THINK
IDEAS • MALTA • RESEARCH • PEOPLE • UNIVERSITY

SING A SONG
For clean food, new tech

ROMAN VILLAS
Ancient secrets revealed

MALTA’S SEA
Through a lens

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SPRING 2013 • ISSUE 5
HEY!

THINK MAGAZINE

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Research for Education

Bringing them out like hot cakes: fresh, sweet smelling, and with great fillings. We hope an analogy for this issue of Think. Within these pages we have found even more great stories from University.

Last summer Dr Gambin introduced me to The Roman Villa of Żejtun. Two site visits and six interviews later I found out about Bronze Age silos, ancient goddesses worshipped in Malta, and many more treasures.

A couple months ago, I heard about another great story: how food can be cleaned with sound. It seemed incredible to me, blast sound waves and out comes disinfected food. I’m sensationalising, but the technology being used is stunning.

Other researchers are talking about monitoring Malta’s beautiful seas to preserve them for our future, or how Malta’s huge traffic issues could be solved. This issue even has opportunities for writers and career tips.

What about the editorial’s title: how can research improve education? More pilot studies are an easy answer. Every new introduction to our educational system, from science reform to tablets, should be rigorously studied to see if they work and to be adapted correctly. The results then feed into policy.

Better-funded labs will also give better student projects. Summer placements could be introduced before undergraduates undertake final year projects. Some labs already do this; University already performs wonders on its budget.

Top Universities also have the world’s best researchers who can draw from personal experience in their lectures. This experience comes from years spent trying to solve research problems. By investing more in research the quality of University education will rise. Our students will receive better degrees.
The Key to Networking
Dr Janet Mifsud talks about COST, a way to meet researchers around Europe

To Drive or not to Drive
How to solve Malta’s big traffic problem

The Einstein Enigma
Solving the final puzzle left by Einstein

Reviewing Mama
This month’s horror film review

Story Works
A great opportunity for budding local writers

Meme: cats to dinos

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 3451
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SPRING 2013 - ISSUE 5

STUDENTS
Students' thinking
About: Titanium, treating stones, logical chemicals, and saving bats

OPINION
Space: the final frontier for Malta
Dr Kris Zarb Adami shares his dreams in space research

FEATURE
Discovering Depression Treatments
On a search for new drugs through myths and new findings

FUN
Fact or Fiction?
Can AI become sentient? Asks a University staff member. Send in your own question

RESEARCH
Dentists on Wheels
From mobile dental clinics to breast cancer research, the UoM’s research trust is on a roll

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MALTA HAS THREE UNESCO world heritage sites which need constant conservation. Generally, it is better to preserve the original building material than replace it. The conservation method called consolidation can glue deteriorating stone material to the underlying healthy stone maintaining it, but few consolidants have been tested on local Globigerina limestone.

Sophie Briffa (supervised by Daniel Vel-

la) tested a new set of consolidants which are stronger than other compounds but affected the colour of the stone. She applied five different conditions on the stone. The first three were novel treatments. They were based on a hybrid silane (tetraethylorthosilicate (TEOS) and 3-(glycidoxypropyl)trimethoxysilane (GPTMS)) but one had nanoparticles, one had modified nanoparticles, and the other lacked them. The fourth was a simple laboratory-prepared TEOS silane. The fifth was untreated limestone samples for comparison.

The treatments successfully penetrated the stone’s surface. Microscopy coupled with other techniques including mercury intrusion porosimetry carried out in Cadiz, Spain, confirmed this infiltration and the stone’s physical qualities: strength, drilling resistance, and so on. Half of the treated stones underwent accelerated weathering. The consolidants with nanoparticles or modified nanoparticles were stronger than the other treatments. They also maintained the original surface colour and improved the stones’ ability to absorb water. On the other hand, they were less resistant to salt crystallisation that can damage the stone making it brittle.

The best consolidant for Maltese stone has not yet been found. Ideally, it should have good penetration and good weathering properties that preserve the stone’s appearance. It should allow ‘breathability’ and be reversible. Current stone consolidation techniques are irreversible since they permanently introduce new material into the stone. These are only acceptable since consolidation is a last attempt to save the stone before complete replacement.

French writer Victor Hugo summed up the importance of this research when he said, ‘Whatever may be the future of architecture, in whatever manner our young architects may one day solve the question of their art, let us, while waiting for new monuments, preserve the ancient monuments. Let us... inspire the nation with a love for national architecture’.

This research was performed as part of an M.Sc. in Mechanical Engineering at the Faculty of Engineering. The research was funded by the Strategic Educational Pathways Scholarship (Malta).
SONAR FOR NAVIGATION was implemented after the Titanic disaster in 1912. Bats have used this remarkable technique for the past 50 million years. These nocturnal animals emit ultrasonic signals and analyse the returning echoes to avoid obstacles or predators and find their prey. For humans, studying bats means long hours in the night spent tracking their movements or capturing them with nets. To avoid some of the bat research difficulties, conservation researchers identify and study bats by eavesdropping on the ultrasonic sounds they emit.

Clare Marie Mifsud (supervised by Dr Adriana Vella) has now studied bats in Malta linking specific sound patterns to specific bat species and their behaviour. Bats can be identified using acoustic detection because they all use different frequency patterns to suit their needs. The analyses can be used for further research and conservation monitoring of local bats.

Her study encompasses 38 research survey sites spread all over the Maltese Islands. Two bat detectors (a heterodyne and a real-time expansion detector) are used simultaneously to instantly identify and analyse the species. Nine different bat species are already confirmed to inhabit the Maltese Islands till now.

Three species (Rhinolophus hipposideros, Myotis punicus, and Plecotus austriacus) were recorded a few times (2% of survey time), since they use low intensity echolocation signals. Other bat species (Hypugo savii, Pipistrellus pipistrellus, Pipistrellus kuhlii, and Pipistrellus pygmaeus) were detected more often (92% of survey time). All Maltese bats feed on insects and are found to spend most of their time in valleys followed by other habitats including cliffs, woodlands, agricultural land, shrublands and urban settlements. Valley biodiversity is important for local bat survival and needs to be preserved.

Through the use of bat acoustic detection systems and signal analyses, this detailed research is providing the first important set of data of its kind for all bat species detected in the Maltese Islands. This complements other bat research which has been ongoing since 1998 by the Conservation Biology Research Group (University of Malta). They have been involved in different bat studies including the ecology and genetics of local bat populations. These research efforts aim at reversing the trend of decreasing bat numbers. Mifsud’s research paves the way towards developing another effective long-term monitoring tool for the conservation of bats in Malta.

This research is part of an M.Sc. in Biology at the Faculty of Science. BICREF (The Biological Conservation Research Foundation) provided voluntary assistance during field work. The research was partially funded by the Strategic Educational Pathways Scholarship (Malta). This Scholarship is part-financed by the European Union – European Social Fund (ESF) under Operational Programme II – Cohesion Policy 2007-2013, ‘Empowering People for More Jobs and a Better Quality Of Life.’
ELECTRON BEAM MELTING (EBM) is a state of the art manufacturing process. Using this process product designers will be limited only by their imagination. This technology uses an additive manufacturing approach where parts are built layer by layer — think of ‘3D printing’. It can use exotic metals like titanium alloys, however it does have limitations such as producing a rough surface finish that hampers its functions.

Christian Spiteri (supervised by Dr Arif Rochman) investigated whether the Electric Discharge Machining process can be used to finish parts produced using EBM to give a smooth surface (difference pictured). He treated titanium products with the Electric Discharge Machining process and microscopy showed that the finished surface consists of a set of micro-craters instead of rough grains. By adding the finishing process, more complex geometries could be created. Overall, adding Electric Discharge Machining to EBM had many benefits.

Dr Arif Rochman (University of Malta) said, ‘EBM parts can be used for a wide range of applications such as implants in the medical sector or complex tool inserts, [...] which cannot be manufactured using conventional methods. Understanding the synergy between both processes is a must for product designers and process engineers to be able to manufacture high quality EBM products.’

This research was performed as part of a M.Sc. (Res) in Mechanical Engineering at the Faculty of Engineering. This research was partially funded by the Strategic Educational Pathways Scholarship (Malta). This Scholarship is part-financed by the European Union – European Social Fund (ESF) under Operational Programme II – Cohesion Policy 2007-2013, ‘Empowering People for More Jobs and a Better Quality Of Life’.

Titanium: Smoother and shapelier

Titanium surface before (top) and after finishing (below). Image taken with a scanning electron microscope at a magnification of 200x
Chemistry is not usually associated with logic gates, sensors, and circuits. However, a new breed of chemist — the molecular engineer — is adding a bit of chemical spice to them. Given the right tools, his/her hands can synthesize anything, from molecules that assemble into large structures to others that can display information about their environment.

Thomas Farrugia (supervised by Dr David Magri), created a molecule that could be toggled between an ON and OFF state using AND Logic. AND logic means that it needs two chemicals to switch state, adding just one chemical makes no difference. The states are easily recognised by shining UV light on the molecule since only the ON state produces blue light.

The two chemicals added were an acid and an iron (III) source (like what is found in rust). The acid provides hydrogen ions that bind to the nitrogen atom, whilst the iron (III) ions attack the molecule’s iron (II) atom (pictured as Fe). The molecule displays AND logic since it needs both the acid and iron (III) to turn on light emission.

The molecule was synthesised using a one step reaction and tested to determine the strength of the ON and OFF signals. Testing by fluorescence spectroscopy is essential to determine whether it would make a viable sensor, since the technique compares the strength of the ON and OFF state. The molecule will only work well if there is a large difference between the different states, since a machine needs to detect the change.

This molecule can sense the extent of acidity and iron (III) ions in a solution, and convey that information using light, which is easily measured. The molecule’s design could also be integrated into bigger and more complicated molecules so as to carry out other logical and mathematical operations using chemicals. These molecules are a step towards chemical computers.

This research was performed as part of a B.Sc. (Hons) Chemistry with Materials at the Faculty of Science.
first heard about COST (European Cooperation in Science and Technology, a networking platform for scientists www.cost.eu) way back in 1996 during a pharmacokinetics meeting in Athens. Some participants mentioned that their attendance had been funded by COST. So on my return I contacted the Malta Council of Science and Technology to try and obtain more information. When I learnt that COST funds EU networking I quickly applied to become a member of a COST action (this is what COST calls a network). After bureaucratic leaps and bounds I became Malta’s representative on a COST action. It certainly opened new horizons to me and the networks I formed with top researchers in Europe were unique.

By 2010 my enthusiasm resulted in MCST nominating me as Malta national contact point for COST. It has been of huge satisfaction that in these three brief years Malta’s participation has risen from 6 actions to over 100. Over 150 Maltese researchers take part in COST.

Why is COST so important for Malta?

The complaint I hear most often in Malta, not only in academic circles but also among SMEs (small to medium enterprises), is that research in science is only for the elite, that it is too high brow and that it is not relevant to Malta. COST proves otherwise. What else could link disaster bioethics, to colour and space in cultural heritage to the comparison of European prostitution policies, with submerged prehistoric archaeology? Other links include the quality of suburban building stocks, integrated fire engineering and response, and language impairment in a multilingual society. COST also funds networks across a whole spectrum of research from the humanities to the fundamental sciences including string theory to childbirth in various cultures.

Participating in a COST action involves very simple administrative and funding procedures. For once, our small size is an added advantage since every COST country is allowed to nominate two members to participate in each action, putting Malta COST researchers at par with researchers from much larger countries.

Achieving these results has not been easy, since many researchers hesitate and require persistent prodding. There are frequent reminders and one to one meetings to persuade them to participate. It has been a real eye-opener meeting researchers in Malta from different disciplines and learning about their research.

