process included a binder to glue the powdered metal together, experimenting further with the polymer they were using for 3D printing brought about another option.

'We noted a tackiness developing in the material depending on the curing we did,' Buhagiar says, 'So we used this tackiness on the printed template surface to adhere the metal powder directly.'

From there, they went on to develop a two-step heat treatment that would later be streamlined to one. It involves placing the plastic template covered in metal powder into a furnace. At 450°C, the polymer template burns away, and at 1120°C, sintering happens, and the powders join to form a solid implant.

TRIALS, TESTS, AND SOME ROAD AHEAD

The team is now in the process of running various tests on their new implants. Their first 'patients' were various pork bones bought from a butcher. The orthopaedic

surgery trainees conducting the procedure, Luke Saliba and Keith Sammut, report that 'the scaffolds were easy to handle and adjust as needed.'

Saliba is also working on cytotoxicity testing, which tells the team how the corroding metal in the implant is affecting live cells grown in a petri dish. The results of this work continue to help the team tweak and perfect the implant's powder recipe.

Meanwhile, Sammut is conducting bacterial testing. 'Whenever you're implanting metal work in the body, there is a risk of infection,' Sammut explains. 'The problem is whenever you have an indwelling device like a metal rod or plate, bacteria tend to form a biofilm. Biofilm acts like a shield for bacteria.' Worryingly, it makes bacteria resistant to antibiotics.

'Antibiotics alone are not enough to tackle this problem when and if it happens, and it often necessitates the removal of the implant. An infection from a prosthetic device is devastating'.

To solve this problem, the team has added silver to their alloy. With it, 'there was a reduction of 92 to 98% in the biofilms when we added silver,' Sammut reports.

So what are the next steps for this project, you ask?

At this point, more and more energy is shifting into solidifying the business plan and giving the team the information they need to make informed decisions on the way forward. Crucial to this is the Knowledge Transfer Office (KTO) and Nicola Camilleri.

'Our role as KTO is to complement the scientific team by bringing in the business mind to the development at a relatively early stage. Just like BioSA, every new invention has the potential of having a great business opportunity ingrained. However, this promising business case has to be validated and a business plan formulated, essentially alongside the technology development. So we have been

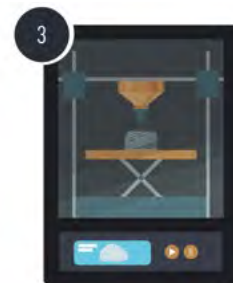
Creating a bone scaffold from scratch



Step 1: Patient with bone defect gets a CT scan



Step 2: Engineers use CT scan to create the bone scaffold's design



Step 3: The scaffold template is created using 3D printing techniques

working hand in hand. While the research team has been advancing the technology's readiness, we have been advancing the market readiness of the future product. In this project, though we are still at the beginning, we just completed the filing of a patent application, which is one of the earliest possible steps on the business side.'

While this might seem like an anti-climax to some, this is the reality of product development, especially in the medical field.

'The way our national health service operates is that it looks at what has been tried and tested all over the world,' explains Giordmaina, 'so a product like this will have to go through a period in the market throughout the world and be taken on by surgeons worldwide. Only then will it be considered to be incorporated in our practice. That's how most implants nowadays are brought into our national health service.'

But this is no reason to despair, as Gatt explains. 'It's true, I probably won't use the BioSA scaffolds in my surgical lifetime, but what Ryan described is a necessary process that should fall into place. The reality is that the idea is the most difficult part. Getting the conception of the technology. And I think, with BioSA, that has been done. The hard part has been done. Now, we wait for all of it to pay off.' **T**

BioSA (R&I-2017-037T) is financed by the Malta Council for Science and Technology through the FUSION: R&I Technology Development Programme.

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THE IDEAL BONE SCAFFOLD

Bone scaffolds are 3D structures, usually made of ceramic materials, used for bone reconstruction. The ideal bone scaffold should be:

1. Porous to allow for vascularisation and transference of nutrients and waste
2. Strong and mechanically sound
3. Biodegradable
4. Biocompatible and non-toxic

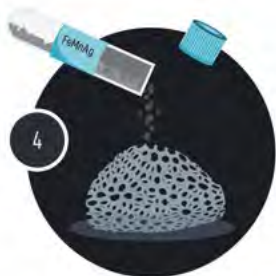
CONTRIBUTING TO MALTA'S RESEARCH FUTURE

The funds granted by the Malta Council for Science and Technology (MCST), a total of approximately €240,000, have been essential for the development of the BioSA scaffold as a product. They have also gone towards securing its business potential through market research, various drafts of business plans, and the patenting process.

Somewhat less obviously, MCST's funding has also contributed to the development of Malta's future researchers. 'Christabelle Tonna's Ph.D., as well as Luke Saliba and Keith Sammut's M.Sc. by Research were made possible through this fund,' explains Buhagiar.

Gatt elaborates further: 'With the research experience they have gained through the BioSA project, [Christabelle, Luke and Keith] have the tools they need to go forward, plan their own projects, and innovate themselves, creating solutions for more of the challenges we are facing in our fields.'

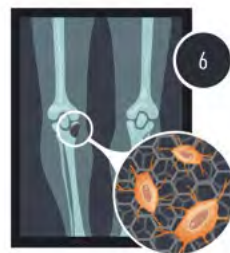
Artworks by Jeanelle Arpa



Step 4: The tacky 3D-printed scaffold template gets covered in metal powder



Step 5: In a furnace, the coated scaffold template is replicated into one made of metal



Step 6: The implanted metal scaffold allows bone cells to grow within and regenerate.





A CAR COUNTRY

Author: **Jonathan Firbank**

*Walking or cycling are challenging in Malta's car-dominated infrastructure. 'Active Travel' is a University of Malta (UM) scheme that encourages students and staff to ditch cars in favour of healthier, greener alternatives. But changing Malta's car culture is no walk in the park. **Prof. Maria Attard** (Director, Institute for Climate Change & Sustainable Development, UM) and **Raphael Mizzi** (UM's Green Travel Plan Coordinator) speak to **Jonathan Firbank** about the project.*

If a person is about to visit Malta for the first time, they will likely wonder how best to travel around. Perhaps there will be bike lanes or trams? Or would it be easier to walk? After all, the weather's great, and Malta is one of the smallest countries in the world, smaller than most major cities.

In reality, the streets are lined with cars. Heavy traffic trundles past rows of parked vehicles, often in front of a remarkable number of car dealerships. There are four cars for every five people, two cars per household, and almost 60 new vehicles registered every day. From time to time, you might see Malta's only public transport amidst the rivers of cars: the humble bus, nearly empty at times, late due to traffic.

Malta has a 'car culture' and a car infrastructure to match. Healthier means of travel are difficult, as missing or dangerous pavements are a major concern for pedestrians. The impact on people's health cannot be understated. Recent studies indicate that over 500 Maltese lives are shortened annually due to air pollution.

The impact on climate change is similarly dire, placing Malta far behind all other EU countries in the race to curb carbon emissions. 'Research shows that only active travel' — that is, people walking and cycling instead of driving — 'can help cities achieve net zero within the timeframes that we require to do so', says Prof. Maria Attard, Director of the Institute for Climate Change and Sustainable Development (ICCSA), UM. She describes Malta's urban space as poorly maintained, with 'poor design, complete neglect, or overly

complicated and sometimes exclusionary infrastructure'. Green travel infrastructure 'is either ignored, or it is provided for PR purposes rather than functional and inclusionary purposes. The reality should be the other way round.'

Raphael Mizzi is the Green Travel Plan Coordinator at the ICCSD. 'People don't like to walk. They'll use a car for small errands or just to go around the corner. There is a mentality that when you reach 18, you buy a car, and it will give you more independence,' reflects Mizzi. Independence can be hard to come by without a car when infrastructure is hostile to healthier transport.

Around 70 years ago, many institutions in Malta made use of the bicycle: mail carriers, police officers, army, RAF, and so on. The amount of cars on the road now make it almost impossible to commute healthily; it's a 'chicken and egg' issue. Mizzi points out, 'if you are walking, you will find obstructions and security issues such as poles, electricity boxes, or garbage in the middle of pavements, which might not be levelled.'

These aren't problems inherited from a bygone era, either. 'It's saddening to see new projects that don't cater for cyclists, that don't have the necessary pedestrian infrastructure. There is a lack of planning and thinking. It results in a lot of small problems that add up to make an area unsafe for walking or cycling. This is not something which is being faced only by us Maltese,' continues Mizzi, 'it is happening all over the world. To change it, we all have to pull the same rope.' ➔



Active Travel presentation by Prof. Maria Attard
Image courtesy of 'Kunsill Reġjonali Lvant' Facebook group



WALKING WORKSHOPS

Active Travel is a project the UM started in 2010 in order to promote and facilitate healthier, greener forms of transport. UM is situated in the heart of Msida, a densely built up and heavily congested area. A great deal of the campus is dominated by car parking spaces and a ring road that lacks proper paving or a bike lane. Attard describes the project as being born from necessity: 'The focus on active travel is important because of the growing car dependence experienced over the years, on the islands and at university. The pressures of parking, increasing pollution, and the evident reluctance of individuals to walk or cycle had become issues that were difficult to ignore. Data kept showing us that many at UM live relatively close by and could indeed walk or cycle – the potential was there.'

