# WIPO MAGAZINE

APRIL 2017

No. 2

Forging the future the Fraunhofer way

p. 8

Patents for Humanity: improving lives across the globe

p. 15

Patent information enables rainwater harvesting in Zambia

p. 20

## The battle to own the CRISPR-Cas9 gene-editing tool

p. 26


Every day, ordinary people are producing extraordinary new things to change the world for the better. Their innovations take myriad forms, from the mundane to the seemingly miraculous. From new medicines and materials to improved crop varieties and communications, innovation is making our lives healthier, safer and more comfortable.

Innovation is a human force that knows no limits. It turns problems into progress. It pushes the boundaries of possibility, creating unprecedented new capabilities.

This special issue of the WIPO Magazine offers a range of perspectives on the enabling role that intellectual property plays in supporting innovation in a variety of settings across the economy and in different parts of the world.

For more on **World Intellectual Property Day**, join us on Twitter (#worldipday) and Facebook (www.facebook.com/worldipday).

# Table of Contents




**Acknowledgements:**

2 **Marco Aleman**, Patent Law Division, WIPO
8 **Claus Matthes**, PCT Legal and International Affairs Department, WIPO
20 **Kiflé Shenkoru**, Division for Least Developed Countries, WIPO
26 **Matthew Bryan**, PCT Legal and International Affairs Department, WIPO
33 **Kaori Saito**, Gender and Diversity Specialist, Human Resources Department, WIPO
38 **Olga Spasic**, SMEs and Entrepreneurship Support Division, WIPO

Editor: **Catherine Jewell**





Cover images:
Left to right: Courtesy of Fraunhofer; Courtesy of GRIT; iStock.com/dave_valler
Main image: iStock.com/cosmin4000

# What lies beneath: the unsung story of biopharmaceutical innovation

Photo: iStock.com/RainervonBrandis

The story of innovation in the biopharmaceutical field involves multiple complex narratives that often go unseen.

By **Corey Salsberg**, Vice President and Global Head of IP Affairs, Novartis

Ingenuity is often portrayed as an archipelago of "Aha!" moments in an otherwise empty sea. Newton and the apple. Archimedes in his bath. Einstein in a daydream that revealed his theory of general relativity. Farnsworth in a cornfield whose neatly plowed rows became the basis for his invention of television. The list goes on.

Without doubt, invention and discovery are unpredictable endeavors: nonlinear and unexpected; one step forward, three steps back. But that does not mean that innovation is random. Quite the contrary, while "Eureka" moments surely have their place, true innovation – that which really touches and transforms human lives – is almost always more a product of the focus and persistence that comes with the pursuit of a mission than of a chance encounter with a wandering muse. As Thomas Edison famously put it, "genius is one percent inspiration and 99 percent perspiration," or thereabouts. This makes perfect sense; for it is precisely the hard work and perseverance that is done towards a mission or a goal that provides the necessary context for those "Aha!" moments to arise, not to mention the uncelebrated before and after steps that enable the conversion of those bold ideas into the breakthrough innovations that they eventually become.

Nowhere is this more true than in the biopharmaceutical field. With an average research and development (R&D) timeline of 10-15 years, biopharmaceutical innovation – the kind that stops a child from contracting a disease, purges a virus from deep within the body, sends a tumor into complete remission, or transforms a death sentence into a manageable condition – neither starts nor stops with a single "Aha!" moment. It is an ongoing, complex, laborious process that begins with disheartening odds (sometimes ten-thousand-to-one), where failures and their many teachings are as important as successes, and where "success" cannot fairly be measured in a single dimension. That is why, at Novartis, we direct our work not merely toward the invention of medicines, but toward a far broader mission: "to discover new ways to improve and extend people's lives".

This broad mission provides the context and focus for our science-based approach to R&D, and for just about everything else we do, including our approach to patenting. As most *WIPO Magazine* readers will know, the patent system is a powerful tool that in our industry helps to offset the high costs and risks inherent in the type of R&D that we do. But, importantly, it is *only* that – a tool, a means to achieve an end, not an end in itself. In practice, this means that we focus on our mission, follow it wherever it takes us, and patent those inventions we create along the way that help us to realize and implement it. Anyone who takes the opposite approach – chasing patents for patents' sake – is destined to end up with a file full of pricey paper, and is unlikely to achieve much else. That, in essence, is the core difference between mere invention and true innovation, the end goal that permeates our

→

Photo: iStock.com/DragonImages

With an average R&D timeline of 10-15 years, biopharmaceutical innovation is an ongoing, complex, laborious process that begins with disheartening odds, where failures and their many teachings are as important as successes.

mission. It is also why, ironically, on World Intellectual Property Day, the best thing we can do to recognize the critical importance of the system is *not* to focus on intellectual property (IP) as such, but on the mosaic of results that it enables.

There are, of course, innovations that everybody sees – the pills in the bottle, the tablets in the blister pack, the ointment in the tube, the liquid in the ampoule – the stuff that saves millions of lives and shapes human history. Think of a medicine, look inside your own cabinets and pill boxes, reflect on any therapy that has given you or a loved one a new lease on life, and you can be sure that the patent system played a central role in its creation: antibiotics, vaccines, pain relievers, antiretrovirals, immunotherapies, nucleotide analog polymerase inhibitors, to name but a few.

Thanks to historic medicines like these, millions of potentially deadly infections are thwarted each year; life's bumps, scrapes and headaches are easier to bear; cancer death rates are plummeting (https://seer.cancer.gov/statfacts/html/ld/all.html), cure rates for Hepatitis C are now above 90 percent (https://tinyurl.com/mgnscjn), and HIV/AIDS mortality has dropped 87 percent (www.cdc.gov/nchs/data/hus/hus14.pdf).

Let me cite a few examples from our own portfolio. Science-based innovation and the patents that enabled it gave us Glivec®/Gleevec®, a tyrosine-kinase inhibitor now on

the World Health Organization's essential medicines list. It has been called a "miracle drug" for its role in converting a once fatal cancer, chronic myelogenous leukemia, into a manageable chronic condition, and in 2016 was named "Discovery of the Decade" by the prestigious Prix Galien Foundation.

Our in-house discovery of Cosentyx®, a psoriasis treatment won Prix Galien's "Best Biotechnology Product" award in 2016, and Entresto®, the first breakthrough in decades for heart failure with reduced ejection fraction, is now considered the new standard of care by the American College of Cardiology, the American Heart Association, the European Society of Cardiology among others (www.onlinejacc.org/content/68/13/1476).

**A DEEPER INNOVATION STORY**

But while medicines as end products may win praise and make the history books, they are only the visible crest of a much deeper innovation story. Sadly, that story is not readily apparent to a casual observer and often goes untold. Look inside a modern car, and it is easy to see the incredible array of innovation that went into its creation. Medicines, by contrast, have no doors or hoods to open. But that does not mean that there is less innovation inside. A lot more goes into creating a medicine than just finding new substances and placing them in pills. Just as a car needs to be roadworthy – effective as a vehicle, safe to drive, consistently producible, and compliant with regulatory standards – so a pharmaceutical substance must meet rigorous safety, efficacy and quality standards before it can be given to patients. This is far from an easy task, as evidenced by the fact that less than 12 percent of drug candidates entering clinical trials result in an approved medicine.

Getting into that "12 percent club" requires science, hard work and many different types of innovation. It may involve developing the safest, most effective or efficient form of a substance; formulating it with the right ingredients; figuring out the disease or conditions for which it is best suited; and determining the right dose and dosage form. It may also involve inventing new ways to manufacture the substance to scale and quality standards, which is particularly critical for complex biologics (large molecules) and biosimilars.