Deciding to participate in COST may seem a small step to some, an added administrative burden to others, while some see it as another travel commitment. COST offers the response to the conundrum of how to overcome our physical (and perhaps in some instances also mental) insularity. You should not let this opportunity pass...

COST in Malta is managed by the Malta Council for Science and Technology. For more information see www.mcst.gov.mt/networking/cost or contact Dr. Janet Mifsud, COST CNC, (+356 23402582/2845, janet.mifsud@um.edu.mt) or cost.mcst@gov.mt

Q Why is COST so important for Malta?

“Achieving these results has not been easy, since many researchers hesitate and require persistent prodding”
Space: the final frontier for Malta

Dr Kris Zarb Adami

“Conducting space research locally would bring us to the forefront of technology”

Think meets up with Dr Kris Zarb Adami to have a chat about Malta’s space opportunities. His research covers subjects from searching for extraterrestrial life to new theories of gravity.

Q: How can a small country like Malta have a role in Space?

As an EU member Malta can continue strengthening our existing cooperation agreement with the European Space Agency to full membership. This will automatically give us access to all its projects. By participating in these projects, we will be able to leverage so that research and development for future space missions is carried out in Malta.

In Malta we are already contributing to a European Space project, namely EUCLID. This satellite is due to be launched in 2017 and will be the successor to the Hubble Space Telescope. Researchers at the Department of Physics are developing image-processing algorithms that can accurately measure the shapes of the Universe’s furthest galaxies and its expansion.

Moreover, they also collaborate with the University of Bologna to monitor ‘space debris’ and near earth-objects. This is important to ensure the successful navigation of satellites to prevent accidental collisions, which cost millions of euros. Collisions are not as rare as we might think.

Q: What are the benefits of Space research for Malta?

From the invention of disposable diapers to the development of laptops and satellite TV, space research has traditionally been a very strong contributor to everyday technology. For Malta space research can help us monitor our climate and atmospheric pollution, while providing an early warning system for tidal waves.

Conducting space research locally would bring us to the forefront of technology: ranging from biotechnology and long-lasting foods for space journeys, to the development of faster and more sensitive communication systems capable of receiving signals from deep space. Malta has just been awarded ERDF funding for new laboratory facilities at University and will contribute significantly to the future of the European Space Programme. In return, Malta will be able to leverage significant funds from this programme and also funds designated to commercialising the technologies. We need more support to get involved in more projects and attract funds to Malta.

Q: What is the future of Space Research?

The next step lies in the development of space vehicles capable of running commercially feasible missions, such as turning the space shuttle into a commercial ‘airliner’ business. Such programmes are beginning to emerge in the US, but Europe lags far behind. Commercial spaceflights will certainly play an important role in future space research.

Apart from research into transportation, researchers are trying to figure out how to live on a planet besides our own. How can future generations be able to create food products and live in space?

In Malta I would like University and the whole country to become more involved in space technology and biotech. We could also contribute to landing and docking systems for satellites and shuttles, plus space-traffic control through the University’s expertise in the Engineering Faculty.

Q: Is there anything to lose?

The danger with taking on some new research area is that funding from other streams is spread too thinly. However, if we can manage to leverage extra funding from large Europe-wide space programmes we will be able to launch Malta’s name into space!
Rush hours, feasts, festivals, beaches in summer, Paceville on Saturday night, all have one thing in common: traffic. Malta has one of the largest traffic problems in the world. Researchers at the University of Malta are trying to figure out what can be done to ease road rage and reduce drivers’ lost time.
The Maltese road network is bloated. Malta has one of the highest rates of car density in the world, rivalling some of the big cities such as London or Paris. The World Bank puts it in 9th place with 693 vehicles per 1000 inhabitants, while the US, famously considered as one of the most car dependent states, is in 3rd place with 797 vehicles. A less quoted but possibly more important statistic is the number of cars per square kilometre: the US has 25 vehicles; Malta packs a staggering 991.

A large number of vehicles means traffic. It wastes time, money, increases stress and noise levels, and pollutes the air. But can the Maltese road network be improved to alleviate these problems? Many researchers at the University of Malta are trying to solve these problems. Our approach involves using varied means like data gathering, policy analysis, transport modelling, and the assessment of innovative transport ideas.

The start of any study is based on a sound analysis of the current state of play. Dr Maria Attard (Department of Geography) has studied the local traffic situation, noting its evolution from just a few thousand cars to over 300,000.

People’s dependency on cars makes Malta a world leader. Just over 1 in 10 trips are carried out by bus. Since the 80s Malta has witnessed a gradual switch from public to private transport, turning walking into a luxury.

Recent governments have tried to manage traffic growth, which has been a big part of Dr Attard’s research into transport projects and policies. The first Park and Ride scheme in Floriana was introduced to try and reduce the stress on the City’s congested roads. On top of this, government even introduced a road-pricing scheme, the Controlled Vehicular Access (CVA) system in Valletta. Drivers had to pay to enter Malta’s capital. In New York and Edinburgh similar ideas failed to be implemented. Certain key town centres have also been pedestrianised. All of these are efforts to reduce the congestion and pollution that come with using our cars so much.

Dr Attard’s research on road pricing showed how such projects can be developed and implemented successfully. Malta introduced road pricing in 2007, three years after London’s congestion charge and one year into the Stockholm trial. In Malta the scheme initially decreased the amount of traffic. Now traffic volume has levelled off as people might be getting used to paying the charge.

Dr Attard compared and analysed different cities showing that successful
introduction in Malta and elsewhere needed a strong political will, thorough research, while being well thought out, designed, and executed. Malta therefore could be a good model for a mid-sized city to learn from.

Maths to the rescue

Malta has many troublesome junctions. Fixing these problems is expensive and rarely reversible, needing extensive testing and serious evaluation before implementation. Dr Kenneth Scerri (Department of Systems and Control Engineering) and a team of engineering students build mathematical models that can test possible changes and see if these new ideas work at close to no cost at all.

The basics of transport mathematics are surprisingly simple and uncannily similar to the drain in our kitchens. The link is not as strange as it sounds.

Imagine your sink. With a slow supply of water, there is no water build up and the water flows straight out. Increase the supply a little and the water level in the sink will probably slowly rise. Clog the drain and the water level will rise higher.

“Traffic flow behaviour can be captured mathematically by difference equations”

Traffic at a junction behaves in exactly the same way. With few cars reaching the junction, they sail right through with close to no delay. Increase the number of cars or block the junction ever so slightly, and the queue of cars slowly increases, just like your rising sink water with a stronger supply or a clogged drain.

Maltese traffic is a bit more complicated. A sink is just one junction. Malta has thousands. Imagine thousands of clogged sinks linked to each other. That is the Maltese road network. Despite its complexity, it can still be modelled with the right equations.

Traffic flow behaviour (and water, if you wanted to model your sink) can be captured mathematically by difference equations — that is, mathematical expressions of how something changes over time. Like roads themselves, the equations can all be connected to form a complex network that represents mathematically the local traffic network.

Coming up with this mathematical model is not as difficult as it might sound, though there are some complications.

First of all, have you ever heard the phrase ‘garbage in, garbage out’? This concept applies perfectly to transport models, since they can only be as good as the data available. Data gathering is a modeller’s first problem.
To make matters worse, capturing the complexities of all roads and junctions on the network requires accurate data over a long time. Thankfully, over the years, various studies have gathered some of the data needed and by collaborating with Transport Malta, University researchers have access to this data to study the Maltese network.

Most transport models require knowing from where people started driving and where they went. This information is gathered as origin-destination data and tries to capture all the regular trips performed by all drivers on the Maltese network. In 2010, Transport Malta attempted to gather this data through an extensive survey. They estimated that over 500,000 trips using a private vehicle are undertaken each day. Birkirkara is the most popular destination with over 34,000 trips, followed by Msida (25,000), Mosta (21,000) and Attard (19,000).

Now that we have the data, how do we build the model? Traditional models assume that drivers all try to find the quickest route that gets drivers to their destination. This assumption runs into a few potholes. First of all, the quickest route will most likely change as the traffic volumes on the roads increase. Troublesome junctions might get so congested that drivers often decide to take other roads to reach their destination more quickly. Secondly, even the simplest Maltese model taking into account all arterial roads still need over 100 traffic nodes and another 100 links. Plug in 500,000 trips performed each day and most computers will burn down.

To overcome these problems, Masters student Luana Chetcuti Zammit has developed models that can work on a laptop. Her models use Bayesian Statistics to represent and estimate the traffic flow on all major roads on the Maltese Islands. This model has many advantages; most importantly they allow busy roads to be given more importance, give better results, and allow for a high level of stochasticity in the drivers choices, that is, they allow the drivers to take longer routes due to habit or because they might feel more comfortable with them.

Every model needs to be tested. To do this, Zammit flung data from another big dataset. It includes information like the daily number of vehicles on some major roads. For example, Aldo Moro Road in Marsa is the busiest road with 90,000 vehicles.
per day. Thirteenth December Road in Marsa sees 50,000, while Marina Road in Msida sees around 40,000 vehicles.

The beauty behind these models is they can fill in the gaps. Transport Malta would need a hefty budget increase to monitor all roads. With this model, traffic flow in roads which are not covered can be predicted and different scenarios tested. What happens if this junction clogs up? Or what would happen if we added a bus lane, or widened the road? This model can test such ideas to make sure they work when carried out in real life.

New ideas go under the virtual hammer

Maltese people use cars to go everywhere. Whether we are on our way to work, the beach, the cinema, a restaurant, or to shop. Most people who can drive do so. Public transport is underused and people walk much less than their European neighbours. Maltese citizens are paying the price of underused transport resources affecting their health and emptying their pockets.

New transport ideas are needed to solve this problem. Prof. Adrian Muscat and researchers from the Department of Communications and Computer Engineering are considering novel transport modes. Their aim is to help people live better lives by reducing the amount of unnecessary cars on the road.

With a local lens, Prof. Muscat’s team is studying the impact of cars on people’s quality of life. Less cars on the road can allow people to enjoy walks around our beautiful villages and help increase the number of green spaces. They are studying how ride sharing and taxi sharing, also known as dial-a-ride can help to tame our addiction to private cars. These ideas are not new, being implemented the world over, but scaling them up and offering them to the general public at low-cost is an innovative concept.

Let’s use another example to understand how taxi sharing works (no sinks this time). Sally is invited to a business meeting in Sliema. She works in Kordin. She picks up her mobile and asks (through a specific app) for a trip to Sliema. In a few seconds, she receives a message offering to pick her up in 10 minutes. She accepts, is picked up, shares her taxi with other passengers (who are travelling to different destinations), then arrives at her destination hassle free, and is finally billed three Euros.

For ride sharing, let’s consider Paul. He works in a large establishment with fixed working hours. The company organises a ride-share programme, with an added reward of a guaranteed parking space. Paul shares with four other employees. They all save on fuel, parking, and help reduce traffic at peak hours. All is again organised through an app on their phone making it quick, easy, and cheap.

Taxi sharing has a few advantages over public transport and normal taxis. It is cheaper than taxis and would only be slightly more expensive than public transport. Ultimately, it is the best of both worlds: affordable to many, flexible, and comfortable.
Ride-sharing is not perfect for everyone. People need to work within the same entity, which needs to ensure personal security. To effectively reduce traffic at peak hours, the scheme needs to be extended to the general public. ‘How?’ Is a tougher question to answer.

This group studies traffic from a holistic point of view trying to consider as many different factors as possible. By changing one point, 10 others could be affected which influences government policy. For example, it is undesirable to encourage a switch from public transport to ride-sharing. People are better off using both.

Malta’s traffic problem is solvable. Between 1998 and 2010 the number of bus trips to Valletta went up from 46.1% to 57% while private cars plummeted from 50.9% to 40.7%. Dr Attard’s work shows how strong policy and effective measures can work. The current strain on roads can be reduced by encouraging more drivers to switch to public transport or sharing modes. Perhaps even reverse the trend all over Malta. But what would convince commuters to switch? Experience shows that fiscal rewards may not be enough. Delivering a high quality service is equally important. We need the right measures, tweaked to consumers’ changing needs.

So let’s start by all doing our part. Try to share a ride to work tomorrow, take a bus, or better still, walk with a friend. In the end, changing our travel habits might help reduce traffic but, more importantly, might make us happier and healthier.
The fried egg jellyfish (Cotylorhiza tuberculata)
Photo: David Watson
Dr Alan Deidun writes about a warming Mediterranean Sea, a recently built centre in Gozo, and collaborations with economists.
FEATURE

Marine Protected Areas are poorly understood and not appreciated but are vital to maintain healthy seas for all who live or enjoy the sea. The areas are a priceless patrimony that we need to preserve. The EU funded PANACEA Project promotes the biodiversity and marine assets of four Sicilian (Capo Gallo/Isola delle Femmine, Ustica, Isole Pelagie and Plemmirio) and two Maltese (Dwejra and Rdum Majjiesa) areas, and aims to maintain them for future generations.

Despite the distances involved, a common thread links all six areas. Their biodiversity is stunning. They are filled with iconic marine species unique to the Mediterranean, such as the Noble Pen Shell (*Pinna nobilis* — *nnkkra* in Maltese), the long-spined sea urchin (*Centrostephanus longispinus*), the star coral (*Astroides calycularis*) and vast Neptune Grass vast meadows (*Posidonia oceanica*), a keystone species. Unfortunately, other species like the Mediterranean coral (*Cladocera caespitosa*) are much more vulnerable. It might become extinct because of increasing water acidity, the ‘evil twin’ of climate change. These organisms are all stressed by an overfished and overexploited Mediterranean Sea, a reason for more frequent jellyfish blooms. Over 150 million people surround our Sea.

Dwejra in Gozo now houses the edutainment arm of the PANACEA project. One of four educational centres built in four of the 6 areas. The Gozo centre was finished in March. Visitors can experience a kaleidoscopic overview of the marine life and habitats present in every area. Underwater documentaries (thousands of views on You Tube), interactive panels, dioramas of submerged landscapes, audiovisual panels, and resin replicas try to encourage awareness. The tools show the complexity beneath our seas and the link with the land.

Apart from communicating with the public, the project is focused on scientific research. It spearheaded the development of a novel 2D-coupled ecological model for the Dwejra coastal area, which considers both physical (temperature, acidity, salinity, and so on) and biological effects. Since it is a 2D model, a single standard water depth is considered rather than every single height. The model can forecast the impact on water quality of development in Dwejra. For example, what is the effect of increasing boathouses around the Inland Sea? This approach can help policy and decision makers keep within EU obligations.

The PANACEA project has similar aims to another project in which Dr Deidun is acting as Project Manager called BioDiValue. Vessels have been fitted with an Automatic Identification System (AIS), which

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Nudibranchs are probably amongst the most charismatic groups of marine invertebrates as a result of their bright colours and graceful movements — they normally feed on sponges, hydrioids, and algae. Photo: D. Bianchini

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Dr Alan Deidun
sends out a signal about vessel location. An antenna at the University of Malta picks up their signal. Monitoring vessel location is important in case of oil spills, and the discharge of fuel and ballast water (potential introduction of alien species). Malta’s coastline and waters can only be protected if we know the risks. Following the International Maritime Organization’s International Convention for the Safety of Life at Sea, all ships above 300 tons must be fitted with this system.

BioDiValue is also building a TowFish, a towed underwater platform. It is equipped with sensors (e.g. chlorophyll, temperature, salinity depth) and video cameras (including one to take snapshots of gelatinous plankton) to determine the water quality and document our beautiful seas. The design and construction is coordinated by Dr Martin Muscat (Department of Mechanical Engineering, UoM) and the University of Catania.

Economics of conservation

One third of the world’s maritime traffic passes through the Mediterranean just a few hundred kilometres off Malta. Ships release huge amounts of pollution, and the BioDiValue project is trying to quantify the economic detriment it has on the environment. This 2.4 million Euro project is seeing the water quality, number of alien species, and so on that ship traffic has on the Malta-Sicily channel. Environmental economists will be translating this information into monetary terms for policy-makers and decision-makers. Economists and biologists seem to be talking more frequently these days.

A tropical Mediterranean

There are signs that the Mediterranean is warming. Dr Deidun, colleagues at the Physical Oceanography Unit (IOI-Malta) 

“These organisms are all stressed by an overfished and overexploited Mediterranean Sea, a reason for more frequent jellyfish blooms”
Operational Centre, University of Malta), and the Department of Biology are working on the EU-wide 'Tropical Signals' programme that is observing how the Mediterranean is becoming tropical. New species, temperature rises, and other changes are all being studied.

The Maltese team is using temperature data loggers donated by CIESM (the project coordinator, International Commission for the Scientific Exploration of the Mediterranean Sea). The loggers were set at 5m-intervals, from a depth of 5m down to a depth of 40m. Since 2011 sea temperature levels around Malta and Gozo have been recorded every hour on the hour. They are retrieved every six months to download the recordings before being redeployed in the field.

The temperature data being collected will be used to see if changes in temperature are changing the local ecosystem. The Department of Biology is monitoring fish assembly changes. By combining the data from all partners a picture of the whole Mediterranean can be formed.

Despite its small size, Malta’s marine area is impressively almost 14 times its land area. Our Seas need to be monitored by local researchers participating in innovative projects.


**FURTHER READING**

- Visit [www.panaceaproject.net](http://www.panaceaproject.net) for more information about the PANACEA project.
- Visit [www.perseus-net.eu](http://www.perseus-net.eu) to learn about the Clean Seas by 2020 PERSEUS project, funded by the FP7 programme.
- Visit [www.ioikids.net/jellyfish](http://www.ioikids.net/jellyfish) for information on the citizen science campaign Spot the Jellyfish.
- Visit [www.alandeidun.eu](http://www.alandeidun.eu) for his personal website and updates about his research.

“Malta’s marine area is impressively almost 14 times its land area”
do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore”, said the famous Isaac Newton. Humanity has progressed in its search for answers by always searching for the next smooth pebble, the next pretty shell. In Malta, a small group of students is trying to understand gravity through the observation of stars and galaxies that light up the night sky.

Gravity has kept our feet on the ground since we started walking upright. Early theories by the Greek philosopher Aristotle (384–322 bc) were interesting but far from the truth. His Universe was built in concentric spheres with Earth at the centre, followed by water, air, fire, and enclosed by the heavens — a rock fell to the Earth because it wanted to go to its original sphere. Clearly, he was wrong.

Aristotle’s concepts were challenged during the Renaissance when the Italian Galileo Galilei (1564–1642 ad) famously dropped different weights from the tower of Pisa. Contrary to the Greek theory which stated that the heavier an object is, the faster it falls, Galileo saw the objects all fall at the same rate. Theories need to match observations, otherwise they fail — an invaluable technique used time and again by any decent scientist including the Malta group of astrophysicists led by Dr Kris Zarb Adami.

The first person to suggest a good theory for why rocks fall was Isaac Newton (1643–1727 ad). As the story goes, watching an apple fall triggered Sir Isaac Newton to come up with his theory of bodies. He said that anything with mass had a force that attracted everything towards it — the bigger the mass, the bigger the force. Since the apple is smaller than the Earth, it falls towards it, and since the Earth is smaller than the Sun, the Earth goes around the Sun. Newton’s law was successfully used to predict the motion of planets and helped discover Neptune.

By the 20th century, holes in Newton’s ideas started to appear when scientists discovered that Mercury’s orbit differed slightly from Newtonian predictions. In 1915, along came Einstein (1879–1955 ad) who again revolutionised our understanding of gravity through the introduction of his theory of general relativity. Newton had considered time and our three-dimensional space to be independent. Einstein replaced this with the notion of spacetime, which combines space and time into one continuous surface. Space is a dynamic entity ‘moving forward’ in time, the two being bound by light itself.

Large objects like the Sun bend the fabric of spacetime (it is convenient to think of spacetime as a sheet of fabric with balls lying on top of it — bigger balls curve the fabric more). Smaller objects (such as the Earth) try to follow the shortest route around the Sun. The shortest way is curved and it is easy to see how this comes about.

Consider the shortest route from the North Pole to the South Pole, you would naturally move down a curved longitude, which forms part of a circle round the Earth. This concept also explains why the Earth traces an orbit round the Sun. The orbit is the ‘best straight line’ that Earth can trace in the curved spacetime surrounding the Sun.

We experience gravity everyday, but how it works is one of the biggest questions in physics. Einstein’s theory of relativity means that we don’t understand over 90% of the Universe. A team at the University of Malta is trying to put that in order.

“Space is a dynamic entity ‘moving forward’ in time, the two being bound by light itself”
As John Archibald Wheeler neatly summarises it: ‘Spacetime tells matter how to move, matter tells spacetime how to curve’.

**Einstein’s biggest blunder**

Einstein’s theory of general relativity describes how gravity works. Einstein wanted his equations to represent a static Universe that did not change with time. To this end, he introduced a factor called the cosmological constant that would bring the Universe to a halt. However, this idea was short-lived. Another great (though highly egotistical) physicist called Edwin Hubble discovered that the Universe was expanding; this was confirmed in the late nineties and led to a Nobel Prize in 2011. It not only means that all matter will eventually disperse throughout the Universe and future generations will see only a blank night sky, but also poses a problem in that the reason for this expansion is completely unknown and unpredicted from Einstein’s theory. And it is not a small factor at all, since this mysterious energy makes up 68% of the energy in the Universe. Nicknamed ‘dark energy’ because it is unseen, this is the biggest problem in modern astrophysics and cosmology.

Scientists either have to accept that dark energy is true, or that Einstein’s model has met its limits and physics needs a new way to model gravity, at least on the largest of scales. The Malta astrophysics group is trying to verify and find new models of gravity — these so-called alternative theories of gravity. The idea is to compare observations to the different gravitational theories, including Einstein’s, and see which works best.

Our focus is split two-ways: one is the effect that celestial bodies have on each other’s orbital motion and the other is the bending of light around heavenly bodies. For example, our sun bends spacetime, causing the planets to go round it in ellipses. The sun also wobbles around a very small orbit. Observations show that the orbiting objects go round a bit longer than we would expect. The extra amount is miniscule, so measurements are taken after many orbits as this magnifies the effect. We use this as a possible test to disqualify alternative theories and have already shown how an important alternative theory of gravity cannot be true.

This is how fundamental science works. If a model does not match observations it needs to be modified to arrive at something that does give all the predictions we require. The end result must be a complete theory by itself but the different components could find their birth in a wide variety of unconnected sources.

The Malta astrophysics group considered a theory called conformal Weyl gravity that is similar to general relativity in every respect except one. This theory behaves exactly like Einstein’s but imposes a further constraint — mainly that the gravitational field remains the same no matter how much it is stretched or squeezed. Simply put, as long as the mass remains the same, gravity does not change. This assumption solves many problems. It makes dark matter and dark energy unnecessary. Dark matter is needed to explain the motion of stars in galaxies. Like dark energy, it is called dark because it cannot be seen or analysed in any way. Making them irrelevant would fill a gaping hole of knowledge for astrophysics.

When the group tested the Weyl theory, it gave the same result as general relativity and

“Dark matter is needed to explain the motion of stars in galaxies. Like dark energy, it is called dark because it cannot be seen or analysed in any way”
a small additional term. That was not a problem, since effects of this term were so small that they could not be observed with today’s largest telescopes. The problem, as shown by the Maltese astrophysics group, is that the term grows larger with distance and contradicts observations at the largest galactic scales. This was an important nail in the coffin for the Weyl theory of gravity and Einstein’s theory still remains the best model.

Our next step is to test other alternative theories of gravity by analysing how objects orbit each other. In the same way we disproved conformal Weyl gravity, we hope that these tests will help astrophysicists to eventually come closer to a model that correctly explains the cosmos.

**Bending light**

Gravitational Lensing is perhaps the most sensitive test of gravity on cosmological scales. To understand how it works, consider a lit candle and a wine glass. Imagine holding the wine glass and peering at the candle through the glass’ base. The flame will be distorted and changes shape. Now picture you are with a friend who stands a couple feet by your side. The flame will appear normal to them since they are seeing it from a different perspective and the light does not pass through the glass. Two people with a different point of view see different flame shapes. The wine glass’ base distorts the flame because it acts like a lens changing the direction light travels. Obviously in the Universe there are no wine glasses between the stars and the Earth but objects with huge masses like our sun or galaxies can act like a lens and bend the direction of light by the sheer force of gravity.

When there is no mass to affect it, light travels in straight lines, but insert a massive object and hey presto, the light deflects around it as if it were going through a curved glass lens. The area in which an object feels the gravitational pull of the Earth is called the Earth’s gravitational field. Each object in the Universe has a gravitational field and can therefore pull other objects towards it — like the Earth’s effect on the Moon, which keeps it in orbit.

Anything that enters an object’s gravitational field will feel a gravitational pull towards the center of the object. Imagine a ray of light travelling from a point to another with nothing in between. In this case the ray will travel in a straight line. Never
Nevertheless, if the ray meets with an object along its way to the Earth, the object will pull the ray towards it as a consequence of the object’s gravity. Even though the ray of light will try to keep moving in a straight line, the gravity of the object is so strong that it bends the ray’s path. If a star’s light is being bent by a galaxy, from Earth it will appear that its light has changed, when in reality it would not have changed at all. This effect is called Gravitational Lensing and is currently one of the best tests for alternative theories of gravity, since one can measure the deflection of light and check whether it agrees with the theoretical predictions.

Extreme situations like the bending of light by galaxies cause problems for Einstein’s theory. When summing up the masses of the galaxies, we obtain the mass of the objects that are visible in the cluster. Comparing the predicted light deflection with the observed one, astronomers consistently find that the light is bent ‘more’ than is expected. The way to solve this issue is obvious. Introduce a completely invisible mass that increases the amount of bending until the predictions fit the observation: enter dark matter!

The idea of dark matter emerged a while ago. In 1933, Swiss astronomer Fritz Zwicky suggested it when studying how a galaxy rotation changes as one goes further away from the galaxy’s center. Zwicky observed that the speed or velocities predicted by Einstein’s theory should tear the galaxy apart. In reality, something must be keeping it whole. The idea of an invisible substance called dark matter was born.

Dark matter keeps the Universe together by opposing dark energy that pushes the Universe apart. Dark energy is related to the cosmological constant, previously discarded as Einstein’s biggest blunder, now reintroduced in astrophysicists’ equations to explain the accelerated expansion of the Universe.

The problem with dark matter is that it has never been seen. There is only indirect proof of its possible existence. Deandra Cutajar’s work focused on testing theories where no dark matter is needed. If true, this would put a small spanner into Einstein’s equations.

She tested two theories. They passed the first tests, but they have to pass many more to unseat Einstein’s general Relativity. Going back to the Swiss astronomer Zwicky, the two theories could explain why galaxies are not ripped apart by the speed with which they spin. Dark matter could be dead.

In another test, both theories failed to explain the extra gravitational effect observed in lensing. One theory failed miserably, while the other yielded less accurate results than Einstein’s general relativity. Dark matter is reborn; on the other hand, it cannot remain dark. It needs to be found and studied.

No theory of gravity has yet been found to beat Einstein’s equations. The explanation of how gravity works according to Einstein is better than Newton’s. A curved spacetime clearly explains why light is bent. Einstein’s theory of gravity still holds water and apart from the cosmological constant (his biggest blunder), he was right on most things. When his stunning prediction of how light can bend was observed, he replied, ‘I knew the theory was correct. Did you doubt it?’

What the future holds for any theory of gravity is uncertain, but what is definitively true is that the astrophysics group in Malta cannot accept the fact that we don’t understand 95% of the universe.
The Roman Villa of Żejtun

Malta has a gem. Underneath metres of soil lie the remains of a Roman Villa. Archaeologists from the University of Malta have nearly finished excavating the site. The secrets they are digging out of the ground are pretty stunning.

Words by The Editor
It was hot, I did not want to touch my own car — the metal was boiling. Summer work in Malta is hard labour. But I was driving to meet teachers, lecturers, and students from the University of Malta who have spent countless summers digging up one of the most important Roman ruins in Malta.

Dated from the 4th century BC (a recent dating that pushes it into the Punic period, the Carthaginians) the site combines a residential and industrial area. It is one of two remaining sites in southeast Malta. The Villa’s industry was mainly pressing olives to make olive oil, a hint to the village’s name Żejtun (żejt is Maltese for oil). One can imagine in antiquity, large numbers of these villas producing a particular type of Malta-branded olive oil shipped around the Mediterranean. To think that this valuable site was nearly lost.

And now for some history

In 1961, while building a school they [construction workers] came across large blocks of stone that indicated an ancient Roman ruin. They did not give it much notice. They cleared enough space for the construction of the first school blocks. In 1964, more bulldozing was done and more stuff was found, remembers Prof. Anthony Bonanno (Faculty of Arts, University of Malta), one of the co-directors of the dig. The marks are still clear today.

At this point the Museums department stepped in to preserve the area. Between 1970 and 1976, Frans Mallia, the Museums Department Director, and Tancred Gouder, Curator of Archaeology at the time, used workmen and foreign students studying English to excavate the site. The site was divided ‘in rectangular boxes or trenches with letters assigned to them in order to excavate in a proper way,’ Prof. Bonanno continued explaining. Unfortunately, they used the old-fashioned Italian excavation style which he summarised as: ‘removing a huge quantity of earth, without sieving, and following a wall’s edge.’ This leads to many disputes for dating. ‘Eventually we learnt proper stratigraphic excavation techniques from British archaeologists, namely, peeling off layer after layer after having identified the difference between one layer and another,’ a much more logical approach.

Prof. Bonanno’s more accurate methods started being introduced in 1976 when he was working at University [its first lecturer in Archaeology]. With the permission of Dr Gouder he directed two short excavations with small groups of students. He introduced the stratigraphic sheet, which recorded what came from where and in which layer of earth. Before they stopped, they had ‘the most important and spectacular discovery in just a five-day excavation, which was the discovery of a cooking pot with Punic inscription. Eventually we »
found out that this inscription was identical to scores of others discovered at Tas-Silġ in the 1960s.

The inscription was dedicated to the goddess Ashtart (in Phoenician, Tanit in Carthaginian), the goddess of fertility, agriculture, seamen, and so on — perfect for Malta. Loads of dedications to her were found in the Punic sanctuary at Tas-Silġ, as expected (covered in THINK issue 02, pages 38–44). The Villa’s inscribed cooking pot revealed that religious life in the Punic and Roman period was incredibly rich and extended outside this sanctuary.

**Olive oil for antiquity**

In the 1970s, they found huge stone blocks used to produce olive oil. The Villa was equivalent to an olive-oil-producing factory.

“In the 1970s, they found huge stone blocks used to produce olive oil. The villa was equivalent to an olive-oil-producing factory”

‘The pressing of olives to produce olive oil depends on a fairly straightforward process,’ explained Dr Nicholas Vella (University of Malta) the other co-director of the dig site. ‘You need to apply pressure to olives which have had their pips removed. The ancient sources tell us you did not want to crush the pip because that would create an inferior quality olive oil.’ Dr Vella continued to explain how, peculiarly, today the whole fruit including the pip is crushed, then separated later. Today’s olive oil could be worse than the Romans’. Research is needed to find out, once and for all, which process makes the best oil.

To press the oil, a screw is twisted in the anchor stone block, like that found at Żejtun, to lower a weight on top of olives in baskets. This squashes them against a stone press bed extracting the olive oil that runs...
into channels cut into it. The anchor stone in Żejtun is a very advanced Roman example. ‘I would say this is the Rolls Royce of them all,’ explained Dr Vella excitedly.

The press bed to this anchor stone has not yet been found. The archaeologists think it might never be found if future site users reused it elsewhere, a lost treasure.

What the archaeologists did find during the dig of 2012, when I visited them, was a small press bed. They found it as part of an ancient wall. ‘This [find] is splendid because we had been missing this from the site, now we have it,’ said Dr Vella. It means that as the villa grew in importance it upgraded its olive oil pressing technology. When the Rolls Royce of olive presses arrived they reused the simpler press bed. Nothing was wasted.

To know your future, you must know your past

As I was interviewing Dr Vella, we both noticed the roofs around us. Few of the massive flat surfaces were collecting run-off water, most pipes let their water seep into drainage systems or sewers. This would never happen in antiquity. If it did, they would have died. The ancient people of Malta could not extract water from the sea like we can today through reverse osmosis plants.

This Roman Villa was a large complex. Water was precious and they had one cistern, possibly two, that stored water for usage over Malta’s unforgiving summer. Water was essential, being used for humans, animals, and farming. Water and food were the mainstay of everything. ‘Certainly over here there was a major concern to collect every millilitre of rainwater that fell on this farm’s roofs and store it.’ Covered water channels led the run-off roof water to the storage areas underground.

Ancient Roman texts describe how a Roman farm was built and how crops could be raised even in arid environments like Malta. The viability of farming in Malta is also described in other historical texts. At the beginning of British colonial rule, a text from 1811 describes how Maltese soil, despite being shallow and dry, could grow cotton and vines. While we still have vines, we do not grow cotton any more. Surely there are lessons to learn from the old ways.

Archaeology today

Archaeology is a discipline that naturally bridges fields but has some peculiarities. Unlike the sciences, experiments cannot be repeated. ‘Excavation is destructive, since once layers are removed they cannot be put back; we can’t think of an excavation as an experiment,’ explained Dr Vella. On the other hand, archaeology is incredibly rigorous. It helps make sense of history.

The most important principles are identification of a layer, its deposits, painstaking excavation, and documenting absolutely everything. Figuring out a site is tough work. Archaeologists usually work with 10 metre by 10 metre trenches. Now let us use an analogy to understand a site. Imagine looking at a trifle from above, and slowly removing every layer, placing a number to »
every layer and every deposit, be it cream, custard, or coffee-dipped sponge fingers. Then using these notes to piece together a picture of the trifle. Now, imagine it again. Imagine 'some kids went in and plunged in their hands, lifted everything, and left you with a mess, this is usually the scenario at a disturbed site,' illustrated Dr Vella.

To understand this mess, archaeologists use the Harris matrix. This simple method was invented in 1974 by Dr Edward C. Harris. Each deposit is given a number and then the deposit is linked graphically to adjacent deposits or those below. 'The Harris matrix would help identify what is coming from where,' explained first year student Luke Brightwell, who was being trained on site. 'For example, if you have soil on top, then a layer of stones beneath, and a pit going through the layers', a Harris matrix can answer, 'which layers did the pit go through? Which is the earliest deposit? [...] This is why a lot of time is spent recording the layers [...] You have to plan the site, dig the layers, and see what kind of material was dug from each layer.'

'The challenge is to recognise each stratum,' continued Dr Vella. The strata are identified on site by eye. The deposit is tested for colour and consistency, normally by wetting the sample to identify the type of soil: is it silty, sandy or clay? 'If we realise that we have samples with a good ash content we often take samples in 10-litre or 30-litre buckets. We take them off site, sift them, and pass the deposit through a flotation tank.' The organic matter floats to the surface, is collected, and studied. Then they can paint a picture of the environment and diet of the inhabitants. The crux is making sure that the layer is not contaminated. For example, 'if I have roots going through my deposit the likelihood is that you have a contaminated layer,' which makes it rather useless.

The 2012 dig may have found a gold mine, an untouched (by the 1970s dig) silo pit. Just before they were stopping the excavation the archaeologists uncovered a circular rock-cut feature. 'The shape of the opening is normally associated with Bronze Age features. [...] If it is a Bronze Age silo pit and full of the original material, it's going to be quite a find. Inside it might be environmental evidence of what people ate, stored, or dumped there.' The material will be studied by local UoM specialists, but other help might be needed for dating. For example, if the archaeologists are sure about the integrity and origin of a sample they can send it for carbon dating. But, 'I can't just send one piece; I have to send half a dozen for it to have statistical value,' said Dr Vella, making it rigorous but expensive. Dating is vital for archaeology and other techniques are also used.

Pottery is a typical dating tool and can be linked to a particular period. Punic pottery is different from Roman and Arabic pottery. Since everything is deposited in reverse or-
der, it is the bottom layer that usually gives a site’s earliest date.

Pottery can even be used to date a wall. For example, to date its construction, ‘I will analyse and date the pottery that ended up in the construction of its foundations. Usually bedrock is cut, the wall is placed in that trench and, if we are lucky, the workmen would have thrown in their pottery together with other rubbish. We look at the latest pottery in the trench fill and if it’s from the 4th century BC, we can safely say that the site is from this period or later,’ said Dr Vella.

The Roman Villa had Punic pottery in the construction fill for some of its walls. An older structure — possibly a farm — must have been present and modified.

More accurate than pottery are coins. Coins from the Roman Imperial period had the emperor’s face struck into them. A quick look through Decline and Fall of the Roman Empire by Edward Gibbon quickly gives you the date of each emperor’s reign. Coins are much rarer than pottery, and if both are not present, the archaeologists rely on other dating techniques like carbon dating.

The UoM only runs a one-month excavation every year, but this is followed up by months of research to write up and process the collected documentation and material. All are performed to paint an accurate picture of a site’s history.

Archaeology for Education

This excavation is a student’s practical training. The site ‘is very different from lectures. […] We have to apply what we learnt in lectures over here on site,’ said student Luke Brightwell. The aim is ‘to train students with the basic skills in archaeological excavation techniques and recording systems’ said Dr Vella. Basically, after they graduate the students will be better prepared to handle their own digs whatever they do afterwards. There are many types of archaeologists needed to monitor building projects by the local planning authority (MEPA), the local state heritage regulator and building contractors.

Archaeology also teaches other transferable skills. A dig enables students to build team-working skills, reports teach writing and research skills, while presentations build communication skills. With a bit of creativity and the ability to put yourself »
Students thinking about Archaeology

This dig is a training excavation. The students are being trained to perform archaeological excavations after graduation. I spoke with three students; below are their thoughts.

Annalise Agius
B.A. in Archaeology (Hons) (2nd Year)

Annalise is the most enthusiastic student I met. The dig made her fall in love with archaeology. ‘The course is fantastic.’ Annalise goes further, ‘it gives you motivation because you know that as soon as you finish your exams you know you’re going to be here.’ Her enthusiasm is infectious. She loves the opportunity of this dig to discover Maltese history, but is open minded enough to go abroad for the right opportunity. Her final words: ‘a student in archaeology must experience a dig to know what archaeology is about. Because once you experience the dig you either like it or you don’t, but if you like it, it will be fantastic. You just want to dig, dig, and dig.’

Joseph Grima
B.A. in Archaeology with International Relations (1st Year)

Joseph is a Gozitan student who wakes up every day at 5 a.m., catches the 6 a.m. Gozo ferry to Malta then arrives on site at 7:20 a.m. Joseph grew up around antiques, ‘my father collects military vehicles and my uncle also collects antiques. So I grew up conscious of old things, a collector.’ Choosing archaeology was a no brainer for him. ‘At University I learnt who they [Phoenicians] really were, why they left their homeland.’ However, he is still uncertain what he will do with his degree. ‘Too far from where I stand right now, I tend to take it as it comes. I’ll try my best.’

Luke Brightwell
B.A. in Archaeology with Geography (1st Year)

Luke was going to choose to specialise in geography till he came on site. ‘This experience caused this change, even the lectures. The way the lectures are given is completely different […] full of information and, for example, the lecturers show you a picture of an object and then you start discussing the item with them: its period, its function, its style of decoration, and why, which is a lot more engaging and practical.’ He also already knows what he wants to do afterwards. ‘I would like to become an archaeologist. Complete my first degree, then do a Master of Arts to continue broadening my knowledge.’

Students are monitored by Dr Dennis Mizzi (Dept. of Oriental Studies, UoM), Rebecca Farrugia (UoM), and Maxine Anastasi (University of Oxford, UK)
out there, abilities learnt from an Archaeology Degree can be adapted to many other jobs.

Even more exciting, UoM archaeologist and lecturer Dr Timmy Gambin wants to plant around 30 olive trees of the Bidnija variety. This variety is unique to Malta and is resistant to flies making it pesticide free, hence organic. They want to reconstruct a Roman era olive oil extraction system and build a small teaching museum on campus, ‘a sort of experimental educational archaeology area,’ explained Dr Vella.

Villa of the Future

Dr Vella wants to find a large flag and plant it near the site. He wants to show what the UoM’s staff and students are doing. He wants the people of Żejtun to know about their history. With Prof. Bonnano, they are working with local NGO Wirt iż-Zejtun to raise awareness about the site. The archaeological team regularly gives seminars to the surrounding community. Ideally, they would have locals participating in the dig, a steep challenge.

Wirt iż-Zejtun and the local council might hold the key to the Villa’s future. When a site is dug up, material, which perhaps was buried and stable for hundreds of years, is suddenly exposed to the elements. The weather has already destroyed the lustre of the beautiful Roman terracotta tiles exposed in the 1970s.

The excavation could be completed in two to three years’ time. After excavating a site, archaeologists usually have two options. They can either bury the site again, which needs re-excavation to be shown to the general public or studied further. Otherwise, it can be sheltered and protected against the elements. This greatly slows its deterioration, allowing the public to visit the site, and the research to continue. Initial steps have already been made by a conservation project co-ordinated by Prof. JoAnn Cassar and Roberta De Angelis (Faculty for the Built Environment, UoM) using funds raised by the cultural NGO Din l-Art Ħelwa through the HSBC Malta Foundation.

Local entities could manage the site through a guardianship deed with the government,’ said Dr Vella. ‘Entities would take care of the site on behalf of the state.’ The site could pull in tourists and locals alike. It would revitalise the area through increased tourism and by acting as a teaching museum. Dr Vella imagines the site being used to teach physics, biology, and Maltese history in a fun and living manner. Maybe, in five years time, I will be driving to take visiting friends to Malta’s newest visitor attraction: The Roman Villa of Žejtun.
The winter rays of sunlight reflected off the snow upon Mount Maiella and the beautiful Adriatic Sea. They lit up the room where I was sitting with Dr Esposito (head of the Neurophysiology unit, Mario Negri Sud, Italy). On this cold day in February the light was blinding and it was difficult to make out my long time friend and colleague. Together we had studied the brain chemicals serotonin and dopamine vital for love, pleasure, addiction, and linked to depression — my research subject.

‘Ennio, I am tired and frustrated. I am increasingly convinced that our in vivo (whole organism) experimental approach is not the right one. There is too much variability in the results and if we really want to understand the cause of depression and find a new cure we need to get some reproducible data and change our tactic.’

At that time, I was using glass electrodes to study changes in the electrical activity of single neurons in brains. Additionally, I used a technique (microiontophoresis) that registers neuron electrical activity and also applies a very small amount of the drug. In this way, I could see which brain cell was active and how different chemicals might influence it. Surprisingly, though introduced in the 1950s, these techniques are still some of the best ways to study drug effects on a living brain.

My research focuses on the role of two brain chemicals, dopamine and serotonin, in mental disorders. When stimulated neurons release chemicals (neurotransmitters), I am interested in dopaminergic neurons which release dopamine and serotonergic neurons that release serotonin. Once released, chemicals can pass through the spaces in between neurons and bind to another neuron stimulating or inhibiting it. They bind on proteins called receptors. When they do, they trigger the cell to fire or shut down. By triggering certain neurons in our brains, they reinforce or change our behaviour.

Dopamine is involved in the pleasure pathway. It switches on for behaviours like emotional responses, locomotion, and reinforcing good feelings. Changes in the level of dopamine effect a person’s reward and curiosity-seeking behaviour, like sex and addictive drugs. On the other hand, serotonin seems to have a more subtle role. One of serotonin’s major roles is to modulate or control the effects of other neurotransmitters, such as dopamine. In the words of Carew, a Yale researcher, ‘Serotonin is only one of »
the molecules in the orchestra. But rather than being the trumpet or the cello player, it’s the band leader who choreographs the output of the brain.” The belief that serotonin is the brain’s ‘happy chemical’, that low serotonin levels cause depression and antidepressants work by boosting it is a very simplistic view. In truth, no one knows exactly how dopamine and serotonin levels induce depression.

A lot of what we do know is because of animal research. The animals used to model this disease are given antidepressants to try and understand how effective they are and how they work. By studying their brains we can start to comprehend what causes depression. Right now we do not understand the whole picture behind the causes of depression and patients end up receiving inadequate treatment. We still do not understand how many psychoactive drugs actually work, meaning that more research is needed.

Most drugs were discovered by chance while being used to treat other disorders. For example, the antidepressant Iproniazid was originally developed to fight tuberculosis.

“We still do not understand how many psychoactive drugs actually work, meaning that more research is needed.”

After the researchers saw less depression in patients suffering from tuberculosis they started prescribing it to depressed patients. In another example from the 1950s, clinicians discovered the first tricyclic antidepressant while searching for new drugs against other mental diseases.

Today, we fortunately have a battery of drugs that can treat depression. Unfortunately, the best drugs on the market only completely alleviate symptoms in 35 to 40 percent of patients compared to 15 to 20 percent taking a placebo (a sugar pill), a fact not publicised in pharmaceutical ads. Another problem is that when people begin taking antidepressants, mood changes can take four weeks or more to appear. This delay in action is one of the major limitations of these medications since it prolongs the impairments associated with depression, increases the risk of suicide, the probability that a patient stops treatment, and medical costs. To tackle these problems pharmaceutical companies and academic researchers want to find more effective and faster acting antidepressant drugs.
Ennio and I, together with Vincenzo Di Matteo and other researchers at the Mario Negri have tried to resolve the antidepressant lag time enigma by studying rats. We first inhibited the levels of serotonin for 3 weeks using the latest Selective Serotonin Reuptake Inhibitors (SSRIs) named fluoxetine, sertraline, and citalopram. Then we measured the electrical activity of dopamine and serotonin neurons in rat brains. We discovered that the therapeutic effect of antidepressants is not only due to their capacity to restore a normal level of serotonin activity. It also induces adaptive mechanisms in the dopaminergic system (that releases dopamine) because of repeated treatment.

How do SSRIs treat depression? At first, these chemicals only slightly stimulate serotonin release. Long-term treatment kicks in an adaptive process. The receptor type located on serotonergic neurons which inhibit serotonin activity become insensitive. Repeated treatment frees serotonin neurons from this ‘brake’. By repeatedly using these drugs (with a lag time of 2–8 weeks), the levels of serotonin being transmitted increase and stay high for a longer time which is responsible for the SSRIs antidepressive effect.

The perfect antidepressant could lie in blocking the activity of these receptors since there would be no major delay in action. This hypothesis was confirmed by Francesco Artigas and his research group (University of Barcelona). They administered pindololo, a drug capable of blocking these serotonin receptors and observed an increase of the antidepressive effect of the drugs paroxetine and fluvoxamine. They worked by reducing the latency period. Patients on pindololo did noticeably better and the clinical data matched that from laboratory animals. Blocking this type of serotonin

>
receptors can be a promising therapy to reduce the latency period and possibly, increase antidepressant action.

My colleagues and I formed an alternative hypothesis as to why the clinical effects of drugs are delayed for so long focusing our attention on the dopaminergic system. We showed that acute administration of different SSRIs reduces the electrical activity of dopaminergic neurons, which release dopamine. These drugs increase the levels of serotonin, which decrease dopaminergic neuronal activity (which release dopamine) by over stimulating another inhibitory serotonin receptor this time located on dopaminergic cells. The result? The drugs taken to cure depression paradoxically initially induce a reduction of dopamine, which is meant to be the neurotransmitter of well-being and happiness! Indeed, SSRIs can worsen the depression of patients in the first few weeks of treatment.

When the drugs are used over a long period of time (3–4 weeks), the initial reduction of dopamine reverses. The change happens because the repeated treatment reduces the sensitivity of this type of serotonin receptor on dopaminergic cells freeing them from their serotonin ‘brake’.

“I have spent my life trying to figure out the role of dopamine and serotonin in the brain”

We think we have found the reason why SSRI antidepressants take so long to work. Two different serotonin receptors need to become insensitive to the level of seroto-
nin in the brain, one found on serotonergic cells, the other on dopaminergic cells. Their insensitivity allows the activity of dopaminergic neurons to return to normal even though the serotonin activity has been bumped up.

Other labs have confirmed our results, which is vital step for a theory to become fact. Cremer and his team (University of Groningen, Netherlands) have shown that blocking the same type of serotonin receptor on dopaminergic cells in rats can improve the effect of SSRIs antidepressants. Ultimately all of our work has made it possible to consider new treatments of depression, which I am very happy to see.

Many questions remain unanswered about depression. The most urgent task is to find a more effective way to treat it. This is my goal. I have spent my life trying to figure out the role of dopamine and serotonin in the brain — with some notable successes. I hope to see the next generation of antidepressants which would improve the life of 121 million depression sufferers.

Ennio listened to me as I expressed my frustration after once again obtaining conflicting results in the laboratory. 'Giuseppe' he said 'You are right, billions of neurons in our brain behave differently, but as Douglas Adams said, 'If you try and take a cat apart to see how it works, the first thing you have on your hands is a nonworking cat. Life is a level of complexity that almost lies outside our vision' (Hitchhiker’s Guide to the Galaxy). If we want to break the code of the brain and hope to treat its diseases we need to take a holistic approach that takes the whole brain into account. ●

Article dedicated to the prominent researcher Dr Ennio Esposito, Prof. Di Giovanni’s (Department of Physiology and Biochemistry, UoM) colleague and friend. In 2011, he died of a heart attack. During his last years, he suffered from a severe refractory bipolar depression. If interested in an M.Sc. or Ph.D. in biological psychiatry please contact Prof. Giuseppe Di Giovanni on giuseppe.digiovanni@um.edu.mt

FURTHER READING

- Depression — National Institute of Mental Health, USA http://bit.ly/1NlMhD
Food safety is serious business. In Germany during 2011 a single bug hospitalised over 4,000 people causing 53 deaths. Scientists learnt afterwards that a strain of *E. coli* had picked up the ability to produce Shiga toxins. These natural chemicals cause dysentery or bloody diarrhoea. The bacteria were living on fresh vegetables and it took German health officials over a month to figure out which farm was responsible.

On the 2 May, German health authorities announced a deadly strain of bacteria in food. By the 26 May, they pointed their finger at cucumbers coming from Spain. They were wrong. The mistake cost the EU over €300 million in farmer reimbursements. Genetic tests found that the bacterium on cucumbers was different than the one which was killing people. The researchers continued to ask people who were infected what they ate: raw tomatoes, cucumbers, and lettuce remained the prime suspects. Till they tested organic local bean sprouts from a farm in Bienenbüttel, Lower Saxony. By the 10 June, the farm was forced to shut down after it was pinpointed as the source. The sprouts were contaminated from the seeds’ source in Egypt.

‘These bean sprouts are found in several ready-to-eat foods, you could have it in your sandwich and not realise that you’re eating it,’ said food scientist Dr Vasilis Valdramidis (University of Malta). This is the reason why it took German officials so long to find the source. Having to rely on people’s memory of what they ate before becoming sick, something as inconspicuous and mild tasting as a bean sprout can be forgotten. Precisely why industrial food safety is so important: it saves lives.

**Cleaning food**

‘There is no natural sterile environment,’ stated Dr Valdramidis who studies new ways to disinfect ready-to-eat lettuce, cabbage, and bean sprouts to make our food safe. Most bacteria come from nature or during...
handling. ‘After harvesting, there are 3 different steps for processing fresh produce. First, they are washed to remove all external material. Second, there is the disinfection process. [...] Third, they apply a decontamination treatment that most commonly is chlorinated water.’

Dissolving chlorine dioxide powder into water makes most of the industrial chlorinated water. Chlorine is found in tap water so is relatively harmless at low concentrations, but ‘the less we have of this chemical the better for our health, because there are some side effects,’ explained Dr Valdramidis. ‘It can react with the organic substances of food products and produce some compounds [...] that aren’t healthy.’

The environment is another problem. Chlorinated water ends up in ground water or other water sources. Elevated levels of chlorine can decontaminate vegetables but also natural habitats.

Dr Valdramidis’ group works to reduce the amount of chemicals, water, and energy used. Fresh water is a precious resource with less than 3% of the world’s water being fresh. In Malta, pressures on fresh water use are intense and the country is facing a little known water crisis. Worldwide energy efficiency is a hot issue, with both environmentalists and industry pushing for greater efficiency and cheaper energy bills.

From Oregano to Music

The herb oregano can be concentrated with its essential oils extracted. Surprisingly, at the right concentration oregano slows bug growth. Dr Valdramidis’ group is taking advantage of this antimicrobial effect to disinfect vegetables. ‘And it tastes better, but it depends on the amount; if you use too much it is bitter.’

“Fresh water is a precious resource with less than 3% of the world’s water being fresh”

The food industry’s bottom line is cost. ‘The extraction process is quite expensive but now the price is going down. [The food industry already] use oregano oil as antimicrobial agents in feeding products for animals. Their aim is to reduce the use of antibiotics. It [oregano] is becoming more and more accessible.’

Oregano oil might be more expensive, but it is a natural product that is non-toxic. Another advantage is that, ‘if the plant cells are relaxed then these essential oils can penetrate’ into the plant disinfecting it thoroughly. Once optimised, it could easily replace chlorine water, reducing the amount of damaging chemicals used.

Oregano could replace chlorine water, but what about the amount of water? Another technique, which uses sound to clean food, could help. Think about ultrasounds used to scan pregnant women. Those ‘operate on megahertz and create images, this [technology] operates on kilohertz and is powerful enough to create physical changes at a microscale,’ which means they are high power systems. It works by pulsing sound waves at your submerged vegetable or fruit of choice. The sound creates bubbles that implode, creating a very high pressure and temperature. This energy can kill the bacteria. When Dr Valdramidis gets it right, it cleans the vegetable.

The process is even more extraordinary. The sound wave causes a molecule of water to split and create [the molecules] hydrogen peroxide and other radicals, which are very unstable’ so they react with everything around them (including bacterial DNA), either becoming water again or attacking cells. ‘They affect the membrane of the bacterial cell,’ said Dr Valdramidis, ‘killing it.’ They can also damage plant cells, so the technique
needs fine-tuning to get it right. By measuring the appearance, amount of vitamins, enzymes, and other nutrients lost by the procedure, researchers can tweak it to maximise its antimicrobial value and minimise its damage to the vegetable. To continue improving the technique a lot of his work is spent trying to understand exactly how the procedure works and why the bacteria die.

The ultrasound still needs water to work. Water cannot be removed from the equation because bubbles can only form in water and sound also travels better. Water quantity can be reduced. When using chlorinated water, another step is needed to rinse off the chlorine. In this case, it can be skipped. There is an even more radical technique that might bypass water altogether.

**Plasma**

Plasma is made of ionised air. In nature, plasma is made by lightning, leaving a tell tale ozone smell. Food scientists can pass high frequency electricity through air to create a bacteria-killing plasma stream. Ionised air kills bacteria because it forms radicals and ozone. Electric discharges create radicals and turn oxygen into highly reactive oxygen radicals (an unstable oxygen atom) or ozone (3 oxygen atoms joined together). These products can react with bacteria and inactivate them. Like sound waves they can also affect food. ‘High levels of ozone can bleach food by oxidising the product. There is no ideal technology,’ stated Dr Valdramidis. The difficulty in all of this is how to kill the bacteria and not the plant. Everyone wants salads with a nice colour, good flavour, and high nutritional value.

On the other hand, the beauty of this technique is that you can zap the food in its packet. So imagine just zapping the food with a little water, wrapping it up, and finishing off the cleaning process with an electric pulse. The package can be delivered to your local grocer with minimal use of water and your mind at rest. Both sound waves and plasma could also spell the end of excessive chemical treatments.

**A computer model of a fruit**

Measuring microbe levels is the only certain way to know if food is safe. Traditional methods are labour intensive, time consuming, and expensive. Scientists first need to remove the bacteria from the product, then dilute the bacteria, then count the cells directly with plate counting techniques or under a microscope. More modern techniques use molecular methods such as PCR (Polymerase Chain Reaction) to find out the specific type of bacteria. This can make a huge difference since not all bugs are created equal.

To reduce costs and speed up the process, Dr Valdramidis uses mathematical models to predict the shelf life of products and apply the right decontamination process. ‘We want to predict the amount of bacteria present, so with these equations we are trying to describe how fast the bacteria are inactivated then [how fast those that survive] grow,’ explained Dr Valdramidis. The number of bacteria predicts food safety and how fast it rots.

“The sound creates bubbles that implode, creating a very high pressure and temperature”
For mathematical modelling to work, first ‘data needs to be collected [...] by performing some experiments. Then I try to describe how the population responds and behaves using these equations. If I can verify this model, then I can come to you and tell you, ‘look, this product has these specific characteristics, within the range of this model, I can tell you that it will expire in 15 days and you don’t need to do any experiments.’ It’s a very powerful tool but it has to be well validated. It saves a ton of money, but you must be sure of the model otherwise people could be harmed.

Current maths has its limits. Scientists are still trying to correctly model a single cell. Plant or bacterial cells are complicated machineries, with proteins, DNA, and other molecules all jam-packed together working synchronously for a cell’s survival and reproduction. To make things easier, scientists simplify cells when simulating them then consider a whole group of them, a population. Researchers test the whole population. If Dr Valdramidis’ group attempts to model a single bacterial cell’s growth in Malta, he would have to use the University’s supercomputer called ALBERT. Maths on this level uses a lot of computational power.

Taking the cell modelling idea to its extreme, some food scientists are trying to model every plant cell to make a complete fruit — a virtual fruit. They model, ‘the exchange of gases and so on since fruit is still respiring, still alive after harvesting.’ To control the respiration process, they ‘try to control the amount of [the hormone] ethylene, oxygen gas, and so on.’ They also use these models to simulate modified atmospheres around food seeing how they influence respiration rates. Shelf life is affected by plastic packages with different holes sizes, types of plastic, and other parameters. All of these properties are pumped into the mathematical equations and tweaked to maximise shelf life. ‘If you slow rates down, the food lasts longer and can be stored for a longer period,’ explained Dr Valdramidis, which makes both companies and consumers happy.

Working with industry

Dr Valdramidis is young but has a long career in fundamental research. He has modelled and tested the rate of bacterial growth (and inactivation) at changing temperatures, and even investigated how to decontaminate biofilms in industrial food processing plants. Importantly, he has looked into quantifying and speeding up the analysis of microbial levels on food to give an actual ‘best before’ date. His approach always coupled experiments to test his maths and predictions.

Innovations in food science aim to bring down prices, use less water, fewer chemicals, and less energy. For these reasons, Dr Valdramidis is now at a stage where he can collaborate with industrial partners. In Malta, he has already met with the Chamber of Commerce through the creation of a Food Industrial Advisory Platform. With this platform we plan to organise workshops every 6 months. Once to speak about our activities and another to speak about subjects that are of interest to SMEs [Small to Medium Enterprise, or industry]. Malta is run by food SMEs; they account for 65% of GDP.

Researchers need to work with industry — a statement on everyone’s bucket list. Its importance cannot be understated, since it is unlikely that universities will receive substantially more research funds unless businesses start seeing these institutions as partners. And, they could save or make big bucks by investing in research. Dr Valdramidis’ work is a clear call for collaboration.

Working with others is what drew Dr Valdramidis to Malta, ‘I firmly believe in collaboration. A lot of my [research] publications are not just from the university I would be working in but others as well.’ By opening arms wide open perhaps we can prevent mistakes, like those of the German health authorities, invest in research that reduces waste, and cleans our food just by playing a song at the right energy.

Some of the above research is supported by a Marie Curie FP7-Reintegration-Grant within the 7th European Community Framework Programme under the project ‘Development of novel Disinfection Technologies for Fresh Produce (DiTeC), and part-funded by the Malta Government Scholarship Scheme.'
ALUMNI talk

From cancer research to managing Malta’s largest companies, to opening your own ICT business, life after University can be fun

Developing new cancer treatments

TESSABELLE SULTANA talks about her journey from studying chromosomes to researching cancer vaccines

THE LAB IS my second home, with the rugby pitch a close third. My fascination with lab work and science started when I visited Tays Hospital in Finland. It was during my bachelor degree in Medical Laboratory Science. This three-month placement helped me choose cytogenetics for my final year project. My work involved developing a technique to allow for doctors to better manage sporadic and recurrent miscarriage patients.

My interest in cytogenetics (the study of chromosomes where genes are found) evolved to genetics, when I started working at the biotech company MLS BioDNA Ltd. This laboratory focused on the testing of inherited diseases, paternity and forensics, as well as food and water microbiology. Working in a diagnostic laboratory was very satisfying but I had always wanted to pursue research. So I moved to Sheffield to read for a Masters in Molecular Medicine, with the help of the Malta Government Scholarship Postgraduate Scheme (MGSS). My intention was to just stay for the course and return home, however, my current supervisor offered me a 10-month contract to work in a molecular microbiology lab. This was a very pleasant experience, and encouraged me to pursue a Ph.D. I received a scholarship for a Ph.D. in Immunology at the University of Sheffield, which I am currently working on.

Vaccines can prevent certain infectious diseases. Potentially, they can also treat cancer. Vaccines today are based on small proteins, which by themselves do not elicit a strong immune response. To treat cancer a strong response is needed. Immunological adjuvants that amplify the immune response are used to accomplish this. However, no one really understands how these adjuvants work. For my Ph.D., I am part of a research group that focuses on an immunological adjuvant which increases the immune response by over 1,000 times. Understanding how these adjuvants work will pave the way to more targeted treatments and fewer side effects.

My job is to understand which immune cells are responsible for this effect. The adjuvant has been shown pre-clinically to be effective in B cell lymphoma, a type of cancer of the blood that originates in the lymph glands. Patients are currently treated with the drug Rituximab which depletes certain immune cells called B cells. If our treatment requires other immune cells to work, it can be used in addition to therapies such as Rituximab.

Although a Ph.D. is something which I really wanted to do, it was still a shock to my system. Scientific research can be very frustrating as long hours and hard work do not necessarily translate into results. In spite of this, the long-term goal of this project keeps me going making the sweat and tears worth it. ●
My family remains my priority, though they may not believe this. My career has helped shape me. The following are the best values that have made a difference to who I am.

**TOP TIPS TO SUCCEED**

by Antionette Caruana

- Have a dream and go for it... Make it happen. Believe that no one owes anyone a living. If you falter, try again.
- Work with others.
- Be as good as you can in what you do.
- Always have a passion for learning in everything you do. Keep your eyes and ears open. Be aware of what is happening and contribute.
- Keep true to your values.
- Tell people who have made a difference to your life that they have, and treasure them.
- Say sorry at work, at home, and invest time to build trust and commitment.
- Be a good example by working long and hard. Sometimes you will be tired and grumpy but pick yourself up and move forward.
- Invest in relationships which really matter.

**Goings for it... and all it takes!**

ANTIONETTE CARUANA shares her successful career from banks to food manufacturing companies

**FEMALE, OVER 50** years old, raising two young adults (who think their mum is technologically challenged and old), a patient and supportive husband (partner for over 24 years), encouraging parents, and friends and family who have been there for me whenever needed. These qualities are the critical aspects of my life which is full, overflowing, sometimes exhausting but truly rewarding. My first job was nearly 35 years ago, and the years have flown by.

Many opportunities were opened by starting my career at a local bank after my first degree at the University of Malta, B.A. (Hons) in Business Management. At the same time, I married my husband who gave me more enthusiasm. My studies opened up a great interest in understanding the role of people in organisations, management, strategy, and performance.

Then I changed my job. Soon after I got married, I took the plunge and joined Playmobil entering a career that lasted more than 13 years. During this time, I learnt so much about business, running an organisation, and people management. The job was challenging and needed long hours with some tears and a dose of determination to succeed, but I could make things happen.

During my job at Playmobil, I had two children, completed my Masters’ degree and also got involved in many opportunities outside Playmobil including the Federation of Industry, the Foundation for Human Resources Development, the Richmond Foundation and worked with different departments of the public sector. I also took on different projects and lectured at University to keep in touch with students (the employees of the future) and academics (the launchpad of innovation and debate).

Being an idealist who is obsessed about achieving results, I sought my next challenge: to make a difference by taking a leading role. I applied to head Heritage Malta as
Ships to Computers

KEITH FEARNE talks to us about his work and success in the ICT business world

IN 1991, when the first DOS-based PCs started to become available, I graduated from the University of Malta after having read for a degree in Electrical Engineering. The Internet and mobile telephones still had not appeared.

There were no ICT courses at the UoM. Engineering courses were the closest I could come to entering this field. Teaching of computer science was therefore obviously limited, but at least we received a fair amount of computer architecture and networking theory. We also built our first processor boards, and wrote our first code in assembly language. The Dean was not thrilled when I approached him to announce that I wanted a ‘software only’ thesis, a first. But I got away with it, and code in assembly language. The Dean was not thrilled when I approached him to announce that I wanted a ‘software only’ thesis, a first. But I got away with it, and

When I graduated my computing future did not look bright. I was tied by a two-year contract with Malta Shipbuilding, to whom I was assigned during the student worker scheme. I had spent three summers working there managing a team of electrical technicians, which toughened me. After this experience, managing teams should have been relatively easy.

During my last months at University I decided that I wanted to enter the IT world. I started shopping around for a job while doing some teaching at a private school. I landed a job at the software company Megabyte as a systems engineer and decided to end my contract at Shipbuilding paying the required financial penalties. Financially not the best decision but best for my career.

After seven years at Megabyte, I moved on to become the CEO of the Internet company Maltanet. I spent 8 years running the company. In Malta, during this time the Internet market was growing exponentially. The pace of technology accelerated tremendously making it a very exciting time within a highly competitive environment. When GO was fully privatised we merged all the subsidiaries and I spent nearly 3 years as Chief Commercial Officer for the group. Managing the commercial portfolio of a quad play operator was an instructive and rewarding challenge.

Today I run my own firm called ICT solutions. In 2009 I set up a joint venture focused on two areas, ICT servicing and software development. It employs a team of over 20 people, mostly UoM graduates. They provide solutions to cater for the ever growing ICT requirements of the corporate world.

So what lessons have I learnt? Firstly, there is no ‘one size fits all’ solution and everyone needs to build on their strengths. Secondly, you need to put in long hours. If you do not work harder than your normal 9 to 5 employee, then you will remain a normal 9 to 5 employee. Thirdly, you need to keep abreast and understand technology cycles and where the market is going. Be technically competent but appreciate business logic. Fourthly, and most importantly, relate to people and build relationships with your team and clients.
Malta — a tiny Island, a minute social reality, a precursory canovaccio of European unification — has a unique asset it ought to be prouder of: Culture.

For millennia our bonsai place has attracted a continuum of passing civilisations leaving behind them a most colourful and diverse compendium of customs, behaviours, artistic expressions, and intellectual attitudes. Malta's investment in this unique legacy should not be limited to conservation. It needs to be kept alive through constant support of the contemporary expression of its youth. This attitude will certainly transform our Culture into a most effective and efficient currency of change and growth.

An Alternative Currency

by MARIO FRENDO

Malta — a tiny Island, a minute social reality, a precursory canovaccio of European unification — has a unique asset it ought to be prouder of: Culture. For millennia our bonsai place has attracted a continuum of passing civilisations leaving behind them a most colourful and diverse compendium of customs, behaviours, artistic expressions, and intellectual attitudes. Malta's investment in this unique legacy should not be limited to conservation. It needs to be kept alive through constant support of the contemporary expression of its youth. This attitude will certainly transform our Culture into a most effective and efficient currency of change and growth.

Dr Ben Goldacre is on a mission. The 600$ billion pharmaceutical industry, some doctors, regulators, medical journals, and whole governments should be trembling. Goldacre wants to show the truth behind how our medicines are made. He wants transparent companies, properly informed patients, solid research, and cheap, effective drugs, preferably for all.

In typical Goldacre style, he rants. Ignore the apparent chip on his shoulder. His statements are thoroughly based on facts. The facts are shockingly scary.

Take the drug Tamiflu, the supposed miracle cure for flu. The pharmaceutical company Roche made over €500 million in 2009 on the back of the swine flu scare. The drug is known to reduce flu symptoms by a few hours, a hefty price tag for a spot of relief. Initially, Roche said that it reduces complications by 68%, amazing! Though when the gold standard reviewer Cochrane started scratching the surface they hit a brick wall. Roche refuses to publish data requested years ago and we still do not know how effective it is.

Even regulators get it wrong by being too business friendly or opaque. Diabetes drug Rosiglitazone was recently taken off the market after over 10 years of intimidating researchers who published data against the drug in 1999. Rosiglitazone increases heart problems by 43%. Regulators failed to share data transparently, which slowed action, an endemic problem.

Pharma has even failed cancer patients by stopping trials early to make drugs look better. Trials can also be run longer than needed to fuzz data. Goldacre lists endless examples to buttress his arguments.

Companies spend double on marketing drugs compared to research. In the US they can reach and influence consumers directly irrespective of efficacy, price, or need. Where direct marketing is banned, companies shift budgets and reach doctors through drug reps, people whose job it is to convince medics that their company’s drug is the best. Pharma even disguises marketing as research fooling doctors and wasting their time. Well-respected doctors are also paid handsomely to talk about products.

Apart from scandalous facts, Goldacre is a master of explaining science simply and clearly. Chapter 2 has a great introduction on how drugs are made. He clearly explains the difference between relative risk or absolute risk, or how bias and probability are manipulated by pharmaceuticals. His lucid style makes this book a great read and well recommended for anyone wanting to know the dirty secrets behind pill manufacturing.

Thankfully, Goldacre also suggests how it could be solved. My only advice is not to debunk the whole system when reading this book, remember the good stuff: life-saving antibiotics, disease eradicating vaccines and much more. The current system just needs some serious tweaking to remove the bad loop holes Big Pharma exploit to meet profit margins. But drug research has to go on.
**PUSH START.** Grab a weapon. Get shot. Repeat... *ad infinitum.* ‘Punishing’ hardly describes a session of *Hotline Miami.* Typically, within 10 seconds you could die three or four times. It is just as frustrating as it is challenging. Addictively, you will not give up until you pass that sneaky little passage.

*Hotline Miami* is an ultra-violent, psychotic game, where your only aim is to kill all the ‘bad guys’. Yet, every little move counts, and deciding which weapons to use or which door to open first will reveal the deep strategic possibilities of the game’s intense experience. As you make your way through a pile of corpses, the suspense builds up to unbearable levels as you risk losing all in-game progress for just a little mistake. The massacre is only interrupted by brief moments that reveal details of our mysterious ‘hero’s’ back-story. Keeping true to expectation, even these interludes are awkward if not disturbing, and hardly shed light on our displaced, faceless avatar.

The excellent game tops it all with an irresistible ‘80s aesthetics and a neurotic electronic soundtrack. You’ll quickly find out why this game has stolen the show winning so many awards, and has hooked fans of *Grand Theft Auto* and of good old *shoot ‘em up* games. *Hotline Miami* is a joy in repetition, providing that being stuck in a *Clockwork Orange*-like scenario is your idea of joy.

**FACT or FICTION?**

**Can AI ever become sentient?**

*Asked by Malcolm Bonnici*

There is hope, there is fear, but no solid answers. Many bicker on the definition of artificial intelligence (AI), computers, robots, machines, and being sentient. If your definition of sentience includes being conscious, arguments can be bogged down in whether material objects can ever become conscious.

In 1950, Alan Turing circumvented the problem by suggesting the Turing test. If a human cannot distinguish between a computer and human then the computer has achieved sentience. The illusion of sentience is enough for Turing. The argument has its flaws, but with the US starting a brain-mapping project and the EU recently launching a billion euro project to simulate the human brain with supercomputers, artificial sentience could become reality. And, the next inevitable question would be: would they take over the world?

A tricky question since boredom is a mental state. Usually it is triggered by an uninspiring, monotonous environment and/or certain brain chemicals like dopamine (for more on this chemical see page 36). People who produce less dopamine, or are less sensitive to it, are bored more easily.

People bored for a very long time can suffer from clinical depression, which surely reduces lifespan. Other boredom sufferers have ADHD (attention deficit hyperactive disorder) and extreme ways of combating boredom can be equally dangerous. They could abuse drugs and alcohol or seek thrills in risky sports. Others could become sexually promiscuous. All of these behaviours reduce lifespan.

**CAN YOU DIE OF BOREDOM?**
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ELECTRICITY HAS KILLED the ghost story, said author Ruth Rendell while commenting on a tale by M. R. James. She has a point. The ectoplasmic pose thrives on darkness, occupying those spaces that elude the intrusive sanctuary of light. Thomas Edison and his light bulb must be the greatest ghostbusters of all time and Andy Muschietti’s film Mama, one of their latest casualties.

Candlelight encourages unnerving narratives: a flickering flame, after all, choreographs crazy cavorting shadows. And gaslight creates pools of light amid pitch blackness, which is why the Golden Age of the ghost story was between the 1830s and World War I, when candles and gas were mostly used.

A trip to the cinema combines all three: the film is essentially a beacon of moving shadows (candlelight) on a screen surrounded by obscurity (gaslight) and a source of electricity (the projector). In a way the cinema offers horror lovers what the ghost writers of old offered to readers: access to the land of the Bogeyman.

The Bogeyman, or Babau, or El Cuco, or whatever you want to call it, is scary as hell because we never get to see him. He is not really underneath the bed, or inside the closet, or waiting by the wayside to snatch those pesky children and put them in a sack. Then again, be might be there, waiting for the right moment to strike. Ghost stories need this kind of tension to instil a sense of dread.

Unfortunately, the latest movie trend is to dispense with tension in favour of a sedated compromise to appease a mainstream audience. Mama falls into this trap. The film revolves around the battle between two mums, one alive and one dead. They are both surrogate mothers as the two girls’ real parent was killed by their very anxious dad. The arising conflict drives the narrative forward but then everything goes belly-up when the ghost, in all its CGI glory, takes centre stage. And, of course, CGI is all electricity.

Once the ghost of Edith Brennan becomes a central figure in the story (visually), the excellent sense of amassed dread all but disappears. Instead, CGI wizardry takes over: magnificent wraithlike tendrils of ghostly garb, creepy head tilted at a slightly awkward angle, a face that might stretch and scream at any moment, giving us the intended scare. We are shown too much. Movies such as Paranormal Activity (2007) and The Innkeepers (2011) take a better approach by creating and sustaining suspense by only showing the bare essentials. They leave you gripping your seat.

So: is Mama any good? Well, yes, in an average-film kind of way. But there is definitely no need to watch it with your lights on.
Stories have flourished throughout the inhabited world, at all times, and under every circumstance. They have inspired the activities of the human body and mind, defined groups and held them together. Stories have guided humanity. Sitting around their campfires, through stories humans learnt how to be warriors, farmers, mothers, sons, and good citizens. Stories brought order to a world fraught with chaos. They gave answers to timeless questions that have haunted humans since the very beginning; “Who am I? Why am I here? What is good and what is evil? What will tomorrow be like? Where did yesterday go? Is there anybody else out there?”

As G. K. Chesterton tells us, stories “are more than true — not because they tell us dragons exist, but because they tell us dragons can be beaten”.

Joseph Campbell (2004) in his book, *Pathways to Bliss*, uses a beautiful analogy to synthesise our need and appetite for storytelling. Campbell suggests that stories function like the second womb of a kangaroo that protects the young after it is born. In that pouch, the infant attaches itself to the mother’s nipple until it is able to crawl out and walk.

In that same nurturing manner, stories help us develop.

“People are hungry for stories. It’s part of our very being. Storytelling is a form of history, of immortality too”

*Louis Terkel*

The same drive fuels the multi-billion entertainment industry. In *Exodus to the Virtual World*, economist Edward Castranova argues that we have begun the greatest mass migration in history. People are moving en masse from the real to the virtual world, interacting and participating in their narratives.

There has never been a more exciting time for storytellers. We are living in a time of immense creativity, with new opportunities for creators appearing nearly every single day.

Whether you’re a filmmaker, writer, cartoonist, journalist, or any other kind of storyteller, it is now easier than ever to deliver your story to an audience. New platforms and business models are emerging, gatekeepers are falling and the possibilities are astounding.

The media world right now is a multiplatform world. People and companies are pushing creativity around this fact. It includes all aspects of television, from initial development to script writing, from marketing to distribution, and from technical implementations to audience interaction.

In this revamped world, Malta is still struggling to find its voice. Film and television productions have failed to cross borders.

Valletta 2018’s primary mission is to be a long-term catalyst for culture led regener-
FROM ARISTOTLE TO FILMS

ARISTOTLE’S Poetics is, as far as we know, the first ever work of literary theory. Written in the 4th century BC, it is the work of a scholar who was also a biologist, and treats literary works with the detached analytical eye of a scientist. Aristotle examines drama and epic poetry, and how they achieve their effects; he analyses tragedy and the ways in which it plays on our emotions. Many of the ideas he articulates, such as catharsis, have remained in our critical vocabulary ever since.

FRANTIŠEK DANIEL was a film director, producer, and screenwriter born in Kolin, Czechoslovakia. He produced over 40 films, including Ján Kadár’s Oscar-winning The Shop on Main Street (Obchod na Korze) (1965).

After the Soviet invasion, the prolific filmmaker fled the country and found refuge in the United States. Heading the most prestigious film schools (Columbia and University of Southern California) has been his biggest contribution to filmmaking, particularly American cinema. David Lynch was one of his protégés who specifically mentions a special thank you in Eraserhead, 1977.

When Robert Redford founded Sundance Institute in 1981, Daniel was appointed Artistic Director, a guiding post he held for over a decade. He continued to develop scripts and work with students until he died on March 29, 1996, at the age of 69.

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Dentists on wheels

The RIDT is supporting a community project that is being spearheaded by the Faculty of Dental Surgery (University of Malta). The project should improve the Maltese population’s quality of life and supply vital oral health information.

The Mobile Dental Clinic Project will carry out research through standardised scientifically established methods to determine the oral health status of Malta. As a result of scarce epidemiological data, this particular health status is not known, although various factors suggest it may be suboptimal. With such a mobile unit at hand, the Faculty will be able to study (and prevent) all areas of oral health. It will be in an excellent position to reach all sectors of society, providing routine dental care as an outreach clinic. The clinic will visit all localities in Malta and Gozo, focusing on underprivileged communities, homebound elderly patients, special-needs schools, and institutionalised people.

Equipped with modern facilities on par with any dental clinic, this unit will be manned by staff members of the Faculty of Dental Surgery together with final year dental students.

To finance this community project, the RIDT has found the backing of a number of corporates and institutions who have pledged their support through their donations. The clinic is estimated to cost around €120,000. The mobile dental clinic is expected to be on the road this Autumn.

RIDT annual report

2012 was the first full year of operation of the University’s Research Trust. An account of its initiatives and achievements is given in the first annual report of the Trust. The report highlights the RIDT’s community involvement, a small selection of the University’s ongoing research projects, the results of the Trust Fund for 2011–2012, and credits all donors who contributed in 2012. The report can be accessed at www.ridt.eu.
Correction

In the previous issue of THINK, we apologise for misquoting Dr Ing. Anton Bartolo who said ‘newly refurbished Faculty of ICT Building’ when what was meant was ‘newly refurbished old Faculty of ICT building’. The photo should have represented this building.

Funding of academic chairs by FIMBank and The Alfred Mizzi Foundation

As from the next academic year, the Faculty of Economics, Management and Accountancy of the University of Malta will be providing a course in International Trade Finance which is being sponsored by FIMBank Malta plc and the International Factor Group (IFG). The same faculty will also introduce a course in Digital Marketing which is being sponsored by The Alfred Mizzi Foundation. These new additions will offer a unique educational experience in modern commercial activities to both local and foreign students. The financing of the courses has been facilitated by the RIDT.

KSU joins list of donors

In a typical case of charity beginning at home, the Kunsill Studenti Universitarji (KSU) has donated €1,000 towards the research trust of the University of Malta. Speaking during the presentation of the donation, Mr Mario Cachia, former president of the KSU pledged that the KSU shall venture to promote the objectives of the Trust among the students it represents, and encourage them to support it, even by organising activities to raise funds for specific future research.

Cycling for breast cancer research

Forty cyclists will be covering an endurance route of 720 km. They will cycle from London to Brussels to Paris this July to raise funds for breast cancer research at the University of Malta. For this initiative to happen, the RIDT has teamed up with two not-for-profit organisations, Action for Breast Cancer Foundation and ALIVE Charity Foundation. The former is an organisation that brings together breast cancer survivors, patients, and well-wishers, while ALIVE consists of a group of cyclists are dedicating their cycling efforts towards good causes. The cyclists are currently undergoing training to get in shape for this challenge. Their objective is to each raise €1,800.

Your contribution towards research

The University of Malta needs the support of the whole community to sustain and grow its research activity. In particular it needs the support and commitment of its alumni and other well-wishers. Please consider making a contribution towards the Research Trust online at www.ridt.eu. Each donation, large or small, is appreciated.
Coffee.

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