

WIPO MAGAZINE

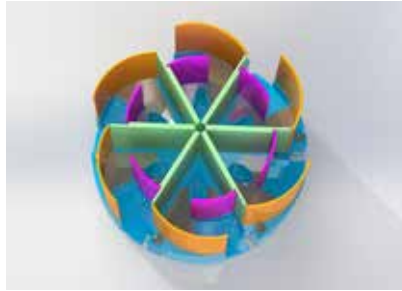
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Dear Readers,

We are pleased to inform you that from January 2023, the WIPO Magazine will be moving to a digital-only format. Curated quarterly editions of the WIPO Magazine will continue to be available in PDF format for those who wish to print-on-demand.



This move will enable us to provide you with a more regular stream of content on topical issues relating to IP, innovation and creativity. It is also in line with the Organization's commitment to reduce its carbon footprint.

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Apheris: solving the data privacy dilemma

By **James Nurton**, freelance writer

How do you enable sophisticated artificial intelligence (AI) tools while respecting the privacy and protecting the intellectual property of data assets? A Berlin-based startup believes federated learning provides the answer.

In his opening speech at the fourth session of the WIPO Conversation on IP and Frontier Technologies in September 2021 (read *Data: the fuel transforming the global economy*), WIPO Director General Daren Tang described data as the “fuel” that powers digitalization. Algorithms for machine learning require large volumes of data to learn from – but what happens when the flow of fuel is interrupted, in other words when the data cannot be shared for reasons of privacy, security or intellectual property (IP) protection?

One solution to that problem is known as federated learning, where the data never leaves the control of the data owner. Rather, the machine learning algorithms are trained on the data locally, without it ever being shared. In a simple example, sensitive data such as patient records from a hospital can be used in the development of a new drug by a pharmaceutical company without the hospital having to disclose any data. In more sophisticated cases, data from multiple sources can be used to train the same algorithm, bringing benefits in both volume and diversity.

Federated learning requires a trusted third party to bring together the algorithm and data owners. Berlin-based startup Apheris, which was launched in 2019, is one such company. Apheris has a team of about 20 developers, privacy experts and data scientists who provide a secure platform for secure data sharing. Its Head of Legal, Lucie Arntz, recently spoke to the *WIPO Magazine* about the company’s business model, data protection and security.



Photo: Courtesy of Apheris

Federated learning is based on the belief that “sensitive data is best kept local and under the control of the data controller,” and delivers results that are “as good as if you had all the data on your own servers,” says Lucie Arntz, Head of Legal at Apheris.

BENEFITS OF FEDERATED LEARNING

Ms. Arntz joined Apheris in summer 2020 – the first employee not to be a scientist – and is responsible for ensuring a proper legal foundation, protecting customers’ rights and overseeing contracts. She says that federated learning is based on the belief that “sensitive data is best kept local and under the control of the data controller” and that it delivers results that are “just as good as if you had all the data on your own servers”.

Up to now, the benefits have been most evident in the healthcare sector, where AI techniques are advanced and there are fundamental concerns about confidential and sensitive patient data. But Ms. Arntz points out that federated learning offers benefits even where data is not sensitive with respect to personally identifiable information (PII). For example, Apheris is now working on a project for a chemicals manufacturer, which involves product and customer data that is commercially sensitive and secret. Federated learning could also apply where certain data is protected by IP rights.

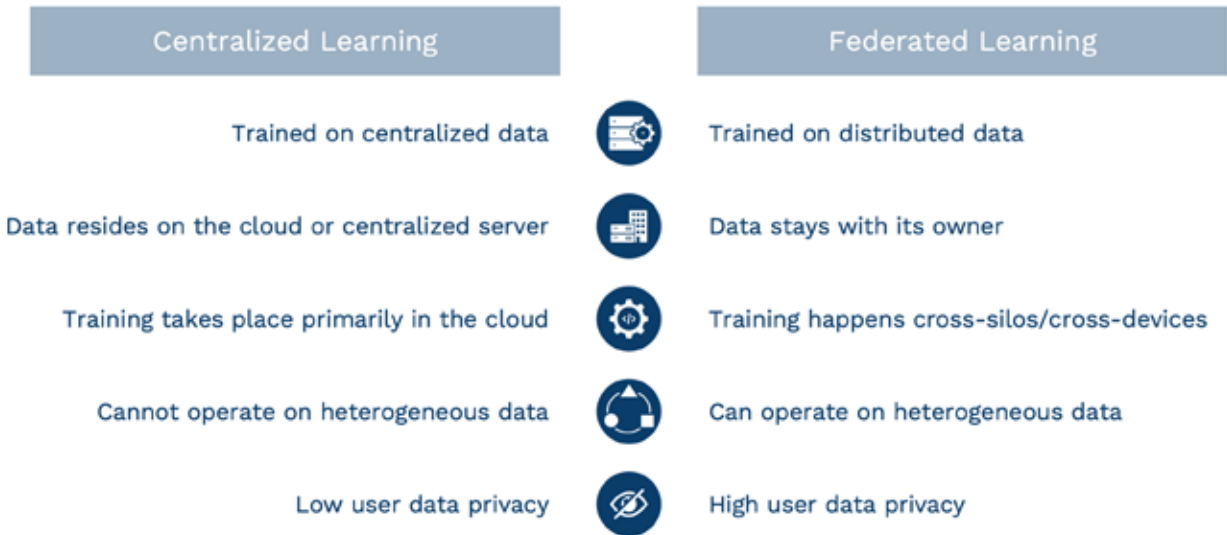
“Centralizing data is becoming outdated,” says Ms. Arntz, who adds that many companies own large amounts of valuable data which is not leveraged because of concerns about sharing: “You might have lots of data that could be super important to someone else but not to you, so without partnering with someone there’s no value in that data at all.”

In some cases, the value of data might only be apparent when it is combined with data from other sources through federated learning. For example, medical data from patients in the United States could be supplemented with that from Africa or Asia, resulting in a more diverse clinical trials dataset. “You could scale it up as much as you wanted and that’s where it gets magical,” says Ms. Arntz.

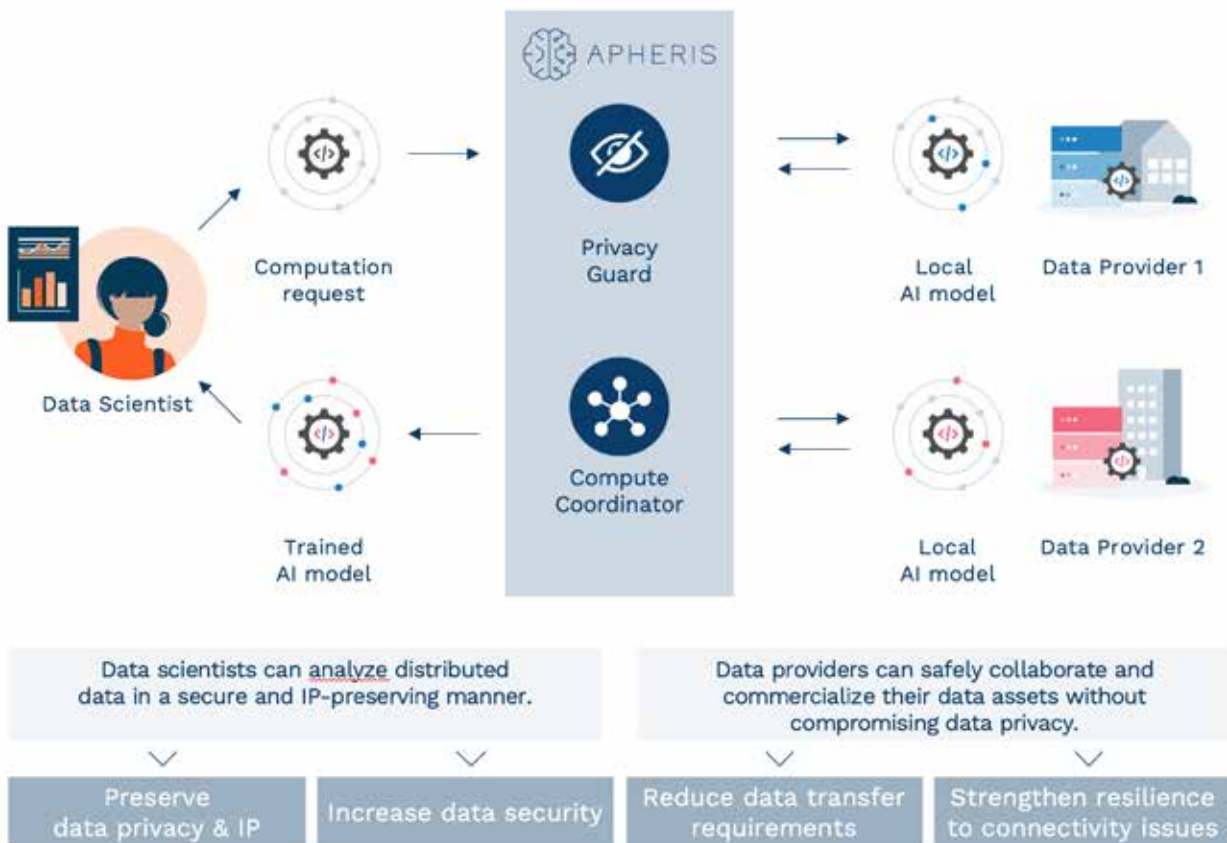
But she adds that the potential of federated learning is still probably three years away from being fulfilled. One reason is the need for more standardization in the collection and formatting of data. While increased computing capacity enables the processing of larger volumes of data, for optimal results that data needs to be well structured to enable secure data collaborations. Here, again, the healthcare sector is leading the way, but other sectors are catching up. One that Ms. Arntz identifies is the automotive industry, where the development of partially and fully autonomous vehicles depends on analysis of a great variety of data from various sources – including drivers, vehicles, highway authorities, law enforcement agencies and insurers. “The automotive industry is very focused on getting that standardization in place,” she says. “There’s great interest in being able to collaborate on that data and there are efforts to get the big manufacturers together to standardize. It’s a particularly interesting area because it involves both public and private sector interaction.” In the automotive sector, the solution is likely to be voluntary and industry-led, but it will take time to develop.

“While increased computing capacity enables the processing of larger volumes of data, for optimal results that data needs to be well structured to enable secure data collaborations.”

Comparing Centralized and Federated Learning



Centralizing data is becoming outdated, says Ms. Arntz. “You might have lots of data that could be super important to someone else but not to you, so without partnering with someone there’s no value in that data at all.”



Apheris enables companies to securely analyze data of multiple parties while keeping proprietary information private.

THE ANONYMIZATION CONUNDRUM

One big challenge for the development of AI tools is the level of anonymization. Individuals are understandably concerned to protect their personal data (whether medical or family history, financial information or other personal details) but, as Ms. Arntz says, “the more anonymized the data, the less relevant it becomes. Anonymization is not the future of machine learning.” Effective drug development and testing, for example, needs to take account of age, ethnicity, allergies, medication and other factors; self-driving cars need information on where you’re travelling to, what kind of vehicle you drive and how fast you want to go. Ms. Arntz believes federated learning can help provide a balance and show that “it’s not a conflict to have both privacy and innovation.”

Overcoming such challenges requires a mix of technological and legal solutions: the technology can ensure the security of data through processes that are rigorous and intensely tested, while law enables contracts that stipulate who controls the data, who can receive the results and what level of detail they receive.

How data is actually protected remains a difficult question: while copyright law and *sui generis* tools such as database rights in the EU might offer some protection, the boundaries are not clear and most organizations are likely to favor keeping data secure, relying on contractual provisions and protection under trade secrets or confidential information laws. But Ms. Arntz says the question of whether and how data is protected need not be a problem: “If you have data, you probably think it’s important and should be protected. For federated learning, it does not matter whether the data is protected formally or not. We err on the safe side.”