Then, of course, there are the other 88 percent – the projects that fail at the clinical stage. These are also part of the innovation story. Why? Because the road to failure is often lined with a host of interim successes, many of which will have application elsewhere. And because every "failure" is also a success if it sends us down a different path that ultimately yields a medicine. Though they may not make the headlines, these interim discoveries and developments (wherever they may arise) are the critical backstory to the precious few medicines that do make the grade. This is a narrative which deserves more prominence in the innovation story.

Photo: iStock.com/DNY59

Less than 12 percent of drug candidates entering clinical trials result in an approved medicine.

→

Photo: iStock.com/Reptile8488

The 88 percent of projects that fail at the clinical stage are also an important part of the biopharmaceutical innovation story. They often lead to interim successes with applications elsewhere. Every failure is a success if it leads to the development of a new medicine.

So, for that matter, does the chapter that comes *after* a successful medicine is marketed. In some respects, a marketed medicine is just another milestone on a longer road to improving and extending people's lives (albeit an incredibly important one). While sometimes the next stop is a completely new medicine, often progress comes through incremental improvements to therapies that already exist.

Some argue that such improvements are trivial and do not merit patent protection. But patent laws have expressly sought to incentivize "improvements" for centuries. The first US Patent Act (1790), for example, awarded patents for "any useful art, manufacture, engine, machine, or device, or any improvement therein not before known or used." Its author, Thomas Jefferson, later wrote in a letter to Marc Pictet: "many ingenious improvements are made in consequence of the patent-right."

Indeed, ingenuity should not be assessed merely by reference to what came before. If the goal of the patent system is to encourage innovation, and innovations are inventions with meaningful impact, the appropriate question to ask of an otherwise patentable invention is not how much it builds on the past, but what it brings to our future. In the case of medicines, a new formulation can hardly be "trivial" if, for the first time, it allows a child to take a medicine previously reserved for adults (i.e. a pediatric formulation), or makes it possible to distribute an existing medicine to remote areas (e.g. heat resistant formulations).

Nor is there anything remotely trivial about the novel and inventive use of an existing medicine to effectively treat a different disease. These and many other types of improvements, which can translate into everything from reduced side effects, to broader

Photos: © Novartis

Coartem® is a cutting-edge anti-malarial which Novartis has provided without profit to more than 60 malaria-endemic countries.

patient use, to better compliance and health outcomes, form another crucial narrative in the innovation story that is too important to ignore.

There are others, too, like the critical role that IP plays in enabling *generic medicines* that are so important to today's budget-conscious healthcare systems. Today's generics are but copies of yesterday's innovative medicines, made at lower cost by foregoing independent R&D and copying successful outcomes once patents expire. Tomorrow's generics will likewise follow the lead of today's innovative medicines, relying again on the IP-driven R&D undertaken by innovators to create new medicines.

**FACILITATING ACCESS**

There are also more complex narratives, like the central role that IP plays not just in enabling the invention of tomorrow's cures, but in facilitating access to today's medicines by creating the conditions that help ensure that medicines actually reach patients. Evidence shows that strong IP results in faster launch and more rapid access to new medicines; the introduction of medicines that would not otherwise be available in a given market (in brand or generic form); and investment in activities like building distribution chains and doctor and patient education which have been shown to lead to improved access and better health outcomes.

Then there are the myriad alternative ways in which we are able to apply our innovation expertise and global reach to advance public health and improve people's lives. This includes our work in developing Coartem®, a cutting-edge anti-malarial which we have provided without profit to more than 60 malaria-endemic countries (over 800 million treatments to date). And social ventures, like our pioneering Novartis Access program which offers affordable access to a portfolio of our non-communicable disease medicines. It even includes innovative partnerships like our work with WIPO and the World Economic Forum to build an international platform (the Inventors Assistance Program (www.wipo.int/iap/en/)) that brings developing country inventors into the global innovation ecosystem.

Last, there is perhaps the oldest narrative of all: "The only constant is change." Science is changing as our understanding of disease rapidly evolves. Medicines are changing as we continue to transition from chemistry-based small molecules to biology-based large molecules, and from one-size-fits-all to personalized care. Technology is changing as once-disparate fields converge, bringing apps, software, data and wearables, even "smart lenses" and "chips-on-a-pill", into medicine. With all these changes the innovation that defines our future will only grow more intricate, interconnected and complex.

Now, more than ever, the full picture of the role that IP and innovation play in extending and improving people's lives needs to be brought to the surface. There is too much at stake to let it lie beneath.

# Forging the future the Fraunhofer way

By **Catherine Jewell,**
Communications Division, WIPO

Photo: Courtesy of Fraunhofer

"WIPO's Patent Cooperation Treaty is a cornerstone of our IP business," says Alexander Kurz (above). "It provides a great deal of legal security and gives us additional time to find the optimal commercial partner and the most appropriate market for our inventions. It is an excellent way to establish IP rights internationally."

Fraunhofer is Europe's largest applied research organization. Its research institutes are pushing the envelope on innovation in a dizzying array of fields, including health, security, communications, energy and the environment. From fat-free sausages to the audio and video compression technologies that allow us to listen to music on the go, and from better biopsies for breast cancer patients to solar panels – it holds the world record for solar panel efficiency – Fraunhofer's research touches the lives of millions, and in many different ways.

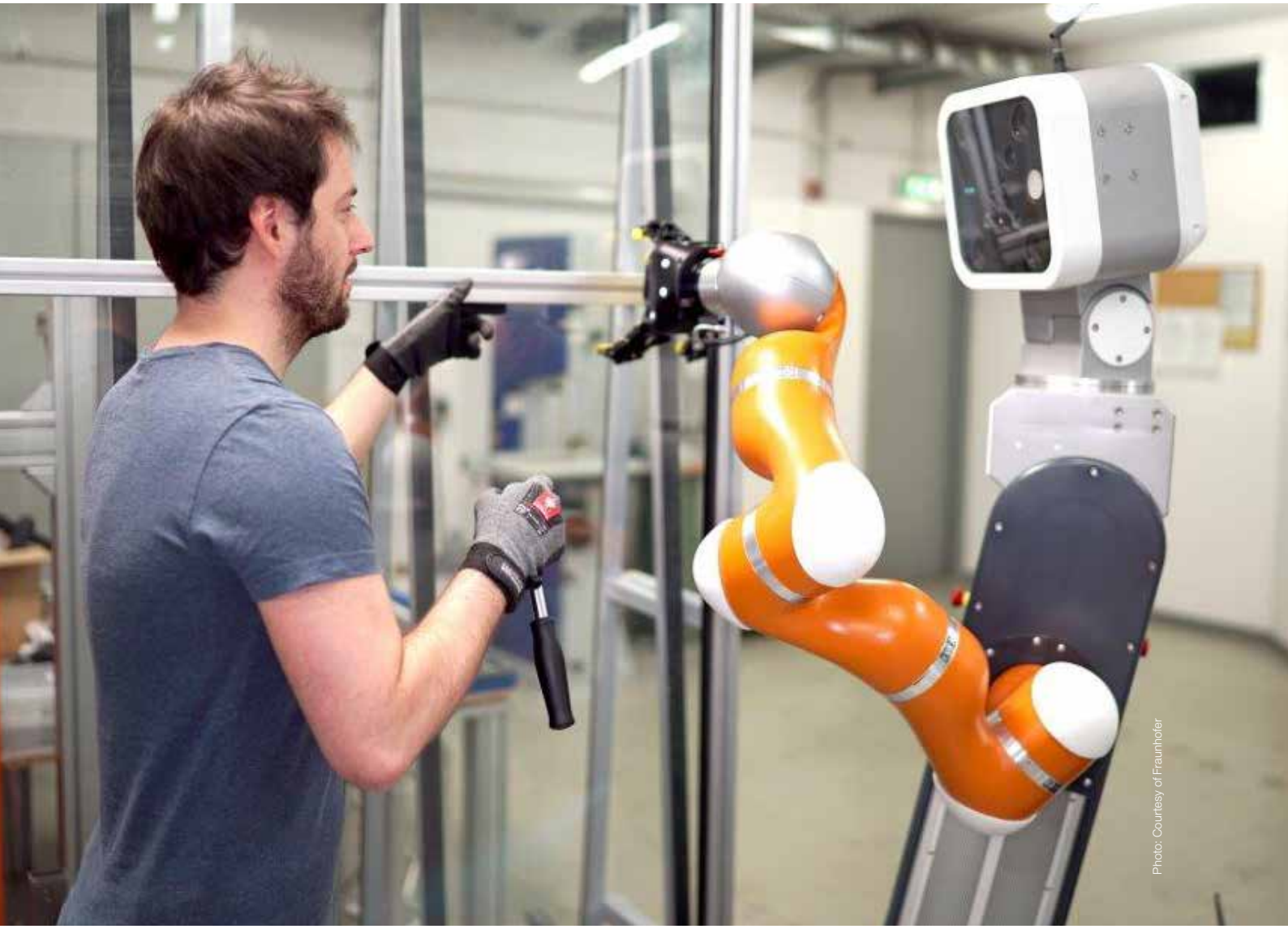
Alexander Kurz, Executive Vice President for Human Resources, Legal Affairs and Intellectual Property (IP) Management, explains what drives innovation at Fraunhofer and how IP supports it.