The foundation of Active Travel's work is research, and collecting information from Malta's concrete jungle requires an active approach. A recent Active Travel workshop involved walking or cycling along routes around the university while taking pictures. These photographs would give any Maltese wanderer some unpleasant *deja vu*. The commuters teeter over loose cinder blocks, walk tightrope-thin paths alongside traffic, and find their routes obstructed by rubbish and disappearing pavements. Oddly enough, there has been a recent push to criminalise jaywalking. If walking on the road became illegal, pedestrians might find themselves forced to break the law.

Finding safe routes for commuters is paramount and requires innovation. 'We have a Ph.D. researcher at the Institute for Climate Change and Sustainable Development,

Carlos Cañas,' explains Mizzi, 'He is creating a walkability index around the university that uses "totems" to indicate routes and distances. We are about to extend this network to another region of Malta.' Active Travel has integrated walking groups with this network, targeting people from walkable areas. The groups' safety is improved by the predetermined routes, and they, in turn, provide a valuable data source for the walkability index. For example, the groups take part in activities that challenge suggested walking times. Group workshops also provide an opportunity to invite local councillors to take part so they can experience Malta's infrastructure problems first hand.

ACTIVE INCENTIVES

Encouraging healthier modes of transport is complex. 'Staff have a sum to spend on allocated materials every year. We have been able to have bicycles and cycling equipment included in that list of materials,' says Mizzi. He goes on to explain: 'we also organise campaigns to bring cyclists together every year.' Providing free breakfasts for cyclists, for example, serves as an incentive but also serves to bring people together. This helps nurture a growing cycling community and helps cyclists share route ideas and issues with each other. Many of the concerns on campus have been solved with improvements to infrastructure. Campus showers and security measures like CCTV-monitored bike racks are simple ways to get people on their bikes. The emphasis is on growing a culture of active travel, described by Mizzi as 'ingraining a cycling culture, creating this network, and then keeping it alive.'




As the results of Active Travel show, patterns of behaviour change far quicker if the right infrastructure is provided

Prof. Maria Attard (left) and Raphael Mizzi (right)
Photo by Sarah Zammit

DRIVING CHANGE

Active Travel acts on the principle of ‘being the change you want to see in the world’. If a culture of healthier, greener travel takes root at UM, it could positively influence the rest of the country. Mizzi believes Malta’s modest size makes this feasible. As for UM itself, he describes Active Travel as still being in ‘an initial phase of changing people’s mindsets’. But visible change has occurred in recent years. ‘There are more bikes on the racks, more people walking. Even five years ago, you wouldn’t see carpooling or electric scooters. Things are improving. People are more concerned about the planet, and they want to be healthier. I think we have a positive future.’

But while the long-term goal of a healthier Malta seems tantalisingly realistic, the global crisis of climate change demands faster solutions. Implementing those solutions requires more administrative power beyond that of a university. As the results of Active Travel show, patterns of behaviour change far quicker if the right infrastructure is provided. Malta’s government needs to seriously invest in green, active travel solutions.

As a country, ‘we lack in understanding, appreciation, design, and provision... all aspects necessary for the improvements in active travel infrastructure’, states Attard. ‘We build infrastructure primarily for cars, and active travellers are generally a second or a last-minute consideration. Time and again, people tell us they would love to walk or cycle but are too afraid. So we know that safe, well-designed, and attractive active travel infrastructure would be of great benefit to our villages and towns, our contribution to climate targets, and overall to our health. If you build it, they will come. That’s how it works.’ 

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We chose to go to space – Maleth Program

Author: **Ahmed Taha**

*We've all gazed into the inky night sky and wondered, but for **Prof. Joseph Borg**, wondering wasn't enough – he wanted to launch Maltese science into space. **THINK's Ahmed Taha** gets in touch to find out more about the brave project!*

Darkness covered the scene, and silence was the only dominant voice at Launch Pad-39A at Florida's Kennedy Space Center. Everyone was anticipating the faint voice starting the countdown. A massive combustion broke the silence as SpaceX's Falcon 9 rocket launched in the background, delivering over 2,000 kilos of cargo to the International Space Station (ISS).

This scene might sound like a standard delivery to the ISS, but among this cargo was something special to Malta. Biomedical Laboratory Scientist and Professor Joseph Borg (Faculty of Health Sciences, University of Malta) is the leader of Project Maleth and the SpaceOMIX team, which has ushered in Malta's first space bioscience experiment. He explains why this moment was exceptional for Malta's scientific research.

THE ROAD TO OUTER SPACE

Project Maleth is Malta's first scientific program to be sent to the ISS. The project aims to kickstart a new era of space diplomacy for experimental biology, which could have a significant impact on the medical field.

'I am a member of an analysis working group at NASA's Gene Lab; they handle data, information from astronauts, and various animal models sent to space and back,' explains Borg. Borg is also a member of the European Space Agency's (ESA) space omics team. Omics is a discipline that covers all things related to genetics, genomics, proteomics, metabolomics, and others, as well as experiments carried out under microgravity or in space. Being part of these projects has certainly helped inspire Project Maleth. Borg goes on to say, 'the fact that I was privy to experiments conducted by these types of people, these types of projects, it was natural to think of something along the same lines. Instead of using someone else's data to analyse in space, we chose to send a project which is ours.'

The mission that Borg had in mind was a collection of bacteria, called a microbiome. This particular microbiome comes from human skin samples (specifically wound ulcers) from diabetic patients. The bacteria was packed in a biocube and launched into outer space, but not before the biocube underwent gravity, stress, and vibration testing! The cube was then launched, handled, and installed at the Space Station Laboratory



Top: The Project Maleth biocube
Photo by Jason Borg

Bottom: Contents of the biocube
Photo by Space Applications Services, Brussels, Belgium

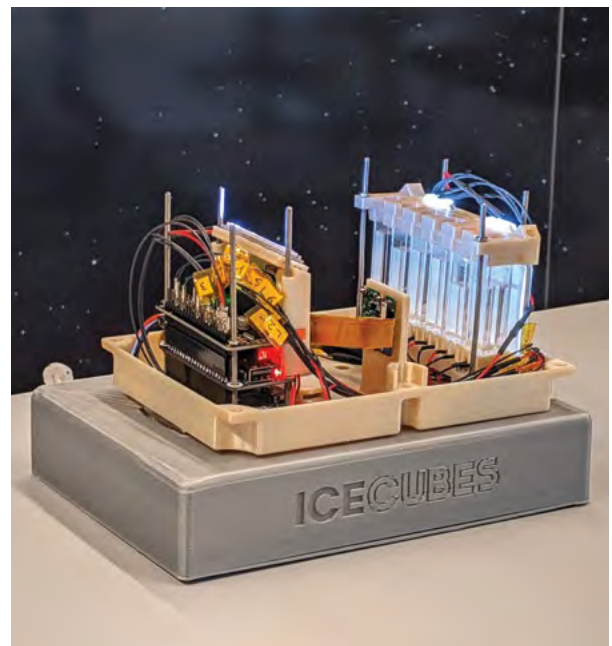
by Expedition 65 European Space Agency astronaut Thomas Pesquet. Meanwhile, in Malta, the mission control centre had direct communication with the cube 24/7.

INSIDE THE CUBE

Sending something into space is always exciting, but why send human bacteria? 'We usually have a lot of bacteria on our skin, which for the most part, is not a problem. But if the skin breaks, such as through a wound, then that can become infected. Diabetic patients in particular have a huge problem with this,' Borg explains. 'Most of these bacteria are very hard to handle or treat. Some are receptive to antibiotics, but others aren't. This got us thinking about what would happen if we exposed these bacteria to the harsh environment of space, high solar radiation, and microgravity.'

The cube itself has a power socket, two cameras to monitor the samples from Earth, and various LED lights and other sensors. After installing the experiment inside the ICEcubes' platform in the Columbus Module of the ISS hosted by Space Applications Services, it remained untouched. The cube worked autonomously, controlled remotely from Malta until the astronaut disassembled and packaged the cube to be sent back to Earth.

The biocube is now back on Earth after 50 days at the ISS. The Maltese team is conducting genetic analysis and comparing the space samples to the control samples ▶





Project Maleth launch site at Florida's Kennedy Space Center
Photo by Michael Seeley



Prof. Joseph Borg
Photo by Jason Borg

that remained on Earth. 'We hope to discover how these bacteria adapt, behave, grow more or grow less, maybe die off. We want to see the genetics behind it, what makes them thrive better, or what kills them faster,' says Borg. The results could have a huge impact for molecular therapy and precision-based medicine to help treat these kinds of ulcers.


Another part of the cube contained a slot for an SD card. Before the launch, during a 'Meet the Scientist' event, a campaign was announced asking children to send their digitised experiments, ideas, wishes, messages, or artwork. These tokens accompanied the experiment to space which, pardon the pun, left the kids starstruck!

CHALLENGES ALONG THE WAY

Borg and his team faced many challenges. They needed to figure out how to access the samples and prepare the cube for space flight. Yet their biggest challenge was balancing design and efficiency.

'Until we nailed the perfect combination, we had a couple of – not failures – but comments coming back from the NASA toxicology lab,' says Borg. 'Questions like, what is the buffer, what are the samples, or what type of organisms are you expecting to see? This was a challenge because it was the first time we had to defend or explain the project in greater detail, but it was fun!'

One heartstopping moment did occur after the cube was launched. At one point, the signal was lost as the ISS was unreachable. 'We couldn't connect or access the cube. It was really a moment of anxiety,' he explains with a giggle.

SpaceOMIX was Malta's first, bold step towards the final frontier. But where next for the Maleth Program? The Moon or perhaps even Mars? Borg remains hopeful, 'We are trying to find a way to hitch a ride with lunar rovers. Instead of having a payload onboard the ISS, we plan on having miniaturised scientific payloads onboard the rover that will be roaming the moon. We have one in design at the moment, and this is the next stepping stone, once it works. We have Maleth II coming up in May 2022, taking a follow-up experiment to the ISS, and a few other surprises along the way. This will of course precede any missions that we plan for the Moon and Mars, the latter planet alone needing about six to eight months for delivery on its surface. But we are very hopeful!' While most of us will never venture into outer space, it is comforting to know that some of the answers to our health problems may be out there, just beyond the stars. It's up to endeavours like Project Maleth to bring them back for everyone. 



Concrete solutions towards sustainable construction

Double C-Block
Image courtesy of Luca Caruso

Author: **Martina Borg**

Concrete forms the foundation of the construction industry, but to better our quality of life, we need to revisit our relationship with the built environment. How can we improve energy efficiency and, by extension, our way of life?

The Maltese Islands often feel like one huge construction site. The financial importance of the sector is massive. According to a study conducted by the NSO (National Statistics Office), the construction industry contributed over €545 million in 2020 to the local economy. To phrase it another way, construction is the only sector that grew in 2020 when compared to 2019, as it was the only sector that did not completely halt operations.

Urbanisation, one of the biggest causes of this phenomenon, is not expected to abate any time soon. By 2050, urban populations are estimated to double. But a quick glance at international headlines will reveal that the construction industry is facing some unprecedented challenges. As the world grapples with the implications of such issues as energy and water efficiency, waste reduction, and the need for implementing circular economy principles, research into more sustainable and greener construction practices seems like a no-brainer.

THINKING OUTSIDE THE BOX

Two researchers tackling these challenges in construction are the University of Malta's (UM) Prof. Vincent Buhagiar (Department of Environmental Design, Faculty for the Built Environment, UM) and Research Support Officer Architect Perit Luca Caruso (Department of Environmental Design, Faculty for the Built Environment, UM). Talking to THINK, Caruso explains that he has always been interested in sustainability within construction and he views it as his chance to give something back to the local community.

Buhagiar and Caruso have been working on a new type of concrete block, which they called the 'Double C-Block' (DCB), named after its geometry. Its special feature is that it maximises the path of heat transfer between its inner and outer skins, which minimises energy losses and makes it more efficient. The innovative idea has already garnered the support and funding from the UM and the Malta Council for Science and Technology. ▶



As part of their experiment, the team constructed two concrete cells to determine the effectiveness of the Double C-Block. Images 3 and 4 show a test cell constructed of traditional Hollow Concrete Blocks,

while image 5 (opposite) shows an identical cell built with a Double C-Block. The ground and roof slabs were insulated with a 10 cm insulation board (top left) to ensure that most of the heat

‘The use of modern concrete in construction has grown exponentially since its invention in the 19th century, and it is here to stay, thanks to the material’s efficient and cheap qualities, as well as the speed of its creation’, explains Caruso. ‘However, as we become a more environmentally conscious society, we have come to realise that concrete comes with a few shortcomings in terms of its heat retention and acoustic qualities.’

Caruso goes on to explain that the most commonly used hollow concrete blocks (HCB), which have a standard, rectangular figure-eight shape, actually lose heat rapidly in winter and struggle to retain air-conditioned air inside buildings in summer. This is ultimately costly for inhabitants. He also explains that research into acoustic transmission suggests that the direct-bridged hollow shape also means that sound is often transmitted easily between party walls and inside buildings.

Cladding boards can be added to buildings to insulate them reducing these problems. Cladding can be internal or external, both are problematic. External cladding can

cause problems if it takes place near the land boundary with other plots, whereas internal cladding eats into indoor floor space, which is never a welcome prospect for home buyers.

Caruso explains that, ‘the idea behind this new concrete block was to create a composite material that would maintain the structural integrity of concrete without compromising on so-called “U-values” or the heat-transfer value.’ U-Values measure the rate of heat transfer through a layered building material – the lower, the better. In other words, they measure how well the material insulates the house in summer and winter.

The new block addresses many of these issues. The new blocks are also more slender; standard load-bearing HCB blocks are mass produced at 230mm width, but the DCB is 200mm thick, which saves space without compromising its compressive strength. In addition, these researchers discovered that filling the Double C-Block with polyurethane insulation foam both acts as an adhesive that strengthens the concrete, keeping it from crumbling into pieces, and

improves its heat-retention qualities. Research already indicates that thermal conductivity improvements also improve acoustic isolation.

TESTING THE THEORY

As part of an earlier M.Sc. research project by Luke Micallef, a prototype was developed and tested for thermal and acoustic properties as well as strength and resistance under laboratory conditions. Caruso enthused that the results of these tests were very promising, leading to the next phase of testing – seeing how the DCB performs in real-world environmental conditions.

‘We have now joined forces with local HCB manufacturer Cementstone Manufacturing Company Limited to build two 20m² test cells. One was built using regular hollow concrete blocks and the other built in the new Double C-Blocks.’

According to Caruso, these rooms will be monitored over a twelve month period to determine their performance across the four seasons; the plan is to see the feasibility of the materials used and the DCB. Dr Simon P. Borg, Head of the Department of Environmental



Our goal is to facilitate the exchange of knowledge between researchers and industry specialists and in so doing, find solutions that make environmentally conscious decisions more affordable.

is lost through the walls. This allows the team to calculate how effective the Double C-Block is at insulating. Using materials with low thermal conductivity reduces the speed at which heat is lost. They also prevent thermal

bridges, a phenomenon experienced when materials of different thermal conductivity are adjacent to one another. *Images courtesy of Luca Caruso*

Design is co-supervising the on-site monitoring phase.


INDUSTRIAL IMPLICATIONS

The biggest obstacle the researchers face is the efficiency of producing these blocks. Currently, this is done manually, cutting the blocks by mechanical hand tools and patiently infiling the foam individually. Going from experimental to a more commercial interest would mean the creation of special moulds for the DCB, with other complementary machinery to facilitate the dry-casting and foam injection process. Production time is key to commercialisation, which would see the block's benefit spread through the construction industry leading to better buildings for people.

'We sincerely hope that this research will lead to a commercial product, possibly through a university start-up company. We also intend to continue analysing potential improvements to the DCB materials used, enhancing their properties, as well as investigating their potential for recycling. I hope that we will create a novel concrete block that at its end of service life, could be either reused (the best option) or recycled –

by way of its biodegradable insulation and concrete, that can be re-engineered into new blocks for instance,' Caruso says with infectious enthusiasm.

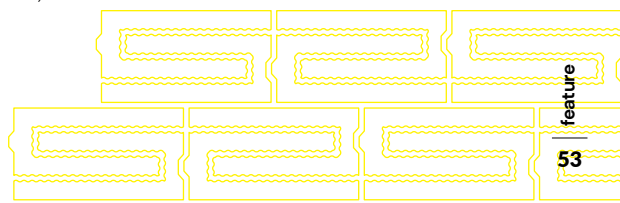
'Our goal is to facilitate the exchange of knowledge between researchers and industry specialists and in so doing, find solutions that make environmentally conscious decisions more affordable.' Indeed, the team has an ongoing collaboration with the Department of Industrial Engineering under the supervision of Dr Arif Rochman, who is an expert in polymer testing. His assistance can help derive the ideal insulation design mix for a novel biodegradable foam that replaces the oil-based polyurethane.

Caruso goes on to explain how the idea for the blocks was a result of extensive brainstorming, creative thinking, and multiple attempts. 'Like Edison and his light-bulb,' he laughs, through trial and error, ultimately, persistence got him there. 'For us, it has taken several years to get to this point, but we can only hope that if we persist, such an energy efficient innovative block could gain ground with just as much popularity.' 

Project R&I 2019 010T Double C-Block is financed by the Malta Council for Science & Technology, for and on behalf of the Foundation for Science and Technology, through the FUSION: R&I Technology Development Programme'. More info at this link: <http://mcst.gov.mt/funded-projects-2017-till-date/>

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Power to the People

Author: Sam Shingles

*Building a nuclear fusion reactor is an extremely stressful process – especially for stress analysts! **Sam Shingles** from **THINK** gets in touch with **Prof. Ing. Pierluigi Mollicone** and **Prof. Martin Muscat**, who are working together as part of a European Consortium to bring fusion nuclear power to Europe.*

The climate crisis is currently one of the biggest challenges faced by modern society. Shifting the world away from coal and fossil fuels to cleaner alternatives is essential. In our first article, 'Europe's Fusion Future', THINK spoke to Prof. Ing. Pierluigi Mollicone and Prof. Martin Muscat (Department of Mechanical Engineering, University of Malta [UM]), to learn how nuclear fusion energy might be the answer and about their involvement in the EUROfusion consortium – a Europe-wide consortium tasked with making nuclear fusion a feasible energy source.

ENGINEERING FOR A FUSION FUTURE

One of the key challenges currently facing scientists and engineers like Mollicone and Muscat, working within the EUROfusion consortium, is trying to recreate the environment of the Sun here on Earth to help facilitate fusion reactions. The gravitational pull of the Sun is 'around 28 times that of Earth', they explain. This gravitational pull contains the hydrogen in the core of the star. That hydrogen turns into plasma, the fourth state of matter, when heated to 15 million degrees Celsius.

Plasma is a key component of the fusion process. Essentially plasma is an extremely hot gas, and as a result, the atoms that make it up split into electrons

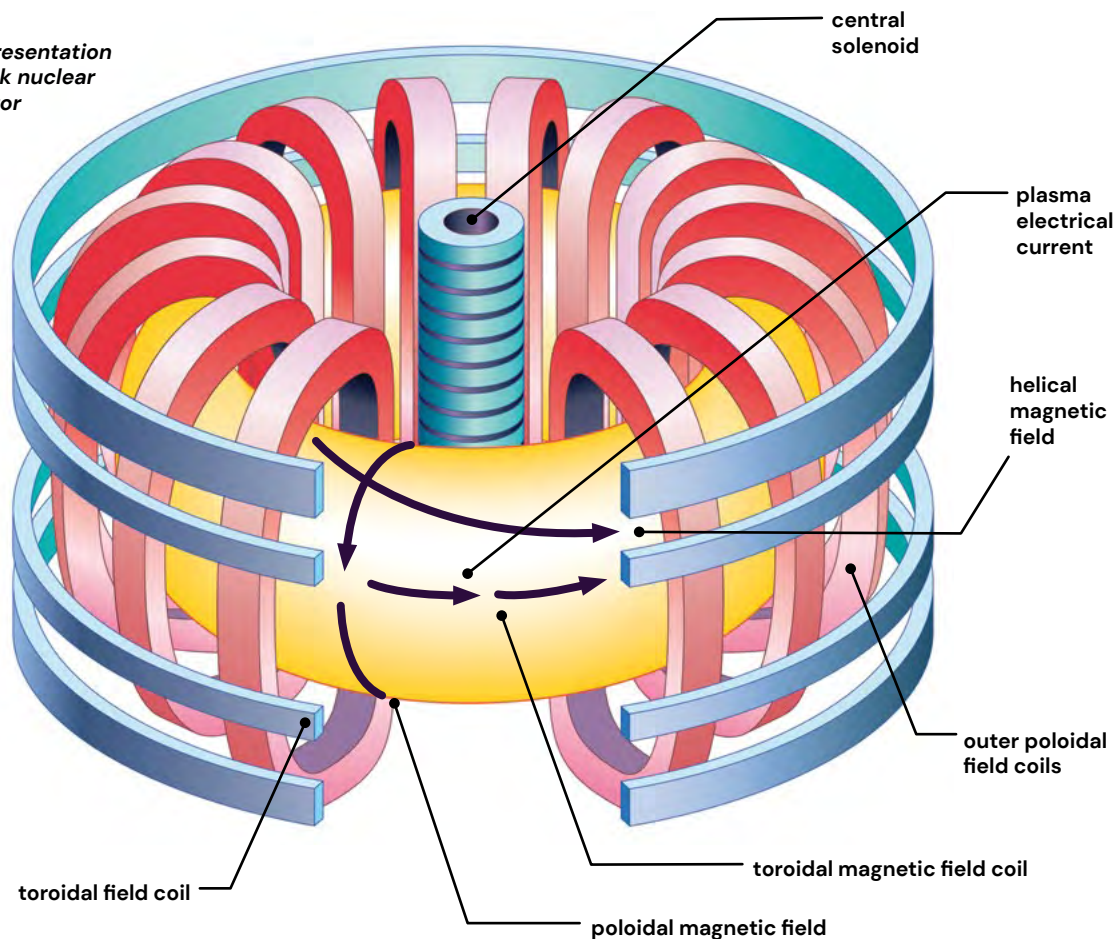
and ions, which can move independently of each other. Due to being electrically charged particles, plasma can be manipulated using electromagnetic fields and forces through high-powered magnets.

Jumping back to fusion, the Sun's gravitational force confines the positive hydrogen nuclei, and the high temperatures cause those nuclei to collide at powerful speeds, fusing them into a helium atom.

Here on Earth, we don't have the advantage of a huge gravitational force to contain the hydrogen atoms. To be able to achieve a fusion reaction, gases must be heated to temperatures of about 150 million degrees Celsius, around 10 times the temperature of the sun's core. Containing

...the Sun's gravitational force confines the positive hydrogen nuclei, and the high temperatures cause those nuclei to collide at powerful speeds, fusing them into a helium atom.

A basic representation of a Tokamak nuclear fusion reactor



plasma at these temperatures cannot be achieved using conventional materials, so one way of doing this is by using electromagnetism. Using strong magnetic fields to create what is in effect a 'cage' prevents the particles from escaping. As Mollicone explains, at the moment 'the best structure for this is known as a Tokamak, which is a donut kind of structure; however, the cross section is not circular but more of a D shape.' This magnetic containment enables the particles to remain in place, allowing the fusion reactions to occur gradually and generate energy.


Designing reactor components for these extreme and unusual conditions is not easy. This is where Mollicone and Muscat come in as stress analysts, studying components to prove each part is fit for purpose.

Isn't all this designing and testing components exactly what engineers do? As Mollicone explains, 'yes, it is standard engineering'; however, it is applied to 'something completely new' on a piece of equipment that 'has never been built before', where Muscat and himself are using the current nuclear code of standards to design components that can withstand extreme conditions. Mollicone uses the fathers of flight as an analogy: 'The Wright brothers proved the concept of flying; however, to go from their first design, which only travelled a short distance, to the planes of today travelling across the globe,

it doesn't happen overnight.' The physics of both designs is the same, but to achieve them 'you need this type of engineering research, and that's what we are doing here'.

THE ENERGY DREAM

Fusion could provide a major part of the world's energy. The source is clean, could be stable, and can complement renewables to help achieve global net-zero emissions. However, there is still a long way to go before the amount of energy produced is more than that used to keep the plasma going. Despite the long timeframes, this research is already reaping benefits.

Muscat and Mollicone are 'generating knowledge on designing components for the reactor' so that future engineers can design better reactors. They are also helping nurture better students. 'When the students see us working on such a huge European and international project, they become inspired to try to do something with the knowledge that they gain from their course,' says Muscat. Students would be able to see what they are learning in an industrial and research context. Mollicone reiterates that 'it's important to have these applications for young people to see that what they study leads them somewhere.' In turn, this allows UM to have more students and encourage engagement through to postgraduate level studies. As 



Prof. Ing. Pieluigi Mollicone



Prof. Martin Muscat



QUICK-FIRE FUSION RECAP

Nuclear fusion involves combining two lighter atoms together to generate energy, the same mechanism that occurs in our Sun. In the Sun, due to the extreme temperatures, hydrogen atoms travel at rapid speeds, collide with others, and fuse together producing a helium atom. The fuels currently used for fusion reactions on Earth are two isotopes of hydrogen: deuterium and tritium. Make sure to have a read of our first article to learn more about fusion and where it fits in the spectrum of other energy sources.

EUROfusion, also referred to as the European Consortium for the Development of Fusion Energy, supports and funds fusion research activities on behalf of the European Commission's Euratom programme. Through Mollicone and Muscat, UM is now a part of this vast consortium of around 150 affiliated entities from 25 European member states.

Initially, Muscat and Mollicone were afraid that they would not be given any work, but the great news is they have received even 'more than they asked for', with Muscat attributing this to their competence in engineering stress analysis. As a matter of fact, there seems to be a lack of stress analysts within the EUROfusion consortium. Mollicone adds that being a part of the consortium also ensures they 'fulfil the role of the university' and not just teach, but show students that their course material does have real-world challenges they can contribute towards.

Mollicone finishes, 'more opportunities within the country, no matter how small, are still important for us,' and the links to other countries can only mean positive things for Malta.

A BRIGHT FUTURE

As Muscat indicates, this is only the very beginning: 'barely six months into a five-year project!' In the long term, ITER, the world's next nuclear fusion research facility, is currently being built and due to be commissioned around 2025, while DEMO, which is planned to demonstrate net energy power output, is planned to start operating around 2050. Europe is planning to have viable fusion energy by then. EUROfusion is a step towards this dream and a new dawn of opportunities for the Maltese Islands to be a part of a zero-carbon future, helping the world achieve a cleaner and less polluting energy future. **T**

The EUROfusion consortium is a project in collaboration with the Malta Council for Science and Technology via the ENDURE programme, helping to design components for a fusion reactor that aims to produce more energy than it requires to run.

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Transhumanism: A Dangerous Two-Way Street

Author: **Christian Keszthelyi**

*What is the next evolutionary step for humanity? One possibility is the merging of man and machine. But is humanity ready for transhumanism, and how should we prepare for it? **Christian Keszthelyi** finds out!*

Imagine being able to view and send emails without using your laptop or being able to browse the web without your phone. Tech devices that are controlled using brain signals are in development, blurring the line between humans and cyborgs and bringing us closer to a transhumanist future. But what are the risks of such technologies? Can they be hacked, phished, or compromised like our current devices?

THINK talks to artificial intelligence Prof. Alexiei Dingli (Faculty of Information and Communication Technology, University of Malta [UM]), Prof. Ing. Kenneth P. Camilleri, and senior lecturer Dr Tracey Camilleri (both from Faculty of Engineering, UM) to understand how humans grapple with attaching machinery to flesh and bone.

HISTORY OF TRANSHUMANISM

'*Lasciate ogne speranza, voi ch'intrate*', frequently translated as 'Abandon all hope, ye who enter here,' is the famous line from Italian writer Dante Alighieri's *Divine Comedy*. The text is inscribed on the gates of Hell as Dante passes through them. In this 14th-century epic poem, Dante coins the word 'transhumanism' to capture his realisation of divine life in paradise. Research today still tries to outline what transhumanism may have meant for Dante. For Heather Webb from the University of Cambridge, the poet may have meant it as the state when an individual, after death, fully integrates into a 'co-presence with other individuals in a network of relations based on mutual recognition and interpersonal attention.' ➔



Prof. Alexiei Dingli
Photo by James Moffett

Some two centuries later, French philosopher René Descartes published *Discourse on Method* (1637) which is still viewed today as one of the early precursors to transhumanist ideas, in which the Frenchman envisions a new type of medicine that would allow humans physical immortality and stronger minds. His pondering hits home with an eerie accuracy in the modern world.

Today, the word's meaning has changed, and some intriguing progress in transhumanism has been made. Elon Musk's Neuralink, a brain-computer interface business, has recently released a video that claims to portray a monkey named Pager playing the video game *Pong* with their thoughts. Pager's brain signals were sent wirelessly to a computer through an implanted device. Pager learned to play *Pong* with a joystick first by being rewarded with a fruit smoothie.

Our brains might soon be able to communicate with computers, and computers might be able to communicate directly with us. The underlying technology is being researched and developed. At the University of Tübingen, neuroscientists invented a method to alter the human brain's activity during transcranial magnetic stimulation (TMS), by simply 'holding a wire coil over the head, resulting in movement of the arms or legs'.

But back to Pager, once their *Pong* mastery reached acceptable levels, the joystick was disconnected. Pager controlled *Pong* with mind signals alone. Neuralink's aim is to bring the technology to a stage where people with neurological conditions would be able to communicate with devices remotely, gaining virtual mobility.

BRAINAPP

The UM is running similar projects with humans. BrainApp exploits non-invasive Brain-Computer Interface (BCI) technology to use brain signals to control motorised beds, opening up accessibility to individuals suffering from motor disabilities.

'We use one particular phenomenon related to BCI, which is based on the flickering of visual stimuli. By attending to

a visual stimulus, a brain signal uniquely related to each visual stimulus is evoked, which is recorded and then identified through signal processing algorithms (a powerful set of computer instructions that are able to learn, reason, and react). Each stimulus, and the corresponding brain signal, is associated with a control function; in our case, to the movement of a motorised bed,' Dr Tracey Camilleri tells THINK.

'Although we are reading signals from the brain, we are not reading thoughts,' Prof. Ing. Kenneth Camilleri clarifies. BrainApp uses the evoked brain signals in the context of brain-computer interfaces, which means that the recorded brain signals are interpreted according to a previously-agreed token. Therefore, each recorded brain signal triggers specific instructions programmed into the computer, such as moving a bed up or down.

In the case of operating more intricate machinery, such as a bionic hand for example, the process is different, Prof. Ing. Camilleri says. 'If I were to move my hand, I have to think about moving it. An EEG (electroencephalogram) cap, for example, will record brain activity as this happens. What is interesting is that when I actually move my hand and when I just *think* about moving my hand, similar brain signals are produced in the brain. It means that by merely thinking about hand movements, a bionic hand could be made to start moving,' he explains.

I, ROBOT

Research suggests that humanity is close to sci-fiesque machine-to-human enhancement. 'I think we are not very far away from such advancement. Today we are already creating smart prosthetic devices for limb replacement,' Prof. Alexiei Dingli tells THINK.

To transfer will from the human mind to inanimate technology, brain signals need to be captured, interpreted, and communicated to a device. While this can be done by physical brain implants, the use of non-invasive technologies is on the rise, creating cautious optimism. A simple headband is able to capture and transfer brain signals to control devices. Today, to a limited extent, the technology is already working.

Currently the biggest research efforts are to improve our brain control devices: one-way communication. As the technology develops, we may come to a stage where communication becomes a two-way street.

Research has recently been enthusiastic about TMS as a technology that does not require any implants. 'In TMS, a magnetic field is applied to certain locations in the brain to, for instance, suppress certain brain activities. As this is done through magnetic fields, TMS does not require any implants. I do think that in some years, it would be possible to specifically write into the brain. This is a point where there could be huge ethical issues,' Prof. Ing. Camilleri says.

Currently the biggest research efforts are to improve our brain control devices: one-way communication. As the technology develops, we may come to a stage where communication becomes a two-way street.

If two-way communication becomes ubiquitous and humans carry devices that are able to facilitate such an exchange, service providers and legislators must ensure that software uses unbeatable encryption. No user should ever have to fear being unconsciously manipulated by third parties; the technological and judicial safety nets must be in place before the rollout of such technology. That is the only way such advancements should be introduced to mass usage.

'This is something that really worries me. What happens if we can implant false memories, ideas, or ideologies? But, let us explore a brighter area of consideration: education. What if we could implant knowledge in people's minds? Instead of children having to go to school, they would upload (or download) data in their brains, leaving them with precious time to run other errands or play. The most precious skill is not possessing the information but processing it. Information is already available thanks to technology and the online world,' Dingli says.


The premise Dingli raises is a genuinely interesting one. If humans had the possibility to download lexical and theoretical knowledge, a lot of time could be spared. That time would be available for learning creative or critical thinking skills and putting theory into practice. It would result in an exponential growth in professional expertise. Furthermore, fine-tuning or updating that

knowledge would also happen in an instant (think about the ever-changing legislative environment, for instance) which would result in fewer professional mistakes.

THE ROAD AHEAD

As technology advances, controlling devices external to the human body will become more integrated and simpler to use. As soon as the technology becomes available to consumers, legislators will need to quickly adapt the legal environment to control previously impossible events. But how fast can the legislative environment respond to technological changes?

'From experience, technology moves forward, and legislators try to catch up at a later stage. Think about where we are at with social media. Nobody would have ever thought that social media could have had such an impact on such a varied spectrum of our lives. I think technologies that involve brain signal communication can be dangerous if left unchecked,' Dingli adds.

While science fiction movies and cyberpunk communities are often dystopian (and sensationally focus on the harmful aspects of human-machine marriage), technology has great potential to support our species. As tech advances, humans must be mindful of the penned legislation to prevent ethical conundrums and be prepared to guard the sanctity of their minds. 

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start up



A greener future from smarter traffic

Author: **Zippy Tseng**

*Traffic! How does one even approach the problem of limited road space? For one start-up, the answer lies in the way we use roads and the data behind it. **Zippy Tseng** from **THINK** gets in touch with **Claire Cianco** from Greenroads to find out more!*

When stuck in traffic, you can't help thinking about improving the design of roads. The good news is that you are not the only one! Greenroads, located at the TAKEOFF Incubator at University of Malta, with the support of Infrastructure Malta, is working on a way to provide arithmetic data that can help improve Malta's roads.

Seeing the traffic problem in Malta, Claire Cianco, CEO of Greenroads, embarked on a mission to help curb the problem. She combines citizens' experiences in Malta and the objectives of the EU Green Deal (issued in 2019, the deal states EU states are to become climate neutral by 2050) to create sustainable mobility solutions.


GREENROADS TO SUSTAINABLE MOBILITY

If we want to give the next generation a greener future, we need to become environmentally sustainable. Sustainable mobility, which highlights the reduction in emissions from transportation, is one of the policy areas under the EU Green Deal. To achieve this goal, research on smart traffic management systems is being conducted. Greenroads is one of the teams dedicated to developing these innovations.

By means of artificial intelligence (AI), Greenroads uses real-world data and delivers information on how different road users behave on existing infrastructure via a dashboard. This information empowers authorities and decision makers to introduce data-driven solutions for road planning. Greenroads captures and analyses traffic data, such as how many cars use a particular road and at what time. This data can then be used to manage public spaces, build roads, and plan smarter transportation systems.

Greenroads not only counts the number of cars passing by; the team has also developed an AI model that can classify the types of vehicles, whether they are buses, private cars, commercial vehicles, motorbikes, bicycles, or even pedestrians. This allows for a more comprehensive idea of who uses the roads and how people access the streets.

SUCCESS EN ROUTE

Like many other entrepreneurs, Cianco faced many challenges when she started Greenroads. The ideas changed from when she started the business to today; having dealt with a lot of uncertainty, she was determined to transform the business. Cianco described the beginning of Greenroads as a 'good idea with no 

financial support.' They submitted numerous projects to seek funding opportunities before Greenroads was awarded Climate-KIC funding and then the MARVEL project (Multimodal Extreme Scale Data Analytics for Smart Cities Environments), within a large consortium, in 2020. The aim of Greenroads matches with the MARVEL project's objectives, which are 'to help decision makers improve the quality of life and services available to citizens, particularly regarding open spaces and the road network.'


While funding is an essential element for a startup company, in Cianco's mind, there is one thing more important than this: people. Seeking funding can be seen as building connections and relationships with others, as Cianco believes, 'getting funding is not just about money, but about making others believe in your ideas and the projects you have been working on.' It's the same mentality when recruiting new talent; you need to find someone suitable for the position, and this person has to believe in the project you will be working on together in the future. For example, when starting off, Greenroads needed expertise in AI and machine learning. These are not Cianco's areas of study, so she teamed up with Adrian Muscat and Johan Zammit, Kenneth Scerri for his expertise in the transport industry, and Louis Borg and Andre Xeureb for innovation. 'If you want your startup business to grow, you have to find people better than you and not be afraid of other people being better than you,' said Cianco when she talked about how the Greenroads' team formed.

Speaking of building teams, Cianco highlighted the importance of having access to talent pools for a business. Being based at TAKEOFF within the University of Malta gave Greenroads the advantage of working with the Knowledge Transfer Office and tapping into researchers in the area, who help develop new projects.

EMBARK ON THE STARTUP JOURNEY

'A start-up is not a part-time gig,' Cianco said when she thought back on the journey she has been through. She suggested that aspiring entrepreneurs should invest in their lives first and have a comprehensive financial plan before jumping into the startup industry. After all, it will be hard for people to chase their dreams without having a roof above their heads. Planning ahead is important, but life is unpredictable, and things can change in just one second, especially in the startup world. 'Young entrepreneurs should be able to accept changes, be ready to adapt to different situations, and move forwards,' Cianco points out.

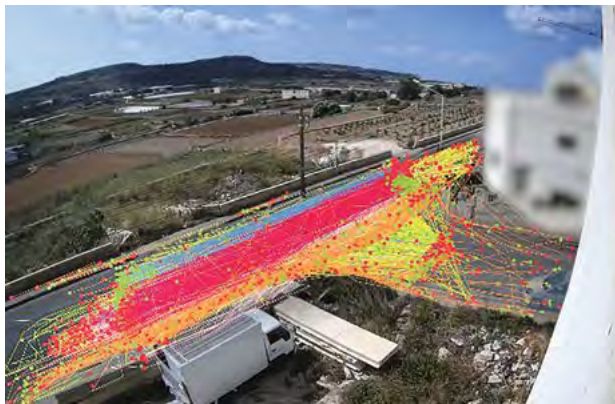
The most challenging thing about a start-up is to actually start it. For Cianco, there are three crucial steps: 'Think about it. Talk about it. Start developing it.' To think about it, you draw a big picture of the ideas you have in mind. To talk about it, you absorb suggestions and advice from others and adjust your ideas. Finally to start developing it, you begin with achievable things, work hard, and wait for the right timing and finances to come. Cianco said, 'the success of a startup business requires a lot of dreams and ideas, but you have to work persistently enough to make that dream come true.'

Greenroads has already accumulated experience through working on projects with partners in Malta. In the future, the team's vision is to go international. They wish to spread their services and solutions for sustainable mobility worldwide. Perhaps Greenroads can blaze a trail towards a greener future. 

Trajectories & Turning Ratios

📍 Żebbiegħ, Imġarr

📅 1-week period



- Entry Points
- Exit Points

- Cars 18,103
- Motorcycles 200
- Light Goods Vehicles 5,686
- Bicycles 31
- Heavy Goods Vehicles 218
- Pedestrians 430
- Buses 476

Images courtesy of Greenroads
These images have been stylised for editorial purposes



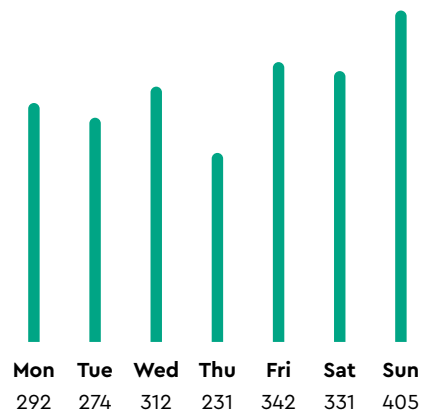
Peak Hour
12:00 – 13:00



Total Vehicles
405



Average Speed
42 km/h



Full heatmap available on **THINK** website

Flywheels – a ‘Goldilocks solution’ for aircraft emissions

Author: **Jonathan Firbank**

Passenger planes use thrust engines to ‘taxi’ on the ground from airport gate to the runway, which creates a large amount of emissions on the ground in a very short time. A collaboration between the University of Malta (UM) and the University of Nottingham Ningbo, China is working towards a solution to this problem. **Jonathan Firbank** explores the subject following an interview with **Dr Robert Camilleri**.

If you drive, you might have noticed that you burn more fuel when you are moving slowly. Urban driving, with all the traffic, red lights, and awkward corners does even more damage to your fuel than it does to your nerves. Your car’s engine is most efficient around 60mph, in its highest gear. As the gears go lower and the cars go slower, more fuel is wasted.

Now imagine that car was hundreds of times heavier. And imagine that its engines were designed to be efficient at 600mph instead of 60, powerful enough to catapult it through the air over vast distances. Then imagine how inefficient its fuel consumption would be if it was stuck in traffic, starting and stopping, trundling around at the frustrating speeds of urban driving. The amount of wasted fuel would be staggering, a financial and environmental disaster. This is the reality of an aircraft taxiing on the ground.

Transport is responsible for approximately 16% of greenhouse gas emissions, with aviation contributing about 2%. Though this portion is relatively small, in the last four decades, the industry has steadily grown at 5% per annum. A bright future for conventional aviation is no such thing for the environment unless new technologies can curb its impact on climate change.

The problem hasn’t gone unnoticed. For decades, research has been directed towards airplane fuel efficiency, with the industry leaning towards hydrogen power, hybrid engines, and increased electrification. Now, eyes move to the situation on the ground. An aircraft might only spend up to 10 minutes taxiing before a flight, but in that time, the engines (which are optimised for flight) can consume around 200kg of fuel. This problem is radically compounded in Europe.

Within the EU, the emergence of budget airlines like Ryanair and Easyjet operate aircraft for multiple short flights a day, vastly increasing the percentage of time moving on the ground (in comparison to transcontinental flights). The EU has legislated that aircraft taxiing must become emissions free by 2030. If this is achieved, it would clearly curb carbon emissions without limiting air travel in the region. But how it can be achieved has been decidedly less clear.

THE GOLDILOCKS DILEMMA

KERS-Air and REACTIVE, two international research projects, are trying to tackle this problem of ground aircraft pollution. The initiatives are headed by Dr Robert Camilleri (Institute of Aerospace Technologies, UM) and Prof. He Zang (University of Nottingham Ningbo, China). They are




research collaborations that also incorporate Medavia Ltd. (a Mediterranean aviation company) with the support of COMAC (a Chinese commercial aircraft corporation). As KERS-Air conducted preliminary research, it became clear that many solutions supporting zero-emission taxiing would generate new problems. Using an environmentally friendly tow truck to move planes would place a lot of new vehicles into an already busy space, creating a logistical nightmare as tow trucks were assigned to each aircraft. On the other hand, on-board solutions such as installing electrical motors at the aircraft's wheels needs a lot of electricity, which needs to come from the plane's Auxiliary Power Unit (APU), which was not designed for that. Upgrading the APU would be an expensive prospect and would add a large weight (which needs to be carried in flight) that would increase greenhouse gas emissions, offsetting the benefits on the ground. A workable proposal would need to weigh no more than the fuel currently used in taxiing.

KERS-Air proposed a more elegant solution. When a plane hits the runway, a vast amount of energy is expended, as the aircraft's brakes work to slow down an enormous weight travelling at high speed. If this energy was captured and stored temporarily, recycling it could provide a green form of propulsion. Similar ideas have been deployed in Formula 1 (F1). As F1 racers have become more electronic, they have incorporated systems that briefly recover and store energy as they brake around corners, then release it to reaccelerate. A less romantic example of the tech is found in the UK in 'soft hybrid' buses, which need to continually stop and start.

Simply upscaling existing technology is not an option. Storing the massive energy from a landing aircraft is not comparable and requires a novel energy storage solution.

While batteries can store a substantial amount of energy, they cannot store it fast enough without suffering degradation. Additionally, reliability and long service life are key in aviation, so batteries were not an option. Conversely, supercapacitors can store energy extremely quickly, but they cannot store enough (unless there were so many that their weight penalised flight). This created a 'Goldilocks dilemma'. KERS-Air needed tech that was 'just right', sitting squarely between batteries and supercapacitors in both power and energy density.

The answer was a flywheel energy storage device, which has never been developed for aircraft before. A flywheel acts like a mechanical battery. It can store energy quickly and can increase storage capacity by simply increasing the speed of its rotation. Flywheels have been around for a long time, made out of steel, and relatively slow; KERS-Air is developing a much needed upgrade with unique geometry from composite materials. In its third and final year, KERS-Air is currently investigating the energy transfer between various components and developing a proof of concept. Meanwhile, the follow-up project, REACTIVE, is developing a prototype of the novel flywheel. The University of Nottingham Ningbo is focusing on developing the system's motor, while UM is focused on the flywheel itself. The challenges for the former is that it requires a slow speed but a high torque, while the flywheel demands far less torque but extraordinary speeds of around 60,000rpm.

REACTIVE represents a collaboration between governments as well as academic bodies, with Malta and China providing matching funding to UM and Nottingham Ningbo. The project is also supported by the Commercial 

For a new, green technology to succeed, it doesn't just need to be economically viable, it needs to be economically preferable.



Dr Robert Camilleri
Photo by James Moffett

Aircraft Corporation of China. COMAC is a state-owned company poised to become a big player in aviation, as the Chinese Communist Party seeks to compete with Western companies currently dominating the space.

But for Camilleri, 'the international aspect of the project is what really makes it interesting to work on. It allows people with expertise in very specific fields to connect. This kind of collaboration is really where the thrill is.'

THE ECONOMICS OF CHANGE

Last year's Global Climate Change Conference was saturated with pro-fossil fuel lobbyists and produced little more than lip service. It vindicated cynics; the upper echelons of politics and industry aren't fans of climate change, but they prefer it to losing money. For a new, green technology to succeed, it doesn't just need to be economically viable, it needs to be economically preferable.

A key part of the research was a 'techno-economic analysis' investigating how the KERS system could benefit a company's bottom line. Camilleri acknowledges that long distance flights don't spend enough time taxiing to warrant the cost of upgrading. Instead, the tech should be targeted at airlines that use the same plane for multiple short flights every day, spending far longer on the ground. Budget airlines like Ryanair or Easyjet operate such business models. Their frequent use of the aircraft and large fleet make them major polluters in the EU. Their impact is as big as major European cities. Here, the KERS tech would have a much greater impact but would have to be fitted retroactively to existing aircraft. A passenger plane might have a service life of half a century; if green technology was only built into new aircraft, it would have little impact on climate change. As such, the KERS system is planned to be as independent as possible, totally separate from aircrafts' existing electrical system. This will facilitate retrofitting and reduce costs.

When it comes to budget airlines, money is paramount, meaning retrofitting aircraft with KERS technology would need to be affordable. It is estimated that the KERS upgrade could cost around €500,000 per aircraft, a cost that seems massive but that would be quickly recouped by fuel savings. The techno-economic analysis showed that the current taxiing process costs Ryanair around 75 million euro a year and Easyjet around 30 million euro a year, which should make KERS an extremely attractive investment. But especially during a global crisis, the radically short-term business strategies employed in budget aviation may not tolerate the up-front cost. Regulation is the answer to this problem.

'Legislation will become very important. In addition to the 2030 deadline for emissions-free taxiing, there are countries like France that are strong on regulating carbon emissions. They will implement penalties on older, polluting aircraft, creating an expense for airlines that want access to France. This will get the ball rolling for change,' explains Camilleri.

The 2030 deadline for emissions-free taxiing may result in airlines waiting till 2029 to make a change. But if just a few countries act early imposing bans, fines, or taxes, the budget airline business model would work against itself as the same planes are used for every route. Hopefully, airlines will see that green tech like the KERSair/REACTIVE flywheel is the cheaper option. After all, Goldilocks didn't only eat the bear's food because it was 'just right'. She ate it because it was free. **T**

KERS-air (R&I-2017-005-T) is financed by the Malta Council for Science & Technology, for and on behalf of the Foundation for Science and Technology, through the FUSION: R&I Technology Development Programme.

REACTIVE is funded by the Malta Council for Science and Technology through the Sino-Malta Fund 2020 (Science and Technology Cooperation).

HUNT

Written by

James Moffett

The thumping, scuttling sounds retreated to the back of the storage room on the upper floor. The man stirred in the darkness, listening to the last, faint steps echoing away before stretching his legs and easing the stiffness in his knees.

The edge of the wardrobe dug into his ribs, and the cold floor seeped into his weary bones. He broke the silence with a hushed gasp at the stabbing pain in his back — it had been years since he found himself crouched down on the floor for so long. He paused once more to listen, straining his ears for any sound from upstairs. The dimness in the bedroom began to lift, and his eyes wandered around the surroundings, before resting upon a framed photograph of himself and his wife. He smiled, his tense body relaxing for a brief instance.

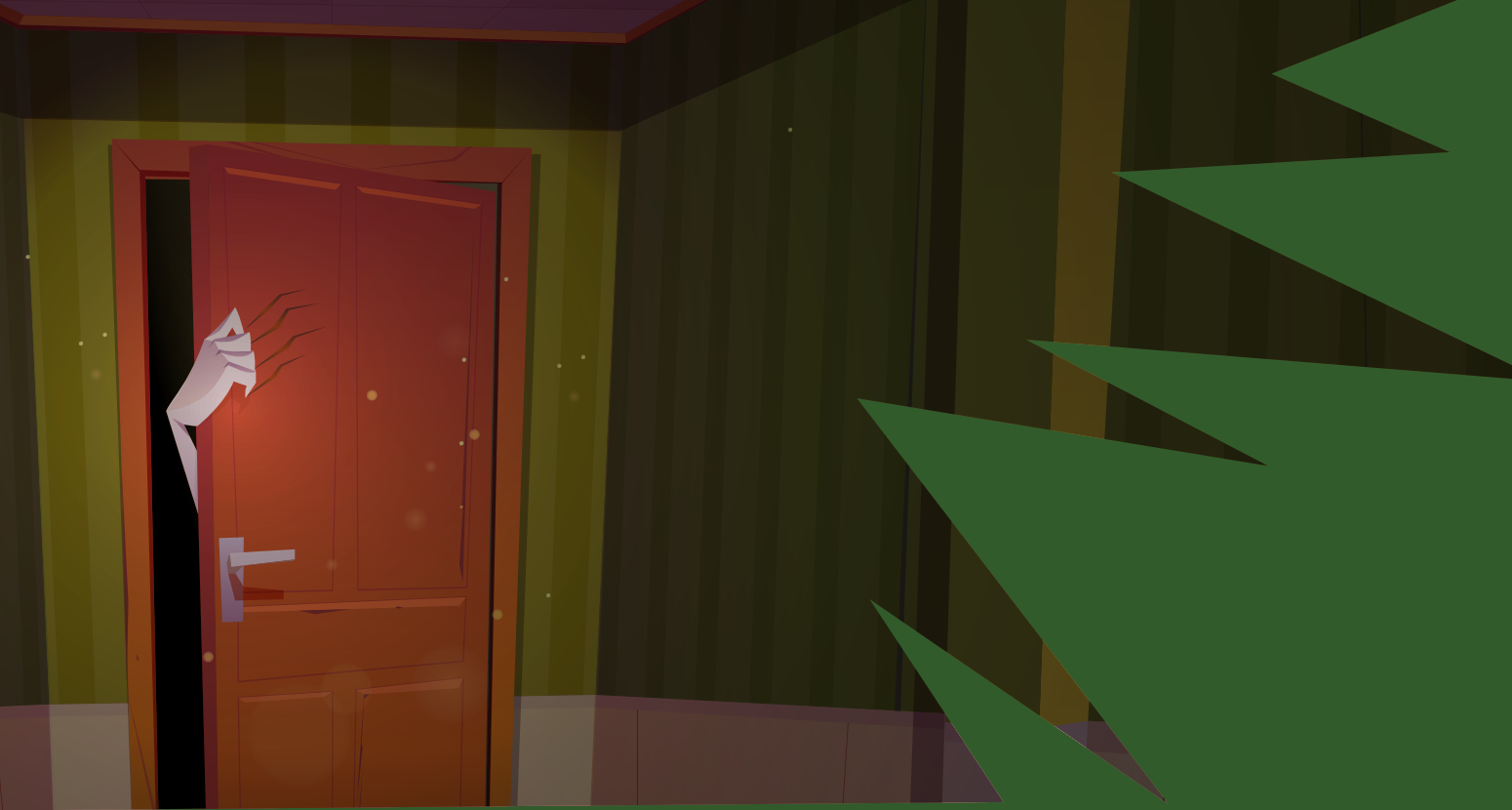
A door slammed with a crash, and the haunting pitter-patter of steps dashed to the other side of the house. He could hear and feel the slight quiver of the walls as each step landed on the floor just above him. He could make out the route his stalker took: out of the storage room, through the corridor, and into the library. The library. *Dorothy!* Peter shook away his thoughts and pushed past the pain. He crawled out of his hiding spot with caution and urgency — the image of his wife, hidden and alone, spurring him forward. As he emerged from behind the wardrobe, his foot caught the leg of the nightstand, toppling over a lamp as it fell to the ground with a loud crash. The footsteps came to an abrupt halt. A moment's hesitation followed. The stalker's attention had been distracted.

Peter froze. In a flash, he heard the footsteps race back out into the corridor, before tumbling down the stairs with a ferocious will, until a faint light came streaming in through the bedroom door. Peter crawled forward, squeezing himself

under the wooden frame of the bed. The effort proved too strenuous. His chest rose up and down, brushing against the floor. He felt trapped — stuck between the floor tiles and the bed slats digging deep into his back. The noise from outside the room rumbled on closer. A shadow flew across the door as the light dimmed momentarily. The stalker had made its way to the bedroom and now loomed in the silence — an ominous shape looking into the darkness before it. It paused there, considering, assessing, waiting. Peter's lungs struggled to inhale in such a tight space. He winced, trying to deaden the sounds of his breathing.

The presence stood there. He could hear its soft breath and see its bare feet, restless — the soles tapping against the floor with impatience. It took a step forward, then hesitated, doubtful.

A shout from upstairs caused it to spin round swiftly and dash back up with a loud banging noise. Peter heard a mocking laugh escape from its mouth as it reached the floor above once again. A shout soon followed, and then a cacophony of wails and cries curdled his blood. He thought of his wife once more. The old man pushed himself out from under the bed and staggered up, trying to regain his balance. In the dead silence, he felt the vicious pounding of his heart inside his chest and the blood rushing to his ears. His legs and back ached, but he forced himself towards the door and peered out into the dim light of the corridor. The doors leading into other rooms had been opened and left ajar. Peter's spine tingled at the thought of some unseen presence lurking and hiding behind one of them — readying to pounce on top of him as he emerged. He leaned against the doorpost and eyed the sinister staircase just a few steps away in front of him, as it rose upwards towards



an impenetrable blackness. His mind harked back to the image of his wife and the disturbance from a few moments earlier. Everything had gone quiet again. He took another cautious look at the corridor and quietly approached the stairs.

He thought he heard a door creak from one of the rooms. He paused a moment to listen. Peter held on to the handrail, his grasp failing him as his hand trembled. The wooden planks groaned. His ascent felt endless, and having abandoned the light behind him, he plunged into the engulfing darkness on the top floor. Suddenly before him stood a ghastly face staring right at him. The old man's heart thumped faster than ever, and his legs felt faint. His mind wavered and struggled to fight off a wave of dizziness. As his eyes adjusted to the dark, the face before him became more clear. It morphed into the smooth and subtle brushstrokes of his grandfather's portrait painting. He cursed under his breath and regained his stance, but had barely stepped off the last set of stairs when the scuttling sound came dashing round the corner. It was somewhat louder, more confused, and faster. It had taken him only a few moments to realise ... *there's two of them!* More clear than ever, he could hear the fall of another pair of footsteps hurtling towards him, like some four-legged beast, ravenous in its pursuit of its prey.

Peter rounded the end of the staircase and dashed into the gloom of the library.

'Dorothy!' he whispered. He pressed himself behind the open door, against the wall, a faint line of light visible in the slit between the hinges and the door frame. Peter heard the footsteps falter and come to an abrupt halt. Its breathing was heavy and hushed. A shadow appeared by the entrance before being joined by another — of the same size and

height as the first. They moved forward together, stalking the inside of the library. Peter's sweating hands grabbed the handle, pulling the door further in towards him. He glanced once more at the slit of light and recoiled in horror at the sudden appearance of another, much larger shadow than the other two — brooding and towering over the entrance.

He felt the horror of it all overwhelm him and resigned himself to the idea of what was about to happen. He felt the door being snatched away from his grasp. He closed his eyes shut and waited ...

'Got you!' a shrill voice screamed.

He felt hands tugging at his clothes, pulling him and shouting. He opened his eyes as the lights in the library sprang to life.

'Not so hidden, eh?' said Peter. He allowed himself a sigh of relief and laughed at the sight of his grandchildren, waving and dancing in triumph at their discovery in the middle of the library.

'So they found you too huh?' he said, emerging from behind the door and dusting off his jumper. He looked at his wife and smiled.

'Exactly where they found you,' said Dorothy, arranging his shirt collar and patting him lovingly on the shoulders.

As they headed back downstairs, Peter's hand slid without effort along the handrail. He dismounted the last step and smiled, as he heard once more the familiar footsteps of the children running around on the floor above. He had left his wife in the library to look up a book whilst he headed towards the bedroom — oblivious of the clawed hand pushing the door at the far end of the corridor wide open.

Cyberselves 2077

Author: **David Mizzi**

*We've been dreaming of robots for over a century, but are we any closer to having fully-automated robots? **David Mizzi** from **THINK** gets in touch with University of Malta (UM) alumnus and CEO and founder of Cyberselves, **Daniel Camilleri**, to talk robots.*

From adorable WALL-E to the smart-talking Bender from Futurama, robots have captured our imagination. Intelligent assistants capable of handling tasks with a greater degree of skill than any human could hope to muster, they usher in a new age where man and machine work together. Despite robots costing the same amount as a mid- to high-end car, not many have made their way into our homes.

Daniel Camilleri, an electrical engineering graduate from UM, has created Cyberselves – a company that aims to realise the true potential of robotics. 'The promise of robotics has been there for a long time and has been tightly linked to AI. Now, we're seeing advances in AI that aren't being translated into robotics. We want Cyberselves to be that link.'

CREATING YOUR CYBER SELF

During our initial call, Camilleri was in his UK offices surrounded by dismembered robots and strewn cables. I asked him how he became interested in robotics. 'Initially, back in secondary school, my plan was to go into medicine. I

loved all the sciences, but then I grew interested in renewable energy, being green, and the environment. So I switched gears (pun intended) and moved to engineering. It was only during my last year that I became interested in robotics.'

During his last year as an undergraduate at UM, Camilleri was studying electrical engineering and working on a mixed-reality project using the first version of the Oculus Virtual Reality Headset. 'My then girlfriend, now wife, was working on robotics, simultaneous localisation, and mapping. That's when my interest got piqued.' After they graduated, they began looking for places to study for their masters. 'We settled on the University of Sheffield, which offered a course on computational intelligence and robotics, a mix of AI, machine learning, neuroscience, and robotics.' From there, Camilleri's passion for robotics only grew.

'Cyberselves started out as an AHRC (Arts and Humanities Research Council)-funded research project at the University of Sheffield. By visiting science fairs dotted around the country with a team of robots, the public started to become more familiar with robots,' explains Camilleri. This outreach



was followed by questionnaires to get a feel for how people's perception of robots changed after the event. Eventually, these outreach events morphed into the Cyberselves Roadshow, which creates dialogue with the public while educating and entertaining audiences with the latest technology.

FROM NEW LANGUAGES TO TELEPORTATION

Despite robots being available on the open market, they don't seem to have taken off (aside from the odd Roomba). For Camilleri, this comes down to the applications available. Without unique and exciting apps, a robot is just an expensive conversation piece.

Camilleri explains how, 'in robotics, there's this vicious cycle where you get a robot manufacturer, they start

hyping their own hardware, which gets users interested — it's too expensive and then there are no apps; there isn't the functionality a user needs. This in turn means the number of users is low, so the number of developers is low.' The first issue Cyberselves needed to address was encouraging developers to write applications. This is where Animus steps in.

Animus is a universal language which allows developers to write programs or apps for robots. 'The idea behind it began from my Ph.D. research at Sheffield. It brings together neuroscience and robotics to create an algorithm capable of learning,' Camilleri says. 'Think of it like the Android operating system for your smartphone.' Essentially Animus ensures that code written for one robot will run on another.

Sticking with the smartphone analogy, if you upgrade your phone to a different model, from Samsung to Huawei for example, the app you created will still work. This saves the designers having to re-write the app for each new robot model.

After developing Animus, the next step was to actually create an application using the language. For Camilleri, this meant creating a use case or a 'hello world.' 'In programming, a *hello world* is the first thing you do. We landed on using telepresence so people using it can be in the robots' shoes.' Besides being a great use case, it also helps to dispel the fear around robots.

Teleport is the first application developed using Animus. It allows the user to control any robot anywhere in the world directly. By using commercial virtual reality headsets,

Ultimately the goal is to have robots capable of a variety of tasks, rather than one super-specialised robot only capable of doing one thing.



Daniel Camilleri
Photo courtesy of Cyberselves

the robot acts as a virtual presence device, giving the user the ability to see, hear, and feel whatever the robot senses. The applications vary from visiting relatives or museums in a different country to hazardous environment navigation.

Besides Teleport, Cyberselves also released a software development kit to the public. This allows developers to create and write their own apps.

THE FUTURE

The work Camilleri and his team at Cyberselves have done is not going unnoticed. In 2021, Cyberselves won a spot in the finals of the prestigious ANA Avatar XPRIZE global robotics competition. This is a four-year global competition aimed at developing an avatar system that can transport human presence to a remote location in real time.


Camilleri explains how, due to Covid, telepresence experienced a significant push and investment by companies. 'I feel in the next 5 years, telepresence will become a mainstream way of travelling — either to be greener or on a tighter budget.'

While Camilleri and his team are excited for the finals (scheduled for autumn 2022), they also have other plans in the mix. One of their goals is to create a universal marketplace for robotics. By bringing together users, developers, and manufacturers in a single place, they hope to streamline the collaboration between different service providers.

While a robot future seems just within reach, there are still challenges that need to be overcome. 'Hands and touch are two of the challenges robotics has. For hands, we're looking at creating a more

dexterous type of hand, while for touch we're working with a company that's created a new type of skin. Once we have that and the software side sorted, robots will be able to complete a number of household tasks, such as doing the laundry.'

Ultimately the goal is to have robots capable of a variety of tasks, rather than one super-specialised robot only capable of doing one thing. Only then does Camilleri believe we will see robots in the house. 'Robotics are the third generation of personal devices. There's a lot to be gained from them, especially in Covid times.'

There is still a long way to go before we live side-by-side with robots, but through Camilleri and his team's work, we're one step closer to that future. And a future with our very own robot butler is certainly worth being excited about! 

to-do list

podcast



The Yes Theory Podcast

For *Yes Theory* founders Thomas Brag, Ammar Kandil, Matt Dajer, and Derin Emre, discomfort is necessary for authentic growth. In their podcast, they discuss with expert guests how discomfort might hold the keys to happiness.

book



Laughter in the Dark by Vladimir Nabokov

Love (or lust) can drive us to do terrible things. *Laughter in the Dark* follows Albinus, a married middle-aged art critic, through an affair with 16-year-old Margot and shows his passions blind him to the cruel reality around him.

movie



Don't Look Up

When two astronomers try to warn the world about a giant comet, the world reacts with surprising indifference. The film follows the researchers as they embark on a global media campaign to force the world to 'look up.' The film hits close to home, considering how we've handled disasters in recent years!

youtube channel



Veritasium

Videos about the remarkable world of science, education, and technology. Have you ever wondered what dust is made of? What about how to slow down the ageing process? *Veritasium* has plenty of binge-worthy (and educational) videos!



tv



Altered Carbon

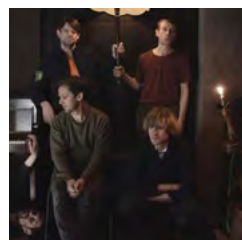
The year is 2300; death is no longer permanent. Your entire consciousness can be transferred to another body — if you can afford it. Elite soldier Kovacs has been imprisoned for centuries but is given the chance to be resurrected if he can solve a murder. When death isn't permanent, solving a homicide case is much harder than you'd expect!

music



Sea Power

The English alternative rock band has been compared on more than one occasion to bands such as Joy Division and the Cure. Their post-rock experimentalism is perfect alongside a cup of dark coffee on a rainy day!



instagram



Guff Facts

scrolling on instagram ad, fanart, post from a friend, artsy photograph *yawn*. Male bees' testicles explode after sex. *What?*

Guff Facts posts weird and wonderful facts to your Instagram. The best part? Every single one is linked to the original source!



A DECADE OF THINKING

2012 – 2022
and beyond



THINK





**A DECADE
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**THINK
10
YEARS**