A more pressing issue, she believes, is “broad consent.” The GDPR recognizes that it is not always possible for scientific researchers to identify all the purposes for which data is collected. Therefore, they may not have to be as specific about their plans in other areas, but should nevertheless provide options so that data subjects can give informed consent for future research uses. “We need clearer guidance on what “research purposes” are. At the moment, there is uncertainty for universities and researchers and that is limiting innovation,” she says.

Data in the EU – existing and proposed

General Data Protection Regulation (GDPR):

The 2016 GDPR superseded the EU Data Protection Directive and regulates the processing of personal data of data subjects in the European Economic Area. It has been followed in many other countries and regions, for example in the California Consumer Privacy Act (2018).

Data Governance Act: The Act was adopted

by the European Parliament on April 6, 2022. It is heralded by the European Parliament as a move that “will stimulate innovation and help startups and businesses use big data.” The rules will benefit business by lowering the cost of data and market entry barriers. Consumers will benefit, for example, by having access to smarter energy consumption and lower emissions. The rules are also designed to build trust by making it easier and safer to share data by ensuring it conforms with data protection legislation. They will also facilitate the re-use of certain categories of public sector data, increase trust in data intermediaries and promote data altruism (the sharing of data for the benefit of society). The Act will create “the processes and structures” to make it easier for companies, individuals and the public sector to share data. It will have to be adopted by all EU countries in the Council before it becomes law.

EU Data Act: The Act, also known as the *Proposed*

Regulation on Harmonised Rules on Fair Access to and Use of Data, was adopted by the European Commission in February 2022, and is a key pillar of the European data strategy. It clarifies who can create value from data and the conditions under which they may do so.

Artificial Intelligence Act: The proposal for an

AI Regulation to lay down harmonized rules for the EU is part of the European Commission’s AI package published in April 2021. It is the first attempt to “enact a horizontal regulation of AI,” and is designed to turn Europe into the global hub for human-centric and trustworthy AI.

SHINING A LIGHT ON FAIR REGULATION

Ms. Arntz believes the GDPR is an example of legislation that is “much-criticized but also much loved”: it provides a sound basis for data protection but will need to be updated as technology changes. “Above all, we need clarity: even if the guidance is that you can’t do something, at least it’s good to have a clear line.”

She also argues that the GDPR is an example of how a region – in this case, the EU – can “shine a light” to promote fair regulation: as she says, data cannot merely be regulated nationally so multinational or international solutions are needed – even if compromises have to be struck along the way. She is optimistic that new EU initiatives, such as the recently adopted Data Governance Act and the proposed AI Act, will provide further clarity: “Policy should be always open to optimize. We will need to adapt it in future and revisit what we’re trying to achieve.”

She warns though, that the process must be inclusive and interdisciplinary: too often the business, legal, policy and technical experts are not in the same room or even talking the same language, and the voice of startups and SMEs is not always heard. “Governments talk to big corporations a lot but if they’re not talking to startups so they don’t hear about innovative technology,” Ms. Arntz explains.

The conversation is important, she says, because the technology is getting more and more sophisticated, and there is abundant funding available for new products and services that are derived from AI and data analysis. The importance of data is apparent in everything from tackling the COVID-19 pandemic to assessing the impact of climate change. “We’re going to see lots of growth in data analysis, and the policy will have to move in response,” says Ms. Arntz.

The metaverse, NFTs and IP rights: to regulate or not to regulate?

By **Andy Ramos**, Partner at Pérez-Llorca, Madrid, Spain

As far back as the late sixth century BC, the Greek philosopher Parmenides declared, “nothing comes from nothing.” In the digital era, every two or three years now, apparently unprecedented phenomena seem to come from nothing and yet appear to have the power to revolutionize the world and the law. A few years ago, it was Web 2.0, then Cloud Computing, Blockchain and Web 3.0. Over the last year, countless articles have anticipated global transformation through the metaverse and NFTs (non-fungible tokens), fueling interest around the question of whether there is an urgent need for new regulations to adapt to these innovations. In other words, should the law adapt to the metaverse or should the metaverse adapt to the law? For the reasons set out below, the most appropriate response at this stage is the latter.

Since the rise of the Internet over two decades ago, we have enjoyed an online network based on information, data and telecommunication, with a range of standalone virtual worlds emerging, mainly on social media and video games like Second Life, Instagram, Fortnite, TikTok and Roblox. The metaverse promises interconnected virtual environments controlled by electromyography (EMG) movements and neural interfaces. In the metaverse, companies will have the unprecedented ability to exploit the full potential of the data they collect.

The technology sector and the video game industry are preparing for the advent of the metaverse: a network of 3D virtual worlds, where humans can interact with each other socially and economically, mainly through avatars. Despite great media attention, the metaverse does not yet exist, and is still far from being a reality, at least as currently described by some reporters. This is largely because of the demanding computing requirements and standardized protocols needed for it to take off.

In contrast, NFTs are already with us. Based on existing blockchain technology, NFTs are cryptographic units of data, with unique metadata. As such, NFTs can be distinguished from one another and can hold other kinds of information, like the identities or artwork of different individuals. Their uniqueness makes them capable of being sold or traded, with a digital ledger registering all transactions. NFTs harness the capabilities of blockchain technology to create non-fungible digital files with — most importantly for the entertainment industry — an image, graphic or video embedded in the token, which determine its value in the market.

As noted above, many voices are now demanding new regulations for the metaverse. Why? To protect users when they interact in this virtual world, and to close an apparent gap between reality and the law.

Assertions that the current regulations do not apply in the metaverse, that existing laws are not adapted to that environment, or that technology travels faster than the law, are common but, in my view, they are generally incorrect.

Over the last 30 years, countries with a strong Internet presence have established new rules to address e-commerce, criminal activities involving technology, consumer rights on digital content and the liability regime for Internet service providers, to name a few.

Take intellectual property (IP) laws as an example. They protect, among others, authors, inventors, producers, designers and performers by granting them exclusive rights over their copyright, trademarks, patents, industrial designs or trade secrets. The regulation of IP rights is not primarily focused on the physical object in which a creative work, a distinctive sign, or a technical innovation is embedded, but rather on their intangible aspects.

While civil legislation regulates the ownership of physical property (a car, a book, or a purse, all of which can contain trademarks, patents, or works of authorship), IP laws govern the ownership regime of the non-tangible elements of such property. In IP jargon, this is the difference between the *corpus mysticum* (the intangible asset) and the *corpus mechanicum* (the physical representation) of such an asset. This principle has been applied for centuries and is also fully applicable to the metaverse and NFTs.

The technology sector and the video game industry are preparing for the advent of the metaverse: a network of 3D virtual worlds, where humans can interact with each other socially and economically, mainly through avatars.



Photo: naratrip wboonroung / iStock / Getty Images Plus

The metaverse is a virtual universe where avatars controlled by humans or computers can control virtual items, such as vehicles, weapons, or furniture, all of which can feature trademarks or copyrighted works. Because IP laws deal with the intangible elements (*corpus mysticum*) of an object, whether physical or virtual, the obvious conclusion is that the builders of the metaverse will have to respect the rights of inventors, designers, and owners of distinctive signs as in the real world. Consequently, a given right holder will be entitled to prosecute the exploitation of his or her IP rights in the metaverse, for example, when attached to a virtual purse or jacket developed for digital avatars.

Regarding NFTs, the conclusion is similar. NFTs are digital files in which creative works or other subject matter, such as a video or an artwork, can be embedded. As long as copyright provides an exclusive right over original works of authorship (*corpus mysticum*) and this is distinct from the ownership of any digital object in which the works are embedded (*corpus mechanicum*), then anyone who uses, for example, a sound recording or a clip from a video game in an NFT will need prior authorization from the copyright holder of such work. There is, therefore, little debate on the application and validity of the current regulations to NFTs and the metaverse.

From a legal standpoint, the Berne Convention for the Protection of Literary and Artistic Works, now ratified by 181 countries, establishes that contracting parties must grant exclusive rights to authors over their works irrespective of the type or form of their expression. The Berne Convention has since been supplemented by other international agreements, including the WIPO Copyright Treaty, adopted in 1996, which adapts the Berne Convention to the digital environment. This agreement (Agreed Statement concerning Article 1(4) of the WIPO Copyright Treaty) makes it clear that the storage of a protected work in digital form in an electronic medium (such as an NFT or a file, the content of which is displayed in the metaverse) constitutes a reproduction which needs the prior approval of the copyright holder. It seems that the law does not always travel so slowly.

NEW CHALLENGES FOR IP RIGHTS OWNERS

However, these new forms of entertainment do raise a number of challenges for IP rights owners, although these challenges stem from other sources. Authors, producers, publishers, and proprietors of trademarks have exclusive rights over their intangible assets. These rights, however, are not absolute, as the Berne Convention contemplates certain scenarios in which they may not exercise such rights. Some uses, such as the reproduction of a literary work for a book citation or the use of a brand to depict a brand owners' products or services are outside the exclusivity space of right holders.

In principle, therefore, if we want to use the trademark of any company in a digital object, such as an NFT or an item in the metaverse, we need to request permission from the owner of the

“In the metaverse, companies will have the unprecedented ability to exploit the full potential of the data they collect.”

Photo: LisaChristianson / iStock / Getty Images Plus



While, in principle, we need to request permission to use the trademark of a company in a digital object, in cases involving video games, some courts have established that certain descriptive uses of third parties' trademarks don't need their prior consent. An example is the famous Humvee case (*AM General LLC v Activision Blizzard, Inc. et al*).

“In principle, if we want to use the trademark of any company in a digital object, such as an NFT or an item in the metaverse, we need to request permission from the owner of the mark.”

mark. Notwithstanding the fact that in cases involving video games, some courts have established, for example, that certain descriptive uses of third parties' trademarks don't need their prior consent.

In 2017, AM General LLC, the manufacturer of the famous Humvee military vehicle, sued the publisher of the video game franchise *Call of Duty*, for the depiction of the vehicle in the game, which reproduced the vehicle's design and used the trademark. The United States District Court, Southern District of New York concluded, however, that as Activision's goal was to develop a video game that realistically simulated modern warfare, their use of the vehicle and the trademarks had artistic value and, therefore, met the requirements of the so-called Rogers test.

WHAT THE COURTS ARE SAYING

In the copyright realm, there have also been a number of prominent cases of use of third parties' content without permission. One of the most relevant examples is the claim brought by Solid Oak Sketches, the copyright holder of certain tattoos, against 2K Games, the publisher of the well-known video game franchise *NBA 2K*. The claimant owned the rights to several graphic designs featured in the tattoos of famous basketball players (including LeBron James) and argued that its copyright was infringed when reproduced in the digital avatars of the athletes in the video game. The same court that judged the Humvee case (the United States District Court, Southern District of New York) also ruled in the defendant's favor, applying the *de minimis use defense* (where such a small portion of the protected work has been used that the infringing work is not substantially similar to the copyrighted work and is therefore none-infringing), the *implied license defense*, and the *fair use defense*, based on the artistic nature of video games.

Nevertheless, in other cases, courts have determined that video game developers have gone too far when using third parties' IP. As such, it is clear that these matters need to be analyzed on a case-by-case basis.

The immediate conclusion, however, is that there are a good number of precedents to rely on when debating the necessity for specific uses of IP rights in NFTs or the metaverse. As said, *nothing comes from nothing* and, in fact, historically, the development of new regulation has been based on the application of the principle of learning from previous experiences. Another takeaway is that the metaverse and NFTs are not, at least from a legal standpoint, as disruptive as some believe; at the end of the day, virtual worlds and digital objects have already existed for two decades.

It is a certainty that NFTs and the metaverse, when it comes into being, will bring many challenges to owners of IP rights. Most of these challenges cannot be anticipated at this stage. Consequently, we must analyze NFTs, the emergent metaverse and any other new digital phenomena against existing regulations, which have been enacted after thorough debate by multiple countries and cultures. These regulations have also been tested in various scenarios and have proven valid for decades. Undoubtedly, some adjustments will be necessary in the coming years to regulate human interaction in digitally-connected worlds, but these must come when we learn the nature of these challenges. In the meantime, IP rights will continue to be as valid as ever for the advancement of science and the arts.

About the Rogers test

In the 1989 case of *Rogers v Grimaldi* 875 F.2d 994 (2d Cir. 1989), the court developed a test to determine whether use of a trademark requires prior authorization. It has two elements: first, it seeks to determine if the use of the trademark is "artistically relevant to the defendant's work," and second, if such use is "explicitly misleading."

Artificial intelligence: deepfakes in the entertainment industry

By **Vejay Lalla**, **Adine Mitrani** and **Zach Harned**,
Fenwick, New York and Santa Monica, USA



Photo: ©MIT/Halsey Burgund

The term “deepfake” refers to an AI-based technique that synthesizes media. This includes superimposing human features on another person’s body—and/or manipulating sounds—to generate a realistic human experience.

Ever since the first *Terminator* movie was released, we have seen portrayals of robots taking over the world. Now we are at the beginning of a process by which technology—specifically, artificial intelligence (AI)—will enable the disruption of the entertainment and media industries themselves.

From traditional entertainment to gaming, we explore how deepfake technology has become increasingly convincing and accessible to the public, and how much of an impact the harnessing of that technology will have on the entertainment and media ecosystem.

WHAT IS A “DEEFAKE” AND WHY DOES IT MATTER?

The term “deepfake” refers to an AI-based technique that synthesizes media. This includes superimposing human features on another person’s body—and/or manipulating sounds—to generate a realistic human experience. Actor Val Kilmer lost his distinctive voice to throat cancer in 2015, but Sonantic’s deepfake technology was recently used to allow Kilmer to “speak.” (The actor’s son was brought to tears upon hearing his father’s “voice” again).

Deepfakes have also been used to break down linguistic barriers, including by English soccer great David Beckham in his Malaria No More campaign. There, deepfakes enabled Beckham to deliver his message in nine different languages. And sometimes deepfakes are used for downright fun, such as in this art installation, which allows users to take a “surreal” selfie with Salvador Dalí.

LEVERAGING DEEFAKES TO ENHANCE A TALENT’S SKILLSET

Commercial applications of deepfakes currently include both hiring the underlying “deepfake actors,” as well as individuals whose likeness is used as a “wrapper” (i.e., the visage or likeness portrayed in the content) for the underlying performance. Where the so-called wrapper is a famous personality, this may save the underlying talent hours of time they would otherwise need to spend on set; that burden can be shifted to the deepfake actor instead. Additionally, such technology allows influencers to create personalized messages for hundreds or thousands of individuals without the need to actually record each message.

The foregoing novel applications of this technology do not fundamentally change the nature of talent agreements or acquiring the necessary rights from talent—however, they do introduce new wrinkles that both negotiating parties must consider carefully. For example, control over the use of the talent’s likeness rights is always negotiated in great detail, but it is unlikely that talent releases or agreements generally contemplate the right to use likeness rights as a wrapper to generate a potentially infinite number of lifelike deepfakes. Additionally, clauses relating to moral rights will require careful drafting to address whether a deepfake performance, potentially one in which the talent had no control, can serve as grounds to trigger termination. Talent unions may also have to consider more specifically how this technology is addressed in future industry negotiations.

Finally, there is the open question of whether this technology will help or hurt talent overall. On the positive side, the scalability of allowing an actor to appear in commercials or on websites for e-commerce all over the world (without requiring trips to the studio, learning a new language or improving accent work) could be empowering. For instance, Synthesia recently did this with two commercials featuring rapper and entrepreneur Snoop Dogg. The initial commercial was such a success that the company’s subsidiary wanted to use the same commercial, but with the branding and names switched out. Rather than having to reshoot, Synthesia used deepfake technology to change Snoop Dogg’s mouth movements to match the subsidiary’s name in the new commercial.



In 2020, MIT's Center for Advanced Virtuality launched a new digital storytelling project to educate the public about deepfakes and show how convincing they can be. With the help of a deepfake actor, the team created a "complete" deepfake (manipulated audio and video) of US President Nixon delivering the real contingency speech written in 1969 in the event the Apollo 11 crew were unable to return to earth.

On the other hand, the widespread adoption of deepfakes could allow for the supplanting of actors who are not celebrities, leading to job losses or a shift in how the industry hires talent for productions. If it becomes more efficient and otherwise desirable to hire relative unknowns to portray those with celebrity status, there are fewer opportunities for these actors to become known or "get discovered" in their own right. That could lead to the creation of a caste of deepfake actors who never achieve celebrity status or the ability to monetize their name and likeness.

INCORPORATING CELEBRITY DEEPPAKES IN DIGITAL CONTENT

Individuals have also leveraged celebrity deepfakes on social media platforms, further highlighting the pervasiveness (and accuracy) of the underlying technology. In early 2021, a Belgian digital AI artist worked with a Tom Cruise impersonator to generate very realistic videos of "Tom Cruise" on TikTok under the account @deeptomcruise.



Photo: ©MIT/Halsey Burgund

Those videos featured “Tom Cruise” partaking in quirky activities, from falling and telling a Soviet Union joke in a retail store to performing industrial clean-up services, and attracted hundreds of thousands of views. Also, a deepfake of Harry Styles demanding more strawberries in a musical ode to his song *Watermelon Sugar* went instantly viral on TikTok last year.

If an individual or business would like to create a celebrity deepfake for media content, it should carefully consider with an attorney whether it is permitted to do so under applicable law. It should navigate some key legal bases to post that type of content, including whether the content is a protected class of free speech (e.g., a parody), whether the celebrity’s rights of publicity have entered into the public domain and whether it has a fair use defense to a copyright infringement claim. Otherwise, as in all other cases, consent is likely required for use of the talent’s likeness in this context.

CONSIDERING APPLICABLE LAWS

In the United States, the legal landscape for deep fakes has been changing rapidly. An individual or business should consider recent state laws that specifically address synthetic and digitally manipulated media.

For example, in November 2020, New York enacted a law that expressly bans the use of “a deceased performer’s *digital replica*” in audio-visual content for 40 years after the performer’s death, if that use is “likely to deceive the public into thinking it was authorized.” This could prohibit the use of deepfakes in instances such as the Anthony Bourdain documentary *Roadrunner*. There, controversially, the film’s director leveraged deepfake technology to generate three lines that brought Bourdain’s “voice back to life” in order to complete the production following his death, despite the celebrity chef’s widow, Ottavia Bourdain, asserting that she did not give permission for such use.

On the political front, Texas enacted a law in September 2019 that banned disseminating deceptive “deepfake videos” intended to damage candidates or influence a voter base within 30 days of an election. The following month, California passed a similar law but specified that the period at issue is within 60 days of an election. Further, the platforms that host deepfakes will also need to consider compliance concerns regarding claims of deception.

AUGMENTING VIDEO GAME CHARACTERS WITH DEEPPAKES

The gaming industry is another natural arena for disruption by deepfakes, particularly with respect to avatars. A key premise



Photo: Courtesy of the Dalí Museum in St. Petersburg, Florida, USA

Sometimes deepfakes are used for fun. *Dali Lives* is a groundbreaking AI experience at the Dalí Museum in Florida, USA. It uses machine learning to create a version of Dalí's likeness in the present day, which appears on a series of interactive screens. Visitors can even take a "surreal" selfie with the master.

“As deepfakes continue to permeate various facets of digital media, individuals and businesses seeking to leverage the underlying technology will have to preemptively think through their existing contractual arrangements and navigate applicable law on this topic.”

of many games is a player assuming the role of a character, such as Luke Skywalker or Princess Leia from *Star Wars*. But an even more immersive gaming experience would be not simply controlling Luke or Leia with a gamepad, but also having the avatar track your face and mouth movements—something deepfake technology is making a reality. Further, with deepfake-generated synthetic speech, it is possible to make your voice sound like Luke or Leia, and this has sometimes resulted in unanticipated positive consequences. For example, these so-called “voice skins” are enabling LGBTQ+ people to change their in-game voices, resulting in more pleasant gameplay—an unsurprising finding given the 2020 statistic from the Anti-Defamation League that more than half of voice chat users are harassed during gameplay, and 37 percent of LGBTQ+ players are harassed on the basis of their sexual orientation.

Of course, general purpose technology like this also has the potential to be misused, such as for fraudulent impersonation for financial gain or fraudulent logins of voice-gated systems. And deepfake technology will impact nonplayer characters (NPCs) as well as your own avatar. The combination of impressive natural language generation models such as GPT3 paired with gaming deepfakes will result in NPCs possessing the limitless ability to converse with your avatar with convincing synchronized face and mouth movements without needing to follow specific scripts. Video game developers will need to analyze their existing licensing arrangements with the content owners of these characters and story arcs to determine whether the deepfake use cases are permitted.

OTHER POTENTIAL BENEFITS

In addition to the economic benefits of using deepfakes discussed above, the underlying technology can also be used for social good in digital media. Take, for example, an HBO documentary that details the lives of LGBTQ+ activists forced to live in secrecy under threat of execution. To protect the identities of these activists, the documentary used deepfake wrappers, where the director reviewed only wrappers who were themselves LGBTQ+ activists but resided in countries free from the threat of death due to their sexual orientation. Deepfakes have also been used to create unique and bespoke voices for the millions of people who rely on synthetic speech to communicate.

PRACTICAL CONSIDERATIONS GOING FORWARD

As deepfakes continue to permeate various facets of digital media, individuals and businesses seeking to leverage the underlying technology will have to preemptively think through their existing contractual arrangements and navigate applicable law on this topic. Further, individuals who enter into talent agreements should carefully review the terms regarding their rights of publicity to ensure that they have sufficient control in how those rights might be used in conjunction with AI-based technologies. If approached thoughtfully, the development and use of deepfakes can be leveraged for good, both commercially and socially.

Villgro Africa: helping health startups take their ideas to market

By **Paul Omondi**, freelance writer



Photo: Courtesy of Villgro Africa

“We want to bring about a paradigm shift in the startup investment space, push for legislation to support startups and build more innovation hubs and incubators,” says Robert Karanja, Villgro Africa’s co-founder and Chief Innovation Officer.

Villgro Africa is a Nairobi-based business incubator and early-stage investor focusing on health and life sciences. Dr Robert Karanja, the incubator’s Chief Innovation Officer and co-founder, explains how Villgro Africa is working to transform Africa’s innovation landscape and helping startups take their ideas to market.

Tell us how you came to start Villgro Africa?

We took inspiration from Villgro India, one of the world’s first social enterprise incubators. In 2015, we started as a franchisee of that model, which we have internalized and customized for Africa. Since then, we have incubated more than 40 companies and invested about USD 1.2 million in grants and equity or quasi equity instruments. This has led to around USD 18 million in foreign direct investment in Kenya and the east African economy, creating jobs and local value chains. We started as Villgro Kenya, but in 2020, we rebranded and became Villgro Africa.

Tell us about your programs.

Our flagship incubation program, which runs mainly in Kenya and east Africa, lasts for up to three years. We also engage startups in other parts of Africa in shorter programs that run from three to 12 months. For example, our Artificial Intelligence (AI) for Development program, which focuses on social enterprise-oriented digital innovations, targets entrepreneurs in west and southern Africa. We also partner with mission-aligned organizations like BioInnovate on a bio-economy program for scientists with a focus on social entrepreneurship. We help these innovators build appropriate business models for their solutions so they can commercialize them.

Why the health and biotech sector?

Africa makes up 17 percent of the global population, but bears around 25 percent of the global disease burden. But as a market, we are totally underserved, making up around four percent of the global pharmaceutical market. A price-sensitive market like Africa with low purchasing power is not attractive for big pharma and biopharma investors. They don't see Africa as a viable market to invest in health innovations and solutions. The vaccine inequity we saw with COVID demonstrates this.

Our market research showed that despite its high potential [for social and economic impact] the health sector in Africa is underserved in terms of incubators and accelerators, compared to the ICT and agriculture sectors. For example, in 2014, before we began operating, there were no incubators in this sector. By late 2015, we were one of just three.

How can Villgro help?

In Africa, we must start appreciating the importance of homegrown innovations to solve our unique health problems. There has been a lot of investment in research and development (R&D) by institutions like the University of Nairobi, Kenya Medical Research Institute and Kenya Agricultural and Livestock Research Organization. Over the years, they have built up biotech infrastructure and a critical mass of expertise in the field. But Kenya still suffers from food insecurity and dismal health statistics because we have not been able to translate the knowledge from research into impact. That requires business processes and the know-how to commoditize new knowledge, create new value chains and markets. That's where Villgro comes in, by offering technical and financial support.

Do you encourage your startups to focus on specific areas?

We are part of a value chain that is shaped by the way funding flows to R&D and innovation. Some areas attract more funding, for example, the Millennium Development Goals, which emphasize maternal and neonatal mortality, maternal-child and reproductive health, AIDS, tuberculosis and malaria. This creates an R&D and innovation pipeline that guarantees long-term buy-in. It's the same with the Sustainable Development Goals. Our role is to work with other stakeholders and help them build infrastructure for the delivery of health technologies to our populations.

Our portfolio of startups largely comprises those with digital innovations like the Internet of Things (IoT), big data, AI and machine learning. These innovations are the future. Supporting them means we don't have to play catch up with the rest of the world.

“In Africa, we must start appreciating the importance of homegrown innovations to solve our unique health problems.”



Photo: Jonathan Erasmus / iStock / Getty Images Plus

Villgro Africa, a Nairobi-based business incubator and early-stage investor, is focusing on health and life sciences and working to transform Africa's innovation landscape by helping startups take their ideas to market.

What are the risks of working with startups?

The risks are very high because we're early-stage investors. They include the risk inherent in the developing any new technology, as well as the business risk associated with commercializing innovation. Typically, we only engage startups with a technical proof of concept. A lot of work then goes into building the actual product and getting regulatory approvals before finally taking it to market. Health sector innovations pose higher risks because many (technologies) can fail even when well advanced. We can even get something to market and discover inefficiencies that necessitate a recall.

The technology risk is borne by the entrepreneur and the investor. The commercial risk is all about business. It's one thing to develop a product, and quite another to generate demand for it and get it adopted at scale. Then there are the administrative and financial challenges that innovators must confront.

What is success for Villgro?

Our measurement of success stops at an early stage as we may not be with the companies when they scale to become pan-African or global corporations. If we're able to raise series A funding, typically around USD 1 million – at that point, the venture capitalist will take a seat on the board, bring in the suits, stabilize the ship and drive accelerated growth – we generally exit and focus on the next crop of startups.

What needs to be done to boost Africa's innovation performance?

Kenya tends to rank highly in innovation performance compared to other development indexes. But there's still a gap between innovations and their deployment to solve our national developmental problems. For example, in biotech, Kenya is second to South Africa in Sub-Saharan Africa, but we remain dependent on imports for food and health technologies. So, the question is: what infrastructure have we built to exploit research outputs to create wealth?

The problem is the assumption that by investing more money into R&D, we will create greater impact in the areas we are researching, when in reality, we get diminishing returns. Our academics are publishing research in reputable scientific journals, but that knowledge rarely yields an impact that changes lives by offering solutions in the marketplace. We need to invest in translating research outputs into creating wealth and in building the infrastructure for businesses to thrive. Villgro is part of that ecosystem.

There are many expectations around youth and their ability to drive innovation and entrepreneurship. What are your views on this?

We are putting pressure on first-degree graduates to be innovative entrepreneurs. This is expecting too much of them and asking the impossible. Even if these young graduates were to start businesses, they are likely to be hand-to-mouth subsistence enterprises. These youth lack domain expertise and don't have industry exposure, which means they can't understand the problems that need solving to maximize impact, create the scope for scale, and make good business cases as entrepreneurs to warrant investment from venture capitalists and other financiers.

Oversimplifying innovation and entrepreneurship reduces impact, especially if we decide to associate innovation almost exclusively with the youth. That's not even the case in the West. When young innovators like Elon Musk (PayPal) and Bill Gates (Microsoft) started out they had seasoned co-founders and/or angel investors who worked with them.

Innovation is fundamentally about creativity. In fact, the average age globally for successful entrepreneurship is 42; a lot of data demonstrates this. We can't expect 22-year-olds to become successful entrepreneurs overnight. Our youth need to graduate into jobs where they can learn. Encouraging them to develop their own hand-to-mouth businesses is, at best, a stopgap; it is not the foundation of a solid development strategy for any country.

Most African economies depend on extractive industries. How do accelerators like Villgro fit into this landscape?

The global economy is now a knowledge-driven economy and favors nations that are able to generate knowledge, monetize it and create value chains from knowledge-intensive startups capable of exporting solutions based on that knowledge.

In a knowledge-intensive global economy, IP is very important for innovators and entrepreneurs. Knowledge gives competitive advantage. That's why it needs to be protected. The obvious ways for startups to protect this knowledge is with patents and/or trade secrets. Regardless of how you enter the knowledge economy, the key issue is to understand the importance of the knowledge and the market intelligence in your possession and how to leverage it to serve your customers better.

IMPACT DELIVERED

Our goal is to help innovators **build viable and scalable health and life science solutions** that improve quality of life for people across Africa.

\$1.8M+

SEED FUNDING

\$19M+

FOLLOW ON
FUNDING

2M+

LIVES IMPACTED



Why should health and biotech-focused startups take IP seriously?

The capital expenditure for R&D, product development and commercialization in the biotech sector is very high. That's why these startups need to protect their inventions, especially with patents. But for these patents to make economic sense, there needs to be a market that is big enough for startups to recoup R&D and product development costs, as well as regulatory and other ancillary expenses. If you're focusing on a market like Kenya with a population of less than 50 million, there's no way you can recoup your costs. Even the East African market of around 120 million is barely big enough. Biotech startups need to focus on markets at least the size of the COMESA or SADC.

Entrepreneurs need to understand how the patenting system works. They need to know that the minute they apply for a patent, they have a short time frame to patent their inventions in multiple countries before that window closes forever. That means they shouldn't just patent their inventions in Kenya, for example, as this will be spilling the beans for the rest of the world to compete with them. They will essentially be revealing their secret sauce, which competitors can use to lock them out of other markets in Africa. No investor will back an idea if it can be appropriated in other markets. So, when it comes to patenting, startups really need to think their strategy through carefully.

Does this mean patenting can work against biotech startups?

No. The problem is the oversimplification IP rights, particularly patents. It's a complex issue, which requires a business model that integrates what these innovators are doing locally into the broader national and global knowledge economy. If we ignore how capital flows, all our efforts will go to waste.

Our startups need training on IP rights so they don't lose their IP by focusing on small markets. At Villgro, we help them understand this. At the same time, we reach out to policy-makers to facilitate the protection of our country's innovations.

How can African governments better support startups?

Government intervention tends to be about microfinance rather than funding innovation. You can't expect a startup to solve an SDG challenge at scale with just USD 500; innovation-based startups need funding equivalent to academic research grants, which range between USD 20,000 and USD 500,000.

Second, traditional funding sources, such as banks, don't to facilitate the growth of startups, which are small outfits that have no collateral or revenues. Even if you give banks a guarantee fund to de-risk these revenues, the reality is that a startup will need around five years to develop and commercialize its product and is unlikely to have capital or revenue before then. Debt is not the way to finance innovation. Startups need equity not loans.

Is venture capital a better alternative?

Yes, but venture capitalists don't consider anything below USD 1 million as a worthy investment. Such engagement is unsustainable because the cost of structuring such a deal and carrying out due diligence, is the same as for a USD 10 million deal. This is why governments need to create policies that encourage angel investors to cover the gap for financing up to USD 1 million and work with incubators.

The potential for venture capital funding in Africa is huge. In 2021, Africa hit a record USD 4.1 billion in venture capital investment in startups, up from USD 2 billion in 2020. This is expected to rise to USD 10 billion by 2025. Kenya is one of the leading innovation hubs and venture capital investment destinations in Africa. We need to work out how to position ourselves as an economy for this anticipated investment windfall. This year, Kenya absorbed just USD 350 million or so of the USD 4.1 billion available. That means we are not competitive even though the opportunities for startups are limitless.

What are Villgro's plans for the future?

We are spreading our wings beyond Kenya to cover the entire continent. We have a role in increasing global venture capital investment in startups and in building a robust knowledge economy. That means issues like IP have to be addressed properly. We want to bring about a paradigm shift in the startup investment space, push for legislation to support startups and build more innovation hubs and incubators.

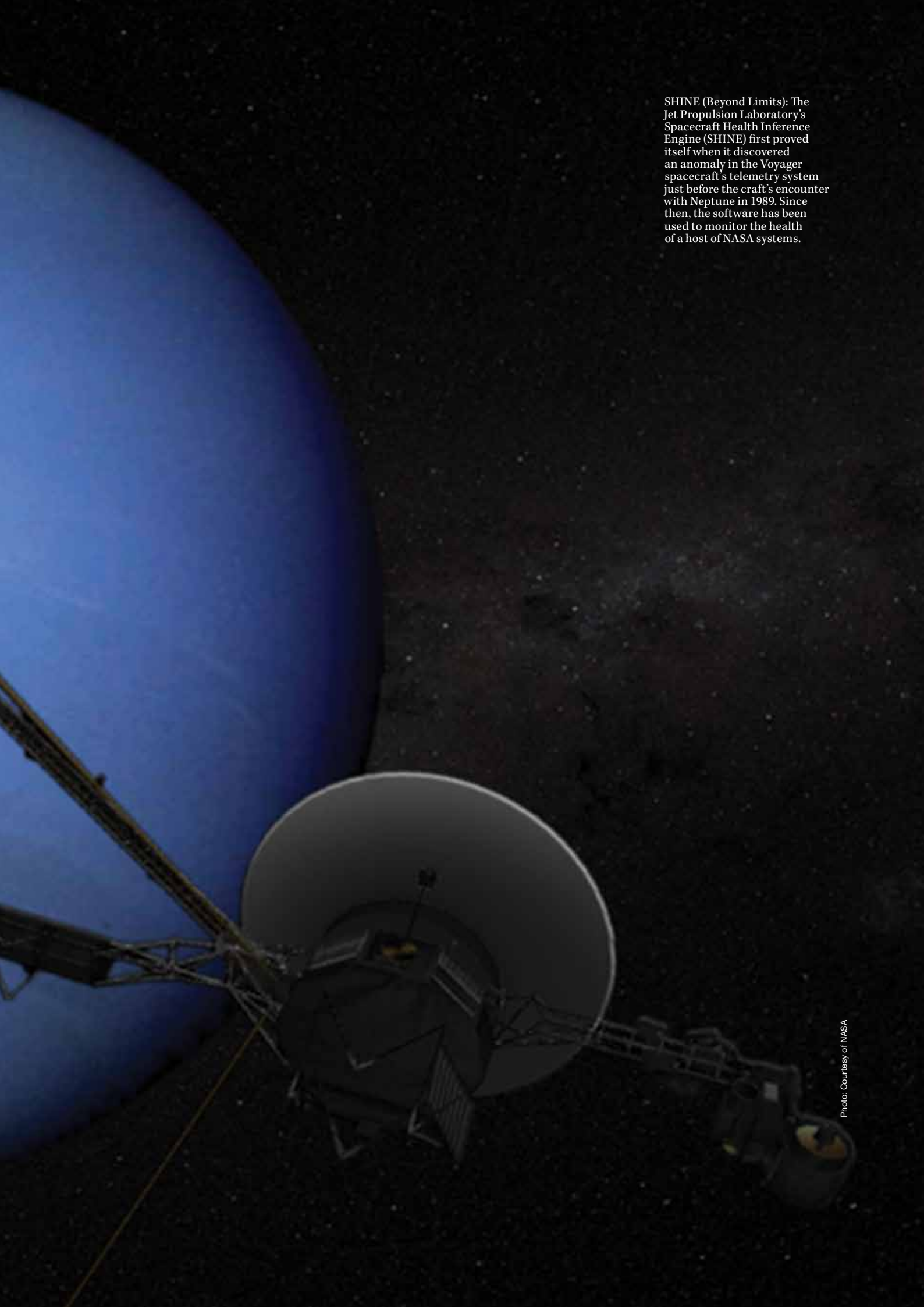
“In a knowledge-intensive global economy, IP is very important for innovators and entrepreneurs. Knowledge gives competitive advantage. That’s why it needs to be protected.”



Tech transfer at NASA: bringing NASA technology down to earth

By **James Nurton**, freelance writer

NASA's well-established technology transfer program is reaching out to support startup companies and a greater range of entrepreneurs, enabling space-age inventions to transform products from bicycles to medical devices.

A spacecraft is shown in space, with a large, bright blue planet (likely Neptune) in the background. The spacecraft has a large, circular dish antenna and various instruments. The background is a dark, star-filled sky.

SHINE (Beyond Limits): The Jet Propulsion Laboratory's Spacecraft Health Inference Engine (SHINE) first proved itself when it discovered an anomaly in the Voyager spacecraft's telemetry system just before the craft's encounter with Neptune in 1989. Since then, the software has been used to monitor the health of a host of NASA systems.



Since the first human expeditions in space, astronauts have always carried cameras to capture the experience for everyone on the ground. Here an astronaut snaps a self-portrait during a spacewalk.

“The 1958 National Aeronautics and Space Act mandates that all scientific and engineering developments be made available for public benefit.”

Darryl Mitchell, Technology Transfer Office Chief, Goddard Space Center





Photo: Courtesy of NASA

In 2022, a US startup called The SMART Tire Company will launch a completely new kind of tire for mountain bikes. Made of a nickel-titanium alloy, the METL tire is airless and superelastic: it will last much longer than standard rubber tires, will never go flat and will lead to much less waste.

But the technology behind the METL tire did not come from a tire or automotive manufacturer. It was developed at NASA's Glenn Research Center in Cleveland. The idea for a non-pneumatic tire dates back to the lunar rover in the 1960s. Under development ever since, it is also set to be used on the Fetch Rover heading to Mars in 2026.

NASA knew the shape memory alloy radial technology (SMART) could also be used by vehicles on Earth and made it available for licensing. In 2020, The SMART Tire Company founders, Brian Yennie and Earl Cole, won a NASA Startup Studio program and took a license to NASA's patents to manufacture bicycle tires. "It's such a cool evolution of the technology," says Daniel Lockney, Technology Transfer Program Executive at NASA Headquarters in Washington, DC. "The company has now moved to Akron, Ohio and they're planning to expand further."

IT CAME FROM OUTER SPACE

Technology transfer has been central to NASA's mission since its creation. As Darryl Mitchell, Technology Transfer Office Chief at Goddard Space Center, says: "The 1958 National Aeronautics and Space Act mandates that all scientific and engineering developments be made available for public benefit." Today, NASA has a large technology transfer program across its 10 field centers, says Mitchell: "The program builds advocacy for the agency, creates jobs and creates a future pipeline for certain technologies."

With some 11,000 scientists and engineers in total, NASA is one of the most productive engines of innovation in the world. The tech transfer program identifies about 1,600 new technologies a year with diverse applications. At Goddard, for example, Mr. Mitchell says a lot of research is in sensors and detectors, which can subsequently be transferred to medical diagnostics.

NASA is the only federal U.S. agency that provides details of its entire IP portfolio on one searchable web portal: there are about 1,500 active patents, of which about 1,100 are available for licensing (the rest are mostly licensed on exclusive terms). In fiscal year 2021, it signed over 200 patent license agreements, the most in its history.

Mr. Lockney took over as program head in 2011. One of his initiatives was to simplify and standardize the policies and processes for technology transfer across the 10 field centers. To help achieve this, NASA developed the NASA Technology Transfer System tool, which consists of a multi-step process for inventions, comprising two independent reviews: an in-depth interview with the inventor; and assessment, which may include outreach to industry about potential applications. Only once this process is satisfactorily completed will a patent application be filed.

The consequence is that NASA files a relatively small number of patents (about 80 a year) given the scale of its innovative activity. "We only file patents for the purpose of commercialization, not for defensive purposes or prestige," says Mr. Lockney. "And if there's no licensee, we cut it loose."



Photo: The SMART Tire Company

SMART Tire's airless and superelastic tire, which lasts much longer than standard rubber tires, was developed at NASA's Glenn Research Center in Cleveland.

STARTUP LICENSING TAKES OFF

One of the successful recent initiatives that came out of the standardization of processes across the centers was NASA Startup Licenses. Startup Licenses are one of three types of license (the others are Standard Commercial Licenses and Evaluation Licenses) that can be applied for on NASA's website.

The standard Startup Licenses are available on a non-exclusive basis to companies formed to commercialize NASA technology. There are no upfront fees and no minimum fees for the first three years. Once the company starts to sell a product, there is a standard 4.2 percent royalty.

Over the past five years, the Startup License program has seen patents licensed to over 100 startups across the United States. But its benefits go beyond that, says Mr. Mitchell: "Even if a company doesn't qualify for a Startup License, we can still make a deal with them. The overall aim is to expedite the licensing process and make it easier for small businesses."

The program makes the technology transfer process simpler, meaning companies do not get bogged down in negotiations and benefit from terms that suit their circumstances. At Goddard, there were 21 new licenses in the financial year 2021, and six of these were startup licenses. "It's not just about access to patented technology, but about helping entrepreneurs get the skills to succeed," says Mr. Mitchell.

Startups that have taken licenses to NASA technology include:

- Beyond Limits Corporation of Thousand Oaks, California, which licensed an artificial intelligence program and language-understanding software from the Jet Propulsion Laboratory for targeting online advertising.
- TellusLabs of Boston, Massachusetts, which has developed a crop prediction model combining Earth-imaging data from satellites built at Goddard Space Flight Center with historical data, weather models and other information.
- Amorphology Inc of Pasadena, California, which was founded by a pioneer of metallic glasses and metal 3D printing at the Jet Propulsion Laboratory. It has exclusive licenses to IP from NASA and Caltech relating to novel metal alloys (also known as amorphous metals) and produces robust gears and other metallic parts.

The startup licenses are part of a range of activities that NASA is taking to reach out to entrepreneurs. These include the NASA Startup Studio – which was held by FedTech (an organization that connects entrepreneurs with technologies from federal labs) last summer and which led to the development of The SMART Tire Company – and Commercialization Training Camps, where professional athletes join in motivational sessions with entrepreneurs.

Some technologies that came out of NASA

Phone cameras: The digital cameras on every smartphone ultimately derive from NASA scientist Eugene Lally's development of a sensor back in 1965, which converts photons into electrons that can be turned into a picture. The technology was originally used on satellites and later licensed to Nokia and other phone manufacturers.

Sunglasses: Glass to filter ultraviolet light was developed to protect NASA workers from flashes, lasers and welding flares in space and on earth.

Ventilator: When the COVID-19 pandemic emerged, NASA engineers at the Jet Propulsion Laboratory developed the Ventilator Intervention Technology Accessible Locally (VITAL). The prototype was ready in just 37 days. NASA has licensed it for free to more than 36 companies, including some in Brazil and India.

Source: <https://spinoff.nasa.gov/>

Photo: Courtesy of NASA



Metallic glass gears (Amorphology): While NASA's Curiosity rover represented the cutting edge of the space agency's robotics when it arrived on Mars in 2012, it has to spend about three hours heating up lubricants for its gears each time it sets out across the planet's surface. To help future rovers save time and energy, NASA has invested in bulk metallic glass for gears that require no lubrication.

After testing a ventilator prototype developed by NASA's Jet Propulsion Laboratory, doctors in the Department of Anesthesiology and the Human Simulation Lab at the Icahn School of Medicine at Mount Sinai in New York City give a thumbs up. Developed in response to the coronavirus outbreak, the device, called VITAL (Ventilator Intervention Technology Accessible Locally), requires far fewer parts than traditional ventilators, making it cheaper to build and ideal for rapid manufacture. Lying on the bed is a human patient simulator used to test the device.

Photo: Icahn School of Medicine at Mount Sinai, New York City and NASA/JPL-Caltech



NASA also works closely with universities and business schools, for example, by providing representative technology for students to use as case studies for creating businesses.

These activities have been accompanied by a change in focus, says Mr. Mitchell: “We’ve seen a shift over the past several years. We did a lot of external marketing but the payoff was not commensurate with the work. We’re now more focused on direct marketing and customer delivery.” This includes promoting the tech transfer program, helping licensees to talk about what they are doing, and fully digital outreach.

REACHING FURTHER

Mr. Lockney believes there is still more to be done to develop the potential of inventions, particularly in reaching under-represented groups (including minority institutions and Native American communities) and areas that are located further away from NASA’s field centers. “We want to create more diversity. Universities and business schools are ripe opportunities for us,” he says.

Another possible growth area is international collaboration. While the startup program is focused on the United States, NASA does license to companies overseas (except where there are export restrictions on the technology). But for budget reasons, NASA rarely files patent applications outside of the US, so it expects non-domestic companies to come on board at an early stage and pay the international filing fees under the Patent Cooperation Treaty (PCT) (see box) or other application fees.

One challenge that NASA faces in technology transfer is the growing role of software in inventions. About one-third of NASA’s inventions are software programs, and as a federal government agency, it cannot own copyright in them. Unless there are restrictions or ownership issues, the software is made available as open source. “That means it can be used commercially but you can’t sell it. So that puts a hold on commercialization but it doesn’t stop you using the technology,” says Mr. Lockney.

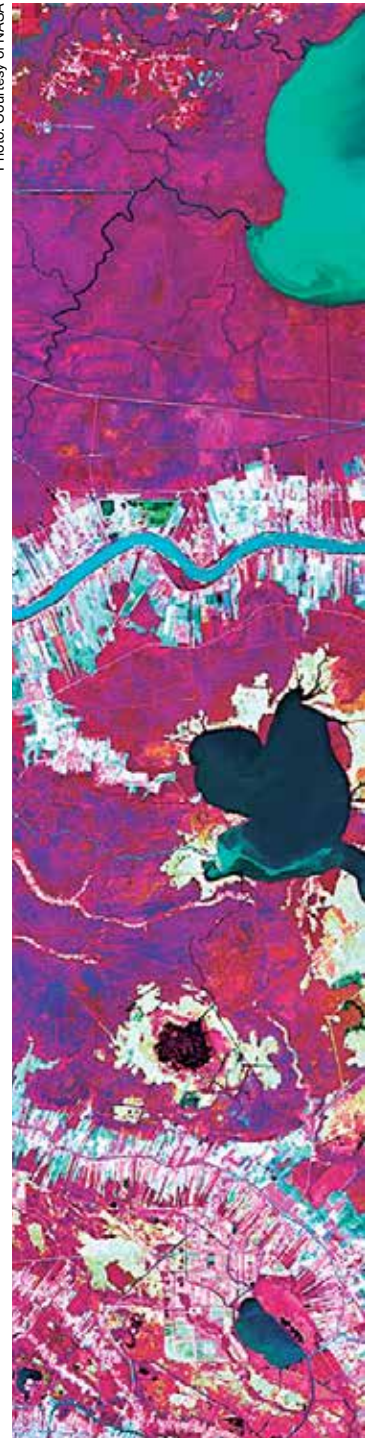
THE SKY IS THE LIMIT

Unlike many technology transfer programs, NASA is not primarily driven by revenue – although royalty income does feed back into the agency and to individual inventors. Instead, the priority is to create new products and services and to enable the potential of technologies to be exploited. That, in turn, delivers downstream benefits such as corporate revenue and job creation, as well as longer-term improvements to quality of life and environment.

“We want to get the technology out there so people can work their magic with it,” says Mr. Mitchell. “We have many remarkable inventions at NASA, but it’s not always obvious what the commercial application might be. It might be completely different to what we’re doing with it.” In some cases, the technology might be five, 10 or even 15 years ahead of its time and might require significant development to get it to the market.

“We have really smart people at NASA working in very difficult fields, and they’re obsessed with the Agency’s mission and with space,” says Mr. Lockney. “Ultimately, what we want to do is extract as many technologies from the labs as possible and for new products and services to reach the market as a result of NASA’s R&D.”

Photo: Courtesy of NASA





This image, taken by Landsat 8 and processed by TellusLabs, shows New Orleans as it sits along the Gulf of Mexico. Agriculture, largely sugar cane, can be seen along the banks of the Mississippi in light pink and blue. Also apparent are sediment swirls in Lake Pontchartrain to the north and the loss of coastal land south and east of the city.

About the Patent Cooperation Treaty

The Patent Cooperation Treaty (PCT) offers inventors and businesses a cost-effective and streamlined route to protect their innovations in multiple markets. By filing one international patent application under the PCT, applicants can simultaneously seek protection for an invention in over 150 countries.

The PCT also helps patent offices with their patent granting decisions and facilitates public access to a wealth of technical information relating to those inventions through PATENTSCOPE.

New generation memory chips promise to cut energy use

By **Catherine Jewell**, Information and Digital Outreach Division, **Yuka Okakita** and **Tomomi Taguchi**, WIPO Japan Office



Photo: Courtesy of SEL

Dr. Yamazaki in a briefing with a team of researchers on SEL's state-of-the-art supercomputers, which enable the company to perform complex, large-scale simulations at high speed.

Semiconductors, “the brains of modern electronics,” without which the digital devices we use every day would not work, have been responsible for driving advances in digital technologies for decades. The pioneering Japanese company, Semiconductor Energy Laboratory Co., Ltd. (SEL), is a world leader in this field, and continues to break new ground in developing high-performance next-generation semiconductor technologies. The company’s founder and President, Mr. Shunpei Yamazaki, inventor of “flash memory,” is the world’s most prolific inventor in terms of the number of patents he has filed, according to *Guinness World Records*. Mr. Yamazaki discusses SEL’s commitment to achieving carbon neutrality through innovation, the importance of intellectual property to its business model and the culture of open innovation that supports SEL’s pioneering work.

Tell us about the current focus of SEL's work and how it supports global environmental goals.

I have been working in the field of semiconductors for several decades, ever since I invented and patented what is known as flash memory (patent no. JP 886343), at the age of 28 in 1970. Flash memory is embedded in most of the electronic devices we use every day. Essentially, it makes it possible to store data and information even when the device is turned off. Flash memory is also the least expensive form of semiconductor memory or data storage. I never dreamed that the silicon large-scale integration (Si LSI) – which made it possible to make computer chips so powerful in terms of their micro-processing and data storage capacity – would be so widespread, nor that it would contribute to global warming because of its high-power consumption.

In 2009, we found a new crystal structure of oxide semiconductors (CAAC structure), which makes for more energy-saving computer chips or LSIs. For more than 10 years, now, we have been conducting intensive R&D to improve the performance of LSIs to reduce the power consumed by data centers and supercomputers.

Our goal is to make semiconductors more energy efficient. Through our pioneering work, we have developed a new semiconductor material with high current retention characteristics. An Si FET has a leakage current of around 10-12A/μm when turned off; on the other hand, an OS FET (crystalline oxide semiconductor field-effect transistor) has an extremely low off-state current of 10-24A/μm. That means that data can be retained for a long time. By taking advantage of these high current retention characteristics and silicon's good electrical properties, we have developed a new Si/OS composite structure. By utilizing their combined synergistic effect, we aim to create semiconductor devices with greater power-saving properties that could ever be achieved by silicon technology alone. Broad uptake and use of this new technology will greatly contribute to the fight against global warming.

For those who are not familiar with semiconductors, can you say a few words about the role they play and their importance in the modern world?

All the electronic devices we use every day, our smartphones, laptops, televisions, computers and so on, use semiconductors. Their use has become so widespread and so common that people tend to take their role and importance for granted. People are generally unaware that in using these devices they are consuming huge amounts of electricity, which, in turn, is contributing to global warming.

How does SEL's work fit into the ambitions of Japan and other countries to digitize and decarbonize their economy?

Japan's Growth Strategy Action Plan approved in June 2021, by Mr. Yoshihide Suga who was Prime Minister at that time, highlights the Government's commitment to promoting the development and production of advanced semiconductor technologies, given their low energy consuming properties. The Strategy also outlines the Government's aim to: a) make all new data centers 30 percent more energy efficient by 2030; b) convert part of the electricity used by domestic data centers to renewable energy; and c) make the semiconductor and information communication industries carbon neutral by 2040.

In the summer of 2021, we had an opportunity to introduce SEL's hyper-power-saving crystalline oxide semiconductor LSI (OSLSI) technology to the Ministry of Economy, Trade and Industry (METI). The Prime Minister had been informed about the potential of SEL's OSLSI technology to contribute to the government's green policy goals, and was interested in learning more about it. We were invited to prepare a document outlining the properties of that technology. The document served as the basis for a detailed briefing on SEL and our technology by the Deputy Director General of METI to the Prime Minister. METI then followed up with us again.

We believe that achieving widespread uptake and use of our pioneering OSLSI technology will make a significant contribution to solving global warming.

In 2016, your entry was renewed in *Guinness World Records* as the inventor credited with the most patents. At that time, you had over 11,350 patents to your name. What inspires your work and drives you to continue developing pioneering technologies in this field?

I had always scored poorly in school, but in my second year at university, I started working with Professor Yogoro Kato (subsequently, he became an Emeritus Professor at Tokyo Institute of Technology), and he was very supportive of me. I worked with him for five years. When I told him I wanted to go to Stanford University in the United States, which was the Mecca of semiconductors at the time, he was furious with me and convinced me to continue my studies in Japan under his guidance. You can't compare lives, so I don't know if my choice to give up on going to the United States was a good one or not, but it was certainly a turning point in my life. I didn't start out as a brilliant student, but thanks to Professor Kato, who took me under his wing, I am here today. And I continue my research to keep faith with his teachings. He was a great teacher.

SEL continues to focus on the development of pioneering, new technologies. How does patenting support the diffusion and uptake of your technologies around the world?

As an R&D-focused company, patents are extremely important for us, just as Professor Kato taught us.

Intellectual property is a great mechanism, but patents do not generate income unless the products they protect are marketable. The nature of an R&D-only company is such that it is essential to hit the market as many times and as efficiently as possible.

With our portfolio of intellectual property rights we can confidently make a case against any party that infringes our rights without flinching. In this way, we have been able to leverage our rights and expand our market share effectively. It is, however, important to have a patent right that can be properly utilized. That is why drafting a patent specification that is based on R&D results and that clearly states the purpose and effect of the patent is so important. Moreover, strategic use of a patent is essential for R&D activities to expand, for the value of the patent to increase and for income from licensing to grow. Strategic use of patent rights may also involve legal action.

Can you say a few words about SEL's innovation culture and its guiding principles?

Since SEL was established in 1980, we have been committed to contributing to the progress of the world through R&D. Our first partner was Sharp Corporation, a world leader in semiconductors and liquid crystal display televisions at the time. The partnership came about thanks to an introduction from an acquaintance. However, when we started doing research with Sharp, they considered that our R&D level was too low. From that point, SEL worked hard to reach Sharp's required level. Some of their demands seemed overwhelming at first, but we managed to keep up with them.

I believe that only through R&D and hard work will we be successful. When your partners point out specific issues that need to be addressed and your employees work hard to achieve them, you will produce better results. I don't think innovation will ever work if you simply ask your partner to teach you or make things easy for you. It will not work if you do not have the commitment and drive to achieve new levels of expertise to meet the needs of your partner. To improve R&D levels it is essential to find a company that will stretch you technically, while maintaining an equal relationship as a partner.

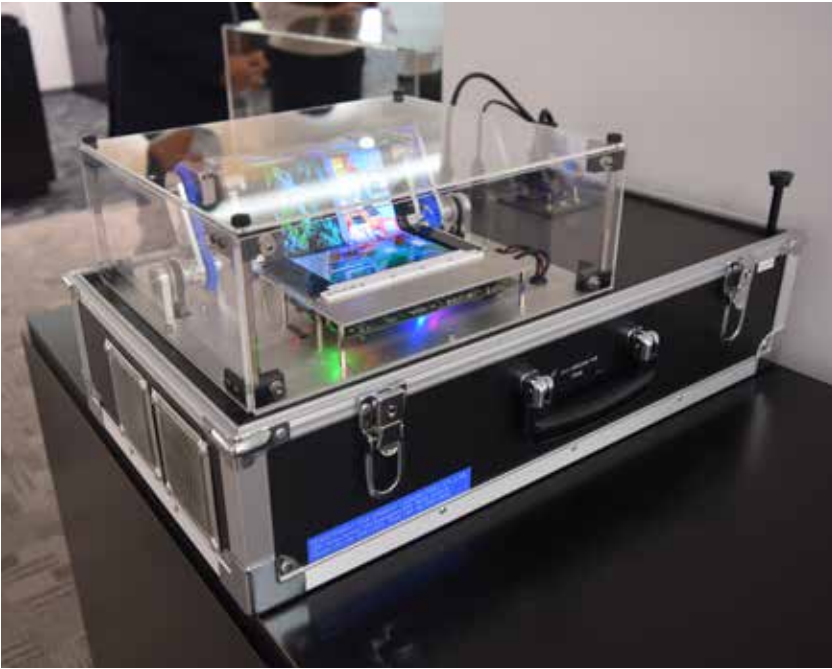
Photo: Courtesy of SEL



Made by SEL in 1987, the Solar Car Southern Cross completed the first World Solar Challenge in Australia in 1987 from Darwin to Adelaide; a distance of 3,200 kilometers.

“All the electronic devices we use every day, our smartphones, laptops, televisions, computers and so on use semiconductors... People are generally unaware that in using these devices they are consuming huge amounts of electricity, which is contributing to global warming.”

Photo: Courtesy of SEL



An 8.67-inch foldable display with an in-cell touch sensor. The display can withstand being folded more than 100,000 times.

WIPO GREEN is a public platform that seeks to promote global innovation in the area of green technologies. Are you willing to support this initiative?

Tackling global warming is the most important issue facing humankind today. WIPO GREEN is a very important initiative that seeks to harness the power of the intellectual property system to protect the environment. We see that WIPO GREEN could be an important vehicle to enable the rapid and widespread uptake and use around the world of OSLSIs, which are highly energy efficient. I believe that cooperation with international organizations like WIPO is essential to achieve this goal.

What advice do you have for young scientists with aspirations to build a better future?

In the past, Japanese companies were driven by a commitment to quality and hard work and the belief that adversity makes people wise. But today, that has all but disappeared. We need to rekindle that belief if we are to continue to thrive. Human resources and intellectual property are extremely important for Japan. We need to do more to promote greater understanding in the courts of the value of IP rights, and patents in particular. We also need to promote greater awareness among the general public of the importance of intellectual property. The only way for Japan to remain competitive internationally is by making use of our intellectual property.

Eco Panplas: better recycling of lubricant containers

By **Monica Miglio Pedrosa**,
freelance writer

In 2020, global demand for lubricants rose to 37 million metric tons, according to Statista. Lubricants play a key role in optimizing the efficiency and safety of machinery. However, the disposal of the plastic containers in which lubricants are delivered to customers is a major environmental threat and their decontamination is a longstanding industrial conundrum.

It takes just 1 liter of lubricant to contaminate up to 1 million liters of water. In Brazil alone, 1 billion plastic containers of lubricating oil are discarded every year. When drained, some 2 million liters of lubricant remain in these containers and are dumped in the environment. Currently, only 9 percent of containers are recycled. Traditional recycling methods require heavy use of water and fail to remove all the residual lubricant, meaning the containers are a low-quality material for recycling.

Recognizing the scale of the problem and its far-reaching environmental impact, the Brazilian company Eco Panplas has developed an award-winning, clean, safe and sustainable solution that is 30 percent cheaper than traditional recycling methods. The company is planning to open five new sites across Brazil to recycle up to 24,000 metric tons of packaging every year. Eco Panplas's CEO, Felipe Cardoso, discusses his entrepreneurial journey, the importance of patents to the company and future plans to expand into international markets.

How did you get into the recycling business?

Before studying Business Administration and becoming an entrepreneur, I worked in the corporate sector, where I headed up a marketing team. But I always wanted my own business in an area that could benefit society. I saw plastic recycling as an interesting value proposition and initially founded a company called EcoPan in 2011.

In Brazil alone, 1 billion plastic containers of lubricating oil are discarded every year. When drained, some 2 million liters of lubricant remain in these containers and are dumped in the environment.

Our aim is to generate around BRL 43 million by late 2023 and to recycle 24,000 metric tons of lubricating oil packaging annually by 2026.

Did that work out?

Unfortunately, no. We were recycling post-industrial waste, but for cost-saving purposes most companies now reclaim and recycle the waste they produce in-house. But that experience set the foundations for Eco Panplas, which I set up with my co-founders in 2014.

After EcoPan folded, I visited well over 300 companies and saw an opportunity; no recycling company could address the problem of decontaminating containers used for lubricating oil. I looked into the problem and found that, in Brazil and elsewhere, the recycling process is always the same — water is used to remove the contaminating material with a negative impact in terms of wasting water and contaminating landfill sites and the environment.

How did you come to establish Eco Panplas?

By chance, I met a local entrepreneur who introduced me to a project that his partner who was a chemical engineer had been developing for two years already. At first, they wanted to sell me the project, but my partner and I invited them to enter into a partnership with us and to apply for a patent. They agreed and the four of us now make up the Eco Panplas team; two on marketing and management, one mechanical engineer, and one chemical and environmental engineer.

How long did it take to develop the technology?

It took us three years to reach technical, financial and environmental feasibility. We then spent another three years validating our technology on the market.

In 2014, we filed our patent application with the Brazilian National Intellectual Property Institute (INPI), through their Green Patents Program. That was crucial for the credibility of our offer, both in Brazil and abroad.

From day one, we recognized that acquiring a patent was important in terms of protecting the company's interests, validating our innovation and boosting its commercial value. A patent is a key differentiator to attract investors, and, in future, it will enable us to take advantage of licensing opportunities.

What sort of interest has your technology attracted?

There's a lot of interest in our technology. We have won over 30 awards for it in Brazil and internationally. These awards have also been an important factor in building the credibility of our solution. In 2020, we were the first Brazilian company to win the Latam USD 100K Entrepreneurship Competition, supported by MIT Management and ITBA (Technology Institute of Buenos Aires). We were also acknowledged as the best innovative solution in Latin America in the last 10 years by the FEMSA Foundation in Mexico. We won the II Latin American Patented Inventions Competition by PROSUR and went on to exhibit our technology at the Geneva

Photo: funfunphoto / iStock / Getty Images Plus



Lubricants play a key role in the efficiency and safety of machinery. In 2020, global demand for lubricants rose to 37 million metric tons.

Disposal of plastic lubricant containers is a major environmental threat and their decontamination is a longstanding industrial conundrum. Just 1 liter of lubricant can contaminate up to 1 million liters of water. Currently, only 9 percent of containers are recycled.



Photo: Courtesy of Eco Panplas

Photo: Courtesy of Eco Panplas



The contaminated plastic packaging Eco Panplas receives undergoes a grinding and decontamination process using an odorless, waste-free and biodegradable degreaser. Unlike traditional recycling models, the process uses no water and recycled waste is fully reusable.



International Invention Fair. We presented our solution at COP-26 in Glasgow and won the Energy Globe Award Brazil 2021, one of the world's top environmental awards. We have also participated in trade shows in China and the GreenTech Challenge in Europe.

What was your experience in seeking patent protection through INPI?

In 2014, we hired a specialized law firm to assist us in seeking a patent. We felt this was important, as they have a far better understanding of the ins and outs of the process. They have expertise in writing patent applications and know how to speed up approval. It was also crucial that we applied for our patent under their Green Patent Program because it validated our solution as a truly innovative clean technology. The Green Patent Program prioritizes environmentally sound technologies and expedites the whole patenting process. Our patent was granted in 2017.

How does your solution work?

The contaminated plastic packaging we receive undergoes a grinding and decontamination process using an odorless and biodegradable degreaser that generates no waste. Through physical, chemical and mechanical processes, the degreaser removes the oil from the packaging plastic and all inputs are separated into plastic, labels and oil. At the end of the process, we generate decontaminated crushed plastic, which can be reused by industry, including for the manufacture of new packaging for lubricants. We sell the oil that we recover back to the refining industry. Our decontamination process uses no water and is 30 percent cheaper than the traditional recycling model for these products. On top of this, the recycled waste is fully reusable so there are no costs associated with waste disposal.

What are your plans for Eco Panplas?

In 2019, Eco Panplas was recognized as a B Company because social and environmental development is central to our business model, which means we balance purpose and profit. We plan to expand our recycling capacity in 2022. The pilot plant in Hortolândia, in the interior of São Paulo state, has reached its annual production capacity of approximately 1,500 metric tons per year, so this year, we are in the process of building another production

plant with five times the recycling capacity of Hortolândia. Our aim is to generate around BRL 43 million (approx. USD 8.26 million) by late 2023 and to recycle 24,000 metric tons of lubricating oil packaging annually by 2026. To achieve this, we foresee operating six units in total — three in São Paulo state, one in Minas Gerais state, one in the south and one in the northeastern region of Brazil.

We are already testing the solution for recycling packaging for cooking oil, vegetable oil, paints and cosmetics and the results are very good. These are entirely new markets to explore, and other potential uses of our recycled materials could arise from them. Our ambition is for Eco Panplas to become a major recycler of complex contaminated packaging, which cannot be easily degreased with water, and to generate high environmental, economic and financial value for all stakeholders.

Are you targeting markets beyond Brazil?

Yes. We have taken part in several programs overseas and there is clear market demand for our technology outside of Brazil. Latin America, Europe, China, the Middle East and India are potential candidates for our plan to expand into international markets. But first, we need to ensure the solutions we are currently developing are protected in those markets. That's why we are looking to use the Patent Cooperation Treaty (PCT), as it simplifies the process of filing for patent protection in multiple countries and is a cost-effective way of doing so.

Companies such as Shell, Ambev and Braskem have also supported you through their open innovation programs. Are other organizations looking at your solution?

More and more companies want to invest in recycling, which is why we are receiving proposals for corporate venture capital. Some companies are interested in licensing and taking the technology abroad. That is why our IP rights are so important. Companies in the fields of petrochemicals, waste management and recycling have approached us, and we are in talks with municipalities and state governments that want to solve this waste management problem. For us, it all makes a lot of sense: the greater the volume processed, the greater the social and environmental benefits generated. This is our mission and the main legacy we want to leave for society.

IP and youth: educating our future innovators

By **Cecilia Thirlway**, researcher, writer and lecturer at Centre for Innovation and Entrepreneurship, University of Bristol, United Kingdom

Today's young people face a complex and uncertain world. Not only does the pandemic continue to reshape the way we work and live, but the looming threat of climate change makes thinking about the future a difficult and anxious task. Many young people around the world are also dealing with poverty, joblessness, war or civil unrest and political turmoil.

YOUTH DRIVING CHANGE

In the face of these challenges, some young people have already taken highly visible action: it would be hard to have not heard of climate activist Greta Thunberg and her School Strike for the Climate. Other teenagers are pursuing governments and companies through the courts for their failure to fulfill their promises relating to carbon emissions and climate change mitigation.

And at the age of 16, Dutch teenager Boyan Slat came up with innovative ideas to rid the ocean of its plastic waste. When his 2012 TedX talk went viral, he dropped out of school to create the technology behind the Ocean Cleanup organization

These are exceptional stories, but not every teenager can (or should have to) drop out of school, go on strike, or take legal action to achieve their goals. Nor are the principles behind these actions held only by a few young people. The World Economic Forum's recent work with their Global Shapers Community reached over 2.3 million young people and worked with them to develop a Youth Recovery Plan, which includes a commitment to conscious consumerism, environmental protection, ethical technology and innovation and action on climate change.

Similarly, in September 2021, the British Council launched the findings of its Global Youth Letter on Climate Action - research spanning 8,000 young people from 23 countries. The survey showed that 67 percent of young people believe their leaders cannot address climate change alone. So, how do we empower more young people to take action, to invent, create, and innovate solutions to some of the grave problems facing our world?



Deforestation is a priority for the Alpha Core primary school and led them to their idea of recycling paper to make saleable products and to reduce the use of virgin paper. In so doing, they developed a range of entrepreneurial skills and with their creativity quickly expanded their product range.

“When young people are given the opportunity to develop the skills involved, such as creativity, collaboration, resilience, inventiveness and initiative, they will be much better equipped to tackle the uncertain and challenging future they currently face.”

EQUIPPING YOUTH TO BECOME AGENTS OF SUSTAINABLE DEVELOPMENT

As Alok Sharma, President of COP26 in Glasgow in 2021, said in a video message: “The key message from the British Council’s Global Youth Letter is that young people are motivated, they are ready to learn and inspired to act on climate. But I have also heard [young people] ask to be included in meaningful participation, and for improved education and training.”

Young people are demanding an education that reflects the nature of the task ahead of them, and in this, they have high profile support. The Berlin statement issued in May 2021 by the UNESCO World Conference on Education for Sustainable Development (ESD) describes ESD as: “providing everyone with the knowledge, skills, values and attitudes to become change agents for sustainable development ... to develop their cognitive and non-cognitive skills, such as critical thinking and competences for collaboration, problem solving, coping with complexity and risk, building resilience, thinking systemically and creatively, and empowering them to take responsible action as citizens...”

ENTREPRENEURIAL EDUCATION

These personal skills of resilience, creativity, initiative and problem-solving lie at the heart of entrepreneurial education. Setting entrepreneurial education apart from the standard business school, the late Professor Alan Gibb described the impetus behind entrepreneurial education as “preparing young people for a life world of greater uncertainty and complexity in both work, social and consumer contexts with enhanced pressures to see and take opportunities on the basis of individual initiative.”

Dr. Don Parker, Education Director at the Centre for Innovation and Entrepreneurship at the University of Bristol, echoes these statements:

“If we do anything here at the Centre, we have got to empower our students to become change makers,” says Dr. Parker. “Change is difficult for everybody - our students come in with the problems they see around them and we help them turn that into a value system, into a new dialogue with industry and with society. They have such power and energy, but it needs direction to be effective.”

CHANGING MIND SET AMONG YOUTH

Over the 20 years he has been teaching, Dr. Parker has seen the mind set of his students change dramatically:

“Sustainability used to be a consideration, and then an aspiration. Now it’s literally top of their list as they walk through the door, and they really mean it.”

The Centre for Innovation and Entrepreneurship's degrees bring together enterprise skills with the creative processes used in innovation. Its undergraduate integrated Masters' course allows students to combine a more traditional core discipline such as anthropology, computer science, or physics (among others) with modules focusing on creativity, design and systems thinking, problem-solving, and creating new business ventures. The teaching approach requires students to work collaboratively in cross-disciplinary teams to tackle real-world problems.

Two recent Centre graduates, Amber Probyn and Hazel McShane, have turned their final year project - a design concept for a women's urinal that will reduce queuing times and provide a safer environment at festivals and other temporary settings - into a successful startup. When I spoke to them for this article, they had recently filed a patent, trademark and word mark for their business - Peequal - and were in the final throes of closing a successful investment round for more than GBP 250,000. Sustainability is at the heart of the way they run the business:

"Our values are about safety for women, gender equality, and sustainability....we both love festivals, but we understand their environmental impact, so we created Peequal to try and alleviate that problem. It can be completely flat-packed so it saves on transport fuel and costs, and although it's made of plastic we are using old sea plastics, such as fishing nets, rather than new. We have had to make some costly decisions in order to meet our sustainability targets, but we think it's worth it."

For Ms. Probyn, the possibility of starting her own business was part of why she chose to study at the Centre, but for Ms. McShane, it was a different story.

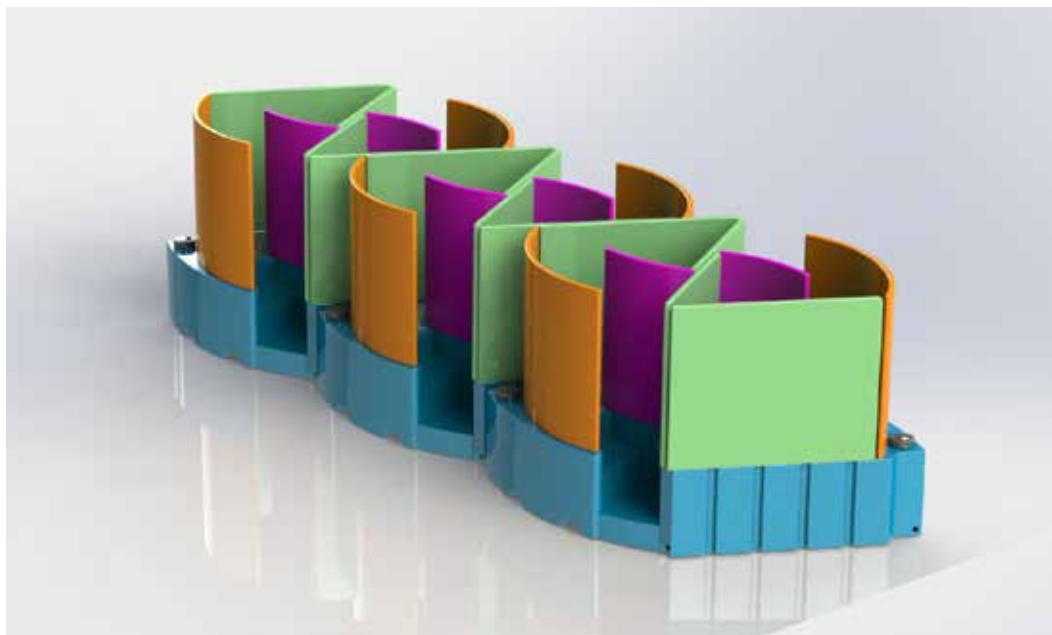
"I had no idea what I wanted to do. Starting a business never occurred to me, so it was all down to the Centre for Innovation slowly introducing concepts such as design thinking and processes, raising investment and intellectual property (IP)."

The skills they learned at the Centre were still very much in evidence as they described how they recently created a cardboard prototype of their product to test a new design. Rather than buying new cardboard, they rifled the local supermarket's bins to find their raw materials.

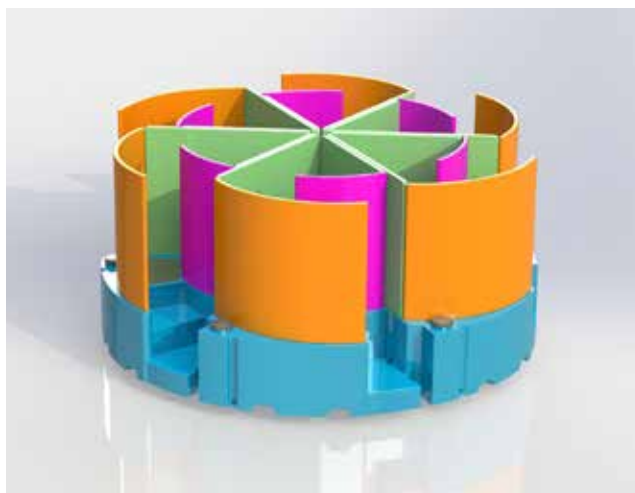
"It was very funny at the time, but it also felt good to know that we were living our values and being as sustainable as we could at every turn," says Ms. McShane.

A MULTI-DISCIPLINARY APPROACH

Andy Penaluna, Professor Emeritus of the University of Wales, has worked in entrepreneurial education all over the world. He has collaborated with governments in over 50 countries including Egypt, Macedonia, and Wales as well as with the United Nations and the European Commission to design curricula and educational strategies that develop entrepreneurship skills and knowledge in young people of all ages. He sees entrepreneurial education as requiring a truly multi-disciplinary approach, drawing from design, classics, neuroscience and other disciplines to develop both the personal skills required to be enterprising, as well as knowledge about business concepts such as finance, investment and IP. As a member of the UK's IP in Universities and Colleges Steering Group, he is clear that starting this type of education early is essential:



Photos: Courtesy of Peequal



Bristol University's Centre for Innovation and Entrepreneurship marries enterprise skills with the creative processes used in innovation. Recent graduates, Amber Probyn and Hazel McShane (below), turned their final year project — a sustainable design concept for a women's urinal for festivals, etc., — into a successful startup called Peequal, for which they recently secured funding.



“Young entrepreneurs can be a powerful force, creating employment for their peers, growing economies, and transmitting their values through their entrepreneurial choices.”

“You often find that skills such as creativity or knowledge about business are mentioned at the top level [of the education system] when talking about essential standards and abilities - but there’s no scaffolding for it earlier on - it just suddenly appears if you suddenly drop these things in then they’re surprising and worrying, but if you create awareness early on and build up understanding, it’s much more effective.”

In Macedonia, Professor Penaluna’s work contributed to the development of their entrepreneurial education methodology, which starts at age 13 and takes students through a range of activities designed around five themes - Innovation and Creativity, Context, Finance, Business Understanding and Communication - culminating in a final year project where students set up and run their own company.

According to the Global Entrepreneurship Monitor (GEM), adequate entrepreneurial education is one of the nine Entrepreneurial Framework Conditions required to facilitate and nurture the emergence of entrepreneurial activity in an economy. The 2016 GEM found that in emerging economies, a higher percentage of early-stage businesses are owned by people in younger age groups (18-24). It also found that and people’s confidence in their entrepreneurial abilities and willingness to take risks are higher than in more developed economies.

This may reflect, in part, the demographics in different parts of the world. For example, around 65 percent of people in Africa are under 35, and young entrepreneurs can be a powerful force, creating employment for their peers, growing economies, and transmitting their values through their entrepreneurial choices.

BUILDING BUSINESS SKILLS IN SCHOOLS

Global charity, Teach a Man to Fish, focuses on entrepreneurial education, prioritizing the developing world through its School Business model. The organization takes students and their teachers through a step-by-step process of setting up their own school business and sees entrepreneurial education as vital to equip young people with the skills, mind set and confidence to deal with turbulent times. While for some students involved in Teach a Man to Fish’s programs, entrepreneurship is a necessary route to survival and lifting themselves out of poverty, sustainability is at the heart of many of the projects.

Students at the Asulma Centre in Kenya produced inexpensive conical solar cookers as part of their Business Challenge. Charcoal is widely used for cooking in Kenya, contributing to deforestation as well as creating many health problems from the smoke. The solar cookers are cheaper and cleaner to run. The students also set up a side business selling smokeless briquettes to replace traditional charcoal to families still using charcoal burners. The students had to learn business skills such, as book keeping, as well as persuading their local community to change the way they cook:



Photos: Courtesy of Asulma Centre, Kenya

Students at the Asulma Centre in Kenya produced affordable conical solar cookers as part of the business challenge set under an entrepreneurial education program offered by the global charity Teach a Man to Fish. They also set up a side business selling smokeless briquettes.



“Convincing community members has not been easy, but slowly the reality is beginning to sink in....[we would like] to empower as many people as possible with business skills and to fight deforestation.”

Deforestation was also a priority for the Alpha Core primary school in Pakistan. Inspired by the Sustainable Development Goals and Prime Minister Imran Khan’s drive to plant a billion trees, the children asked why so many new trees needed planting in the first place. This led them to their idea of recycling paper to make saleable products and to reduce the use of virgin paper. They had to develop resilience in learning how to make a quality end product and a range of skills including creativity, teamwork, critical thinking, leadership and time management. They got creative by including glitter, seeds and food coloring in their products, and quickly expanded from simple paper to key rings, notebooks and other products. The money raised was donated to a local educational NGO to help future students benefit from the program.

Older students at the *Instituto Técnico* in Honduras focused their attention on waste metal from discarded appliances and machines, which had been donated for repair or recycling. The students realized that while some components could be sold to recycling merchants, they could use other parts to create their own new products, such as solar-powered emergency lamps for the local community to use during power outages.

The idea met their requirements to produce something unusual, economical, environmentally friendly and feasible. They also supplemented their capital by creating 3D-printed keyrings to sell to their local community. The students organized themselves according to their skills and abilities and, along the way, taught themselves how to tackle problems that they had never had to consider before, such as how to buy the components they needed in a cost-effective way.

It is clear that whether students benefiting from entrepreneurial education go on to set up businesses is not necessarily the best measure of its success. However, when young people are given the opportunity to develop the skills involved, such as creativity, collaboration, resilience, inventiveness and initiative, they will be much better equipped to tackle the uncertain and challenging future they currently face. As the students of Alpha Core school told me when asked if they would use the skills they have learned in later life:

“The School Enterprise Challenge is the journey that we are going to cherish forever and the skills that we learned here in Grade 3 are now going to be a part of “**US**” forever. We want to polish the learned skills even further! We want to learn **MORE!**”



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