***Can you give us an idea of the scope of Fraunhofer's activities?***

As an applied research organization, our core mission is to ensure our research has practical application by, for instance, bridging the gap between


Photo: Courtesy of Fraunhofer IPA, Photographer: Rainer Bez

The fourth generation Care-O-bot® developed by the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA) is designed to help seniors in need of assistance to continue living in their own homes.




ANNIE (above), developed by the Fraunhofer Institute of Factory Operation and Automation (IFF), is a mobile manipulator intended for future use in industry and business. In addition to its state-of-the-art hardware and software, the platform integrates a range of key technologies developed by the Institute in the areas of perception, navigation, safety, software architecture and interaction.

university and industry. Fraunhofer is made up of 69 research institutes located across Germany and employs around 24,500 staff to work on its wide-ranging research portfolio. We shape technology, design new products and improve production methods and technology in health, communications, security, energy and the environment. We are committed to doing real research for real people. That involves solving existing problems and opening up new vistas for technological development. In that sense, you could say we are in the business of forging the future.

***How is Fraunhofer funded and who are your main partners?***

As a non-profit organization, Fraunhofer operates under a unique funding model. Thirty percent of our budget – what we call our base funding – comes from federal and state (*Länder*) government grants. And 70 percent is generated through research with industry, revenues from IP and publicly financed research projects. This forces our researchers to undertake their work with an entrepreneurial spirit. In 2016 Fraunhofer worked with a budget of around EUR 2.1 billion.

In terms of our collaboration with industry, we work with the smallest of businesses – for example, a Bavarian butcher to develop fat-free sausage – and the largest of corporations, including automotive or consumer electronics companies. But the bulk of our partners – around 60 percent of them – are small and medium-sized enterprises (SMEs). These companies are the backbone and "hidden champions" of innovation in Germany.

But we also have very strong links with academia. Many of our scientists actually hold professorships in universities across the country. This creates many opportunities for cross-fertilization: they share the latest Fraunhofer research with their students, and many of their students do their academic research in our institutes.

We have IP framework agreements with around 180 German universities. This allows us to maximize the impact of our work across the country. The agreements simply state that all relevant parties need to be made aware of any new inventions so that an appropriate IP strategy, including royalty arrangements, can be worked out. In general, if a researcher uses Fraunhofer's facilities, Fraunhofer will own the IP. Otherwise, we develop a partnership agreement that sets out the contribution made by each party and equivalent royalty payments upon successful commercialization. These negotiations are not always easy. Fraunhofer handles all aspects of the patenting and commercialization process and covers all the related costs. Of course, when it comes to our work with industry partners we use contracts to sort out IP matters and royalty payments. These are always hotly debated.

Our strong links with academia and our base funding give us the scientific freedom and scope to develop our own internal research portfolio for new areas of socially relevant technological research that are not yet fully on the radar screens of our industry partners. This is not the case in our contract work, where our research goals are predefined. Our base funding is, in fact, the soil on which everything grows. It enables us to remain creative and competitive. Large companies have their own R&D facilities, so they will only use our expertise if we are better and more original or if we have expertise in a field they cannot cover. So this side of our business is critical to our long-term success.

***Have you ever quantified the economic impact of Fraunhofer's work?***

Yes, although this is scientifically quite difficult to do, we evaluate the impact of our work periodically. Key findings from the most recent study show that Fraunhofer's work generates significant economic welfare and financial returns to society. They also highlight the way in which we support the development of innovation ecosystems through, for example, training PhD students and encouraging the formation of startups. These small companies are part of Fraunhofer's incubation framework which links into and complements regional incubators that are already in place.

***Who identifies promising inventions and how are new research priorities established?***

In the first instance the researchers themselves, but we have a structured process in place for evaluating the patentability and commercial potential of inventions. Fraunhofer's IP department is responsible for this and for developing appropriate IP

→

strategies in partnership with the institutes. The need to generate 70 percent of our income means researchers consciously look for opportunities to apply or commercialize their research results. We work hard to develop an IP-oriented mindset among our staff.

In terms of how we protect our inventions, WIPO's Patent Cooperation Treaty is a cornerstone of our IP business. It provides a great deal of legal security and gives us additional time to find the optimal commercial partner and the most appropriate market for our inventions. It is an excellent way to establish IP rights internationally. That's why we use it.

As for identifying new research priorities, we monitor the technology landscape to spot emerging developments. And, of course, where we can we try to set the trends. This has been the case with our research on audio and video compression technologies and renewable energy, for example. But anything we do has to align with Fraunhofer's mission. In Fraunhofer, it is great having an idea but it is even better when that idea has practical application and generates a return. That is, in fact, what attracts many researchers to work with us.

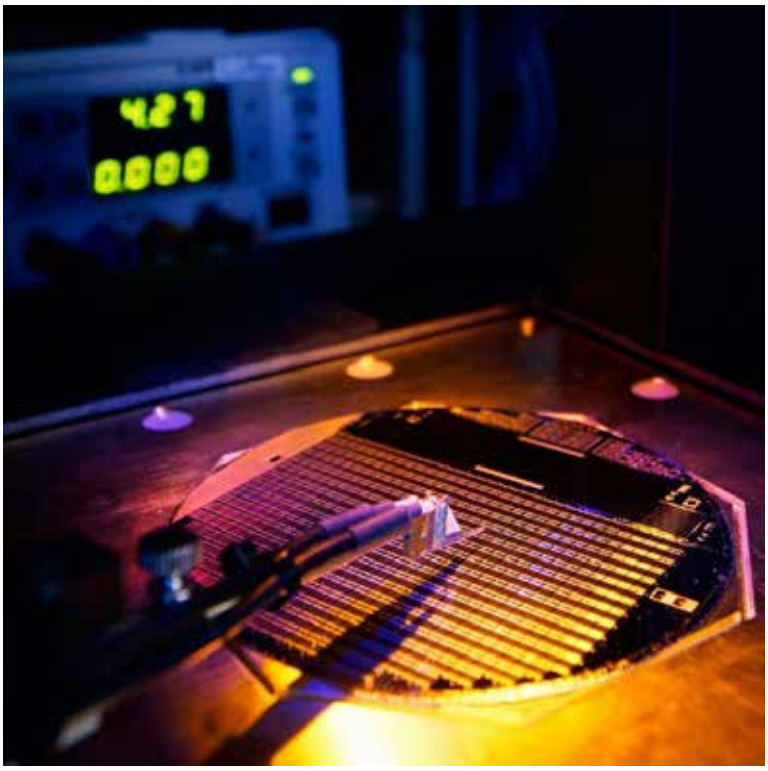
We also use a variety of internal strategic devices to trigger innovation. For example, if we decide to stimulate research in specific areas such as deep machine learning or artificial intelligence, we make a proportion of our base funding available and the institutes apply for it through an internal competitive bidding processes. We also use certain performance indicators as a basis for allocating base funding among the institutes. These mechanisms are proving very effective in promoting collaboration among our different institutes, which is very important, but can be challenging.

***What role does IP play in your organization?***

IP is central to our business model. Legally speaking, we need IP to have the exclusive right to exploit our technology, but once acquired, these rights can be used in many different ways. Fraunhofer's IP portfolio demonstrates our market orientation, strengthens our position in the research market and makes us attractive to industry. IP also allows us to generate additional revenues. Although we have had some success with MP3 and other audio and video compression technologies, it can be difficult to make money from a patent. Sometimes we don't succeed, but fortunately on other occasions we do.

Fraunhofer currently holds 30,000 active patents and around 7,000 patent families covering most areas of our research work. We also register around 60 trademarks per year and hold around 700 active trademarks. Our portfolio

Photo: Courtesy of Fraunhofer



In 2016, Fraunhofer ISE, the largest solar energy research institute in Europe, achieved a new world record in solar conversion efficiency for solar panels.

is managed by 60 IP experts employed in Fraunhofer's central IP department in Munich who work very closely with IP managers at each of our 69 institutes.

Our IP has to add value and ensure we are visible and attractive in the research market, and we have to be able to generate revenue from it.

Generally, in any collaboration we work hard to generate the IP. If we find solutions for industry, we negotiate different licensing options, including exclusive licenses, but, as a rule, property of title remains with us. This approach supports our pre-competitive research and improves our market position. The foreground know-how we develop today becomes part of our background IP portfolio – the sum of all our know-how and IP – tomorrow.

### *What is Fraunhofer's take on technology transfer?*

We support technology transfer and the development of innovation ecosystems in a variety of ways. Our mission is to bring innovation into application, so all channels of technology transfer are relevant to us. One pathway is through contract research. Currently, we have around 10,000 active projects delivering results to our industry partners. Another is through patenting and technology licensing, and a third is through spin-offs. We set up and farm out Fraunhofer technology to around 25 spin-offs every year, with 90 percent of them still operating after five years. We also hold shares in a number of them. This side of our business also generates additional revenues through the contract work we do with them. When they are bought out by larger companies we cash in our shares. Yet another, often underestimated, pathway is employment mobility. Every year, around 900 scientists leave Fraunhofer. Many of them to take up leading jobs in industry.

But technology transfer is not without its challenges. For example, motivating people to become entrepreneurs is not always easy. It is a risky business and not in everyone's DNA. This is not helped by the generally risk-averse culture that exists in Europe along with the stigma that comes with business failure. A product may fail in the market for many reasons that are totally unrelated to its technical merits or quality. Generally, when we talk about innovation we tend to focus exclusively on the success stories, and forget that failure is an integral part of scientific research. Many people enable the development

→

of new technologies because they identify what does not work. These are the unsung heroes of innovation. We need to change this mentality and adopt a more positive and realistic approach to innovation and business development.

***What does the future hold for Fraunhofer?***

There are some very exciting new areas on Fraunhofer's radar. These range from cognitive robotics and artificial intelligence-based systems to deep machine learning and neuromorphic chips, possibly the next disruptive technology in computing, and from smart materials and additive manufacturing to genome-editing. The application of many of these technologies will involve big societal changes and also raise important ethical concerns. If we are to take full advantage of their huge potential benefits – and there are many – we need a social contract. We need experts from across the board to be involved in the process of shaping this new world. But this has always been the case with science and technology.

In the last 10 years our staff numbers and turnover have increased significantly, but going forward our main objective is not growth as such; our overriding focus is to come up with new and improved innovations and technologies.

So in the future we will continue to develop our research and IP portfolios in line with the needs and demands of the evolving technology landscape. Ten years ago, it was enough to develop a technology; today our partners also want a system. That means that we have to adopt a more interdisciplinary approach and become more flexible and agile in the way we work. It also means we have to explore how new innovation approaches, such as open innovation and coworker spaces, can complement existing research practices.

***Why is it important for you to have an international strategy?***

Fraunhofer has a number of international partnerships with research institutes and innovative companies. Our core business, science and research, is global, and innovation is global. If you want to collaborate with the best in the world, you cannot stop at the border.

***What is the secret of Fraunhofer's success?***

We work hard to ensure our mission is not diluted. Everything we do has to support our mission and our business model. I think it boils down to strategy, effective indicators, and – the most important factor – dedicated people.

# Patents for Humanity: improving lives across the globe

By **Edward Elliott**[*], Attorney Advisor, Patents for Humanity Program Manager, United States Patent and Trademark Office (USPTO), USA

As this year's World Intellectual Property Day theme recognizes, innovation has the power to improve lives. People in industrialized countries benefit from innovation every day – from faster computers, more powerful mobile phones, safer transportation, cleaner energy, improved medical treatments and countless other products and services. Commercial markets and incentive structures have proven very effective at deploying innovation to improve lives.

But not everyone is so lucky. Impoverished populations in developing regions and elsewhere struggle with basic necessities like clean water, adequate nutrition and medical care. These regions often do not attract the same attention from innovators, for reasons that include scarcity of capital, lack of infrastructure, low levels of education, insufficient legal protections and a host of other factors. That is not to say innovation does not happen in these regions – clearly it does, because humans everywhere are innovative creatures. But the market mechanisms that are so effective in deploying innovation in advanced economies come up against unfamiliar challenges when it comes to reaching the less fortunate around the globe.

Patents for Humanity is a United States Patent and Trademark Office (USPTO) awards program that recognizes innovators who overcome these challenges to bring life-changing technologies to those in need. Its purpose is twofold. First, it highlights success stories so that others can learn how to reach underserved communities. Second, by providing value to award winners, the program seeks to offset some of the diminished commercial incentives in these regions, thereby encouraging more innovation projects aimed at helping impoverished communities. This value includes public recognition of winners' work and a voucher for accelerating certain matters before the USPTO.

## PROGRAM STRUCTURE

Participants submit applications describing how they are using patented technology to benefit the less fortunate in five broad categories of humanitarian need: medicine, nutrition, sanitation, energy and living standards. Once the application period closes, we run a two-phase selection process with volunteer experts from outside the USPTO, including university faculty and technology transfer professionals, to review the entries according to program criteria. The review committee then sends a list of recommended award winners to the USPTO.

The first Patents for Humanity competition launched in early 2012 as a pilot program. Since then, it has attracted support from the White House and members of the U.S. Congress as well as many companies, trade associations, public interest groups and universities. In 2014, the USPTO announced that Patents for Humanity would be an ongoing program. Subsequent rounds of Patents for Humanity awards were made in April 2015 and most recently November 2016.

## RECIPIENTS

To date, Patents for Humanity has given 21 awards to all types of entities, from large multinational corporations to small companies and startups as well as universities and non-profit

[*]Authored by an employee of the United States Patent and Trademark Office; no copyright is claimed by the United States in this article or associated materials.

→

organizations. These recipients show how even a small group of people with focus and commitment can impact lives around the globe. The program is open to all U.S. patent owners and licensees. Three awards have gone to organizations based in Europe.

Past award winners include patent owners using their portfolios to decrease the cost of HIV and malaria drugs, develop more nutritious food sources, bring solar energy to off-grid villages, combat unsafe counterfeit medicines and purify billions of liters of water using inexpensive packets. Award winners from the past two cycles include:

- **Sanofi**, for supplying large quantities of anti-malarial compounds on an at-cost basis for use in developing countries.
- **Novartis**, for identifying new drug compounds for potentially treating drug-resistant tuberculosis and donating them to the non-profit TB Alliance for further development.
- **SunPower Corp**, for delivering clean solar-powered lighting to replace kerosene in villages in the Philippines through converted shipping containers.
- **American Standard Brands**, for distributing 1.2 million "SaTo" safe toilet latrine pans to communities in Africa and Southeast Asia.
- **GRIT (Global Research Innovation & Technology)**, for developing an all-terrain wheelchair using readily available bicycle parts for use in India, Guatemala, Haiti and other locations.
- **Golden Rice**, for creating vitamin A-enriched strains of rice to prevent thousands of cases of blindness and death each day among people who subsist primarily on rice.
- **Nutriset**, for fighting childhood malnutrition by creating a worldwide network of partners to supply their PlumpyNut formula using local producers.
- **GestVision**, for developing a quick, simple diagnostic test for preeclampsia, a potentially life-threatening pregnancy complication, for use in developing regions.
- **Case Western Reserve University**, for creating a low-cost, accurate malaria detection device using magnets and lasers for quicker diagnosis and treatment.
- **Global Good Fund**, for creating a passive cooler that can keep vaccines cold for 30 days, and for donating dozens of units to the fight against Ebola and other relief efforts.
- **U.S. Food and Drug Administration**, for developing an improved meningitis vaccine production process that has been used to immunize 235 million people in high-risk African countries.

Here are three of the remarkable stories of Patents for Humanity winners.

**GESTVISION**

Preeclampsia is a pregnancy complication that is the leading cause of prenatal death for mothers and babies worldwide, mostly in low- and middle-income countries. Although most deaths are preventable, approximately 63,000 women die from preeclampsia annually. In developed countries, it can be diagnosed by regular doctor visits and laboratory tests, allowing treatment before severe symptoms present if caught in time. But in developing regions without regular prenatal care, the problem is often undiagnosed until serious complications such as seizure, stroke or organ failure occur.

Preeclampsia is a pregnancy complication that is the leading cause of prenatal death for mothers and babies worldwide, mostly in low- and middle-income countries. Startup company GestVision has developed a rapid, affordable urine test that caregivers can use to diagnose the condition in low-resource settings.

Photos: Courtesy of GestVision

Photo: Courtesy of: Patents for Humanity Program

Photo: Golden Rice Humanitarian Board (www.goldenrice.org)

Vitamin A deficiency is the leading killer of children globally, claiming up to 3 million lives annually. Golden Rice, developed by Professors Ingo Potrykus and Peter Beyer (above), is a genetically enhanced variety of rice which provides a source of vitamin A for people in need, making it one of the world's first bio-fortified foods.

Startup company GestVision has developed a rapid, affordable urine test that care-givers can use to diagnose preeclampsia in low-resource settings. The test detects misfolded proteins in urine associated with the condition, which may be shown by a colored dot similar to a pregnancy test. GestVision's test kits are currently being used in clinical studies around the world, including in Bangladesh, Mexico and South Africa, under a grant to the Research Institute at Nationwide Children's Hospital from Saving Lives at Birth, which is a collaboration of USAID, the Bill & Melinda Gates Foundation and others to seek groundbreaking prevention and treatment approaches for pregnant women and newborns in poor, remote communities. Following initial research at Yale University, GestVision was created to further develop the technology. GestVision is working on a manufacturing process to produce the kits in larger volume.

**GOLDEN RICE**

Vitamin A deficiency is the leading killer of children globally, claiming up to 3 million lives annually. It is also the leading cause of childhood blindness. Most cases occur in Asia where the staple crop, white rice, eaten by 3.5 billion people daily, lacks vitamin A sources typically found in animal products and leafy vegetables.

Golden Rice is a genetically enhanced variety of rice which provides a source of vitamin A for people in need, making it one of the world's first bio-fortified foods. Professors Ingo Potrykus of ETH Zurich, Switzerland, and Peter Beyer of the University of Freiburg in Germany, invented the technology after a decade of research. Since 2000, they have worked with Dr. Adrian Dubock and the non-profit Golden Rice Project to donate the rice to resource-poor communities in developing countries. Local Golden Rice varieties have been under development by public sector institutions in Bangladesh, China, India, Indonesia, the Philippines and Viet Nam. Through licenses with national governments, farmers are free to plant, grow, harvest, locally sell and replant seed. There are no licenses for farmers and no fees for use.

→

The GRIT Freedom Chair (above) was created by engineering graduates from the Massachusetts Institute of Technology (MIT) in the USA to increase mobility for people with disabilities, especially on rough terrain. The chair, which is made from standard bicycle parts, has been distributed in Brazil, Easter Island (Chile), Guatemala, Guinea, Haiti, India, Kenya, Nepal and the United Republic of Tanzania.

Photos: Courtesy of GRIT

**GRIT (GLOBAL RESEARCH INNOVATION & TECHNOLOGY)**

An estimated 65 million people in the developing world require wheelchairs. Conventional wheelchairs do not function well on the rough and uneven terrain commonly found in developing regions. GRIT was created by engineering graduates from the Massachusetts Institute of Technology (MIT) to increase mobility for people with disabilities around the world. Their three-wheel Leveraged Freedom Chair uses a push-lever drivetrain to help people move over uneven terrain such as broken pavements, dirt roads, fields, hills, rocky terrain and more. It is built from standard bicycle parts to enable local repairs with available materials. After graduating, the MIT students founded GRIT to bring the product to market, and MIT assisted by transferring the patent rights to GRIT for further development.

The chair has been distributed in partnership with the World Bank, the Red Cross and others in Brazil, Easter Island (Chile), Guatemala, Guinea, Haiti, India, Kenya, Nepal and the United Republic of Tanzania. A new version of the chair, known as the Freedom Chair, is now available in the United States for recreational use, helping Americans move beyond the pavement.

**THE ROLE OF PATENTS**

Sometimes people ask why innovators working to benefit those who are less fortunate seek patents on their inventions, particularly in developed economies where they do not plan to use them. We have found from our winners that patents can be very worthwhile, even for those who plan to give their technology away. Among other things, patents can help in securing funding, forming partnerships and attracting talent, particularly for small organizations.

Patents also enable dual-licensing business models for technologies that have uses in both the developed and developing world. Under such models, the invention may be provided at affordable prices very close to the manufacturing cost in developing regions, while it is offered to consumers at standard commercial prices in advanced economies. For example, 2015 winner GRIT licenses its all-terrain wheelchair technology to low-cost manufacturers for use in developing regions while also selling a version for recreational use on off-road trails in the United States. In some models, sales from industrialized nations can be used to fund activities in developing regions.

For more than 200 years, patents have supported technological and economic progress in industrialized nations. As we strive to bring the benefits of modern technology to the rest of humanity, patents continue to play an essential role in creating lasting solutions. Success will come from a diverse range of approaches, including new models for businesses and public–private partnerships. Patents for Humanity seeks to recognize innovators of all types by celebrating their varied contributions to our common goal: bringing prosperity to every corner of the globe.

*For more information on Patents for Humanity, including the latest announcements, visit www.uspto.gov/patentsforhumanity.*

# Patent information enables rainwater harvesting in Zambia

By **Catherine Jewell**,
Communications Division, WIPO

Photo: iStock.com/dave_valler

The patent system promotes innovation by rewarding inventors for the time, energy and money they invest in coming up with new and improved technologies. But just as importantly, it ensures that information about technology is shared effectively.

Part of the deal when applying for a patent to protect a new technology is that each applicant has to tell the world what their technology can do and how it works. At a certain point in the patenting process, this information is published. So every time a patent is granted, the pool of publicly available technological information expands. This information can inspire new inventions and is also extremely valuable as a means of identifying technologies that can be adapted for use in resource-poor countries.

The knowledge and technology embedded in patent information can be used to tackle poverty, support economic growth and create employment opportunities without having to reinvent the wheel. Enhancing the capacity of least developed countries (LDCs) to access publicly available patent information can ensure that resource-poor communities get access to the technologies they need, and thereby significantly improve their livelihoods.

**HELPING LEAST DEVELOPED COUNTRIES BENEFIT FROM PATENT INFORMATION**

In a move to demonstrate the benefits of strengthening use of IP-related and other technical knowledge in LDCs, WIPO recently developed and launched a pilot project under its Development Agenda. The project is being rolled out in three countries, Bangladesh, Nepal and Zambia. Its aim is to show how LDC governments can use IP-related information to identify and support the transfer of appropriate technologies and the social and economic benefits that can flow from this. Two priority areas for development have been identified in each country.

"Patent information is an invaluable resource, yet remains largely underexploited as a tool to tackle some of the major development challenges facing LDCs. This initiative seeks to demonstrate the practical value of such information to LDCs," explains Kiflé Shenkoru, Director of WIPO's Division for LDCs.

Such information can be used to improve agricultural productivity, for example. Poor food security is a constant threat to the livelihoods of millions living in resource-poor countries. But with the skills and wherewithal to access, manage and use IP-related and other technical information in the area of food production, these countries can boost yields through better soil management, irrigation and cultivation practices.

**HARNESSING IP TO HARVEST RAINWATER**

The water harvesting project undertaken in Zambia as part of the Development Agenda pilot illustrates the dramatic scope for improving the lives of rural communities. In collaboration with a range of national stakeholders, water harvesting and water purification were identified as priority areas for the project in Zambia. The latter is pending implementation but has significant potential to reduce debilitating and life-threatening waterborne diseases.

The country's agricultural sector, made up largely of small-scale producers, is the mainstay of the national economy. But productivity levels are severely constrained by the absence of effective irrigation and water storage systems. At present, farming activity generally only occurs during and shortly after the rainy season, from October to April. It is largely suspended in the dry season, especially in higher areas due to water shortages. Despite reasonable annual rainfall (between 800mm and 1,000mm) and an abundance of ground and surface water resources, many communities still face severe water shortages because of poor water storage facilities. This often results in widespread hunger.

But what if smallholders could harvest the gallons of rainwater that fall each year? "If properly harvested, such rainwater could go a long way towards increasing productivity in the agricultural sector, resulting in improved livelihoods for millions of small-scale farmers," says

Photo: Lloyd Tholle

The water harvesting pilot project undertaken in Zambia is designed to demonstrate how resource-poor communities can use patent information to access the technologies they need to improve their food security and livelihoods.

Allan Phiri, one of the national experts working on the project. However, the practice of rainwater harvesting in Zambia is not widespread, and where it does occur it is often inadequate and inefficient.

Implementation of the project is the responsibility of a multi-stakeholder National Expert Group (NEG) made up of senior government officials as well as representatives from business (including Mr. Phiri), academia and development agencies. The NEG's role is to select one or a number of appropriate technologies to improve rainwater harvesting in Zambia, to prepare a business plan for their application and use, and to identify sources of funding and production know-how.

With the support of the District Commissions and the local Chief, the project was initially rolled out in the drought-stricken area of Simamba Village in Siavonga, in Zambia's Southern Province. A local committee was formed including local government officials, local NGOs, community representatives and farmers. The committee worked closely with the project's national experts, and continues to play a key role in the project's practical implementation.

→

An assessment of local conditions and existing water storage practices revealed that water seepage and evaporation cause significant water losses in traditional storage systems.

Once the NEG had identified and evaluated the community's specific needs, WIPO undertook an international search for state-of-the-art water storage technologies. The aim was to identify technologies that "would enable farmers living on higher ground to carry out irrigation activities even during the dry season and to earn an income throughout the year," notes Mr. Phiri.

The WIPO search generated 28 patented technologies, each with the potential to ensure a continuous supply of water. Each of these technologies was evaluated to determine its suitability for local adoption. National experts were clear that "the chosen technology should be easy to adopt, simple in design and inexpensive to produce," notes Mr. Phiri. The use of locally available materials was another important factor as this would help ensure the technology's affordability and broad uptake. With these factors in mind, the technology selected by NEG was adapted to the community's needs. This essentially involved substituting more expensive elements of the technology with locally available materials.

"Once employed, the technology will allow farmers in groups of 10 families (around 60 people) to grow vegetables and other crops on patches of land of one lime (an area of 50m x 50m) each," Mr. Phiri explains. The idea is that each family will own a 10,000 liter-capacity tank to capture and store rainwater during the rainy season. "The proposed technology has never been used in Zambia. Once the prototype is successfully implemented, we expect this technology will be quickly and widely disseminated," Mr. Phiri notes.

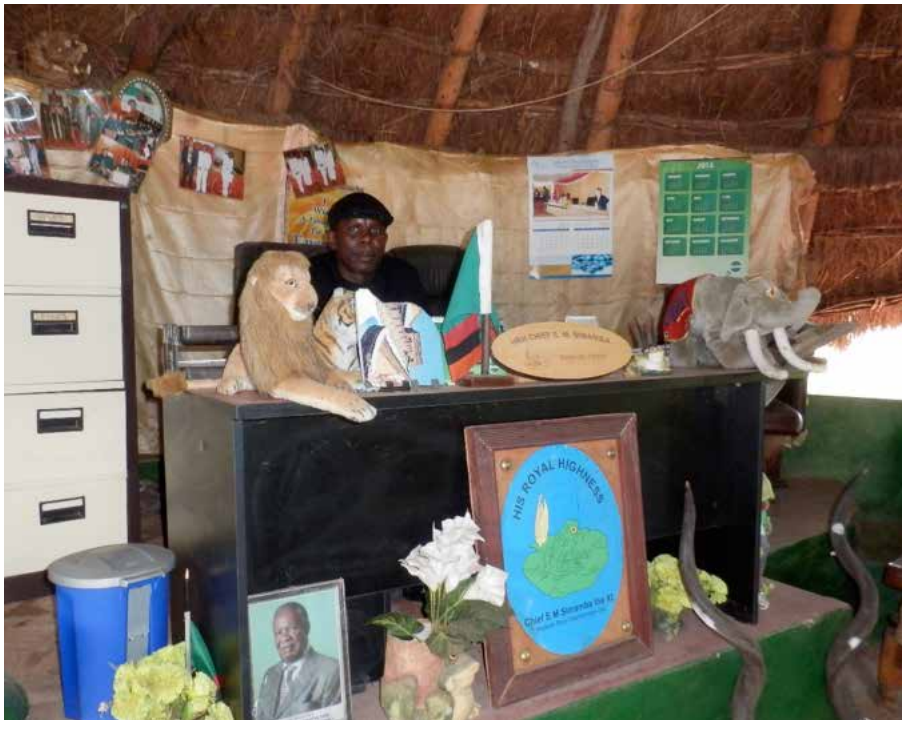



Photo: Lloyd Tholle

"The water harvesting project is making a real difference to the lives of community members," says Senior Chief Simamba XI (left). "Our farmers can now grow crops and can feed their families and their animals during the dry season. We are even thinking about starting to use our water supplies to farm fish."

Photo: iStock.com/Robert_Ford

Water seepage and evaporation cause significant water losses in traditional storage systems used by communities in the Simamba Village area of Zambia.

**A LOCALLY OWNED SOLUTION**

Day-to-day management of the tanks rests with the community under the supervision of the chief or headman, he explains. Ownership of the project by the local community is key to its sustainability and long-term success. By our calculations the project will yield a rate of return of more than 30 percent. This will make a huge difference to the lives of these householders," says Mr. Shenkoru. Mr. Phiri agrees, noting that in addition to improving rural incomes, the project will generate employment, alleviate poverty and improve food security.

"When the people from WIPO first came to our community, we were quite skeptical because we have been cheated in the past, but the water harvesting project is making a real difference to the lives of community members. Our farmers can now grow crops and can feed their families and their animals during the dry season. We are even thinking about starting to use our water supplies to farm fish," says Senior Chief Simamba XI.

More widespread adoption of the technology depends on securing the funds to replicate the project in other communities. That will take time. But the value of the exercise goes well beyond the direct benefits to householders in the Simamba Village area.

"This was a very important educational project, says Lloyd Thole, Former Assistant Registrar of Zambia's Patents and Companies Registration Agency (PACRA). "It is clear testimony to the importance of patents and technologies and their use in implementing different types of projects in the developing world. There is no need to reinvent the wheel as technologies are already available. All that is needed is to transfer and adapt them to the local situation."

# The battle to own the CRISPR–Cas9 gene-editing tool

By **Catherine Jewell**, Communications Division, WIPO, and **Vijay Shankar Balakrishnan**, Science and Health Journalist

Billed as the most exciting breakthrough in biomedical research since the dawn of genetic engineering in the 1970s, the CRISPR-Cas9 gene editing tool has huge scope to improve understanding of human and animal disease and its treatment.

Photo: iStock.com/cosmin4000

Millions suffer from devastating genetic disorders like cancer, muscular dystrophy, cystic fibrosis, sickle cell anaemia, Huntington's disease and many others. Imagine the pain and suffering that could be avoided (not to mention the healthcare costs) if we could cure these diseases simply by rewriting the genetic code of patients. This is the promise of the CRISPR-Cas9 gene-editing technology.

Billed as the most exciting breakthrough in biomedical research since the dawn of genetic engineering in the 1970s, the CRISPR-Cas9 gene-editing tool has huge scope to improve understanding of human and animal disease and its treatment. It has the potential to revolutionize medicine and agricultural research. The race to develop commercial applications of CRISPR-Cas9 in healthcare, agriculture and industry, however, has thrust the technology, its pioneers, the institutions they work for and a clutch of startups in which they are involved into a high-stakes legal battle over who actually invented it and when. The outcome will determine who controls the technology and where the highly lucrative economic benefits it promises to generate will flow.

**THE TECHNOLOGY AND HOW IT CAME ABOUT**

Ever since Watson and Crick identified the DNA double helix, scientists have been searching for ways to better understand the role that DNA plays in the genetic make-up of living organisms. The CRISPR tool is a huge step forward. Compared to existing research tools, it offers a relatively quick, easy, reliable and cheap way to target and edit specific genetic sequences.

CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats. It is a natural defence mechanism that allows bacterial cells to detect and destroy the viruses that attack them.

The CRISPR mechanism was first identified as a "general purpose gene-editing tool" in a scientific paper published by scientists Erik Sontheimer and Luciano Marrafinni from Northwestern University, Evanston, Illinois, USA in 2008. The scientists filed for a patent but their application was rejected because they were unable to reduce it to any practical application, *Science's* Jon Cohen writes.

But CRISPR really began to create a buzz, with the publication in June 2012, of a scientific paper by Emmanuelle Charpentier, a French microbiologist then working at the University of Vienna and now at the Max Planck Institute for Infection Biology, Germany and Umeå University, Sweden, and Jennifer Doudna at the University of California, Berkeley, USA. Their paper outlined how CRISPR, with the help of an enzyme called Cas9, can be transformed into a tool to edit genes. Specifically, how CRISPR-Cas9 can be used to cut DNA in a test tube. They filed their first CRISPR-related patent application in May 2012. It is still under review.

Six months later, in January 2013, scientists at the Broad Institute of the Massachusetts Institute of Technology (MIT) and Harvard University, led by Feng Zhang, reported that


Photo: Keegan Houser/UC Berkeley

Photo: Justin Knight Photography

Jennifer Doudna (top left) at the University of California, Berkeley, USA, and Feng Zhang (top right) at the Broad Institute of the Massachusetts Institute of Technology (MIT) and Harvard University, have each undertaken pioneering work in relation to CRISPR-Cas9. They and others are currently embroiled in a legal firestorm over who owns commercial or IP rights in the technology.

they had found a way to use CRISPR-Cas9 to edit the cells of mammals, further fuelling interest in its potential to generate new and more effective medical treatments. The Broad researchers filed their first CRISPR-related patent application in December 2012 and paid for a fast-track review process. Eleven additional patent applications were filed to bolster the claim that they were the first to invent a CRISPR system to edit mammalian cells, Jon Cohen notes. In April 2014, the United States Patent and Trademark Office (USPTO) granted the Broad team a patent on their CRISPR technology.

**THE BATTLE FOR OWNERSHIP**

The grant of the patent to the Broad team triggered a legal firestorm. Professor Jake Sherkow of the New York Law School characterizes it as "an absolutely humungous biotech patent dispute".

The stakes are clearly very high. Whoever owns the commercial or IP rights to CRISPR-Cas9 has the potential to generate huge financial returns and to decide who gets to use it.

Each of the pioneering researchers and their respective institutions has a stake in a handful of startups which have attracted millions of investment dollars to translate CRISPR-Cas9 systems into new treatments for a broad range of genetic diseases. They include Intellia Therapeutics (UC Berkeley), Caribou Sciences (J. Doudna), CRISPR Therapeutics and ERS Genomics (E. Charpentier) and Editas Medicine (Broad Institute).

An analysis of the CRISPR-Cas9 commercial landscape by *Science's* Jon Cohen reveals that a web of often overlapping licenses have already been granted by CRISPR startups for many applications in medicine, agriculture and industry.

**THE BAYH-DOLE ACT**

Under the 1980 Bayh-Dole Act universities in the United States are able to hold IP rights in inventions arising from federally-funded research. But guidelines developed by the US National Institutes of Health (https://grants.nih.gov/grants/oer.htm) advise that these technologies should be licensed under "reasonable terms and conditions" to

→

ensure they are available to support further biomedical research. Both UC Berkeley and the Broad Institute readily offer non-exclusive licenses for purely scientific research, notes Megan Molteni in *WIRED*. But anyone seeking to commercialize a CRISPR-related product needs to obtain a sublicense from one of the CRISPR startups.

But with the scope of the exclusive licenses they hold covering the 20,000 or so genes in the human genome, some question whether these companies alone can possibly develop all of the technology's potential applications. What will be the impact on other biotech companies that want to commercialize CRISPR-related products? Will the fact that they need to obtain an additional sublicense from these companies put a brake on innovation?

**THE PATENT INTERFERENCE PROCEDURE**

In April 2015, UC Berkeley, representing E. Charpentier and J. Doudna, requested a patent interference proceeding against the patents granted to the Broad Institute. The USPTO's Patent Trial and Appeal Board (PTAB), responsible for hearing such cases, granted the request. Hearings began in January 2016.

Patent interference procedures are effectively "administrative trials to determine which of two (or more) parties invented something first," writes Jake Sherkow. The procedure is a vestige of the first to invent system existing in the United States up to March 2013 when it was superseded by the America Invents Act. The United States now grants patents on the basis of a "first to file" system. As the disputed CRISPR-related patents were filed prior to March 2013, they qualified for a patent interference procedure. "Typically a USPTO patent interference proceeding comes into being when different patent applications filed before the USPTO by different inventors may potentially overlap as the same invention," notes Joe Stanganelli in *Bio IT World*.

The question before the PTAB was whether the work of the Broad Institute researchers was novel or whether it was "the next obvious step to take, and/or fundamentally based on prior art", Joe Stanganelli explains.

On February 12, 2017 the PTAB handed down its decision. It stated that the patents granted by the USPTO to the Broad Institute for the use of CRISPR-Cas9 in editing mammalian cells (eukaryotic genomes), did not overlap or interfere with patent claims filed by

## Summary of the PTAB's *Decision on Motions*

The decision states: "Broad provided sufficient evidence to show that its claims, which are all limited to CRISPR-Cas9 systems in a eukaryotic environment, are not drawn to the same invention as UC's claims, which are all directed to CRISPR-Cas9 systems not restricted to any environment. Specifically, the evidence shows that the invention of such systems in eukaryotic cells would not have been obvious over the invention of CRISPR-Cas9 systems in any environment, including in prokaryotic cells or *in vitro*, because one of ordinary skill in the art would not have reasonably expected a CRISPR-Cas9 system to be successful in a eukaryotic environment. This evidence shows that the parties' claims do not interfere."

Photo: Courtesy of McGovern Institute for Brain Research at MIT

Artistic representation of the CRISPR-associated nuclease Cas9 cutting DNA at a specific target site.

the UC Berkeley team for the use of the system in any environment (see box). The PTAB thus ruled that Zhang's patent claims were not obvious considering the information provided in UC Berkeley's US patent application.

The PTAB's decision means that the Broad Institute will be able to keep its US patents which claim methods of using CRISPR-Cas9 in mammalian cells (eukaryotes). It also means that UC Berkeley can keep its US patent application, which claims methods of using CRISPR-Cas9 in any cells. While this may be good for the two institutions, it spells "maximum uncertainty" for the biotech business community, for whom it is unclear whether they need to get licenses from both universities, notes Kevin Noonan, partner at McDonnell Boehnen Hulbert & Berghoff in Chicago, USA, in *Nature* (www.nature.com/news/braod-institute-wins-bitter-battle-over-crispr-patents-1.21502).

**WHY WE SHOULD BE INTERESTED IN CRISPR-CAS9**

The CRISPR-Cas9 gene-editing system has the potential to "change the way life sciences researchers edit and engineer the DNA of virtually any living thing on the face of the earth," explains Professor Jake Sherkow.

It promises a deeper understanding of the way genes function in cells and the development of new and more effective medical treatments and therapies for a range of devastating diseases. By removing the underlying dysfunctional DNA sequences, it could be possible not only to cure these diseases but to ensure these conditions no longer pass to the next generation. Its application in agriculture and industry also promises the development of more robust, disease-resistant plants and animals. So the potential social benefits are huge.

Researchers around the world are already using CRISPR-Cas9 systems to edit genomes, including for edible mushrooms, corn, mice, monkeys, and even human embryos. In June 2016, the U.S. National Institutes of Health approved the first clinical trials using CRISPR-Cas9 on cancer. And in September 2016, the UK's Human Fertilization and Embryo Authority (HFEA) approved its use to permanently edit DNA in a human embryo.

But CRISPR-Cas9 technology as it currently exists still bears significant risks and needs further refinement, for example in terms of its accuracy and delivery to human cells. It also raises many ethical concerns that deserve serious consideration. After all, it has the potential to radically alter the genetic make-up of humanity. In response to these concerns, Jake Sherkow notes, the Broad Institute has already issued "ethical licenses" to certain licensees to prohibit certain activities deemed contrary to the public interest. Given the time it takes to craft effective policies, he believes this approach offers an effective way "to pause worrisome applications of emerging biotechnologies" (www.nature.com/nbt/journal/v35/n1/abs/nbt.3756.html).

→

**AFTER THE PTAB'S RULING, WHAT NEXT?**

Although PTAB ruling may appear to have given the Broad Institute an outright win, the outlook is not quite so clear-cut. The battle over CRISPR-related IP rights looks far from over (see www.nature.com/news/why-the-crispr-patent-verdict-isn-t-the-end-of-the-story-1.21510) for various reasons.

First, UC Berkeley is weighing its decision to appeal the PTAB's ruling. It remains convinced that "the Doudna/Charpentier team was the first group to invent this technology for use in all settings and all cell types, and was the first to publish and file patent applications directed toward that invention, and that the Broad Institute's patents directed toward use of the CRISPR-Cas9 system in particular cell types are not patentably distinct from the Doudna/Charpentier invention."

Second, various commentators consider it likely that the parties will eventually come to some sort of settlement involving the cross-licensing of their technology. Given unresolved issues of IP rights ownership of CRISPR vectors – which enable delivery of the mechanism to recipient DNA – this seems likely. "If UC gets patent claims to CRISPR vectors granted, it would have rights to stop others from making, using, or selling them," explains Phillip Webber, biotech patent attorney at the law firm Dehns in Oxford, UK. This would mean that even Editas Medicine, which holds an exclusive license to use Zhang's CRISPR methods, would need to take a license from UC Berkeley.

Third, both the Broad Institute and UC Berkeley have filed and are defending patent applications in Europe. Catherine Coombes, a patent lawyer at HGF in New York notes in *Nature* that European case law may bring about a different outcome from that of the PTAB. If the European Patent Office finds that UC Berkeley's research provided "sufficient motivation" for other researchers to try the CRISPR-Cas9 system in mammalian cells then UC Berkeley's patent may be judged to cover applications in all cell types, giving it the edge over the Broad Institute's patents in Europe.

And finally, many other research groups are also getting in on the CRISPR-Cas9 patenting game. According to IPStudies, a Swiss-based IP management consultancy, more than 900 patent families currently exist, all claiming rights on different aspects of CRISPR-Cas9 systems. As these groups assert their rights, and demand royalties, many more legal battles are likely to ensue both for the Broad Institute and UC Berkeley.

But while the courts continue to grapple with these issues, the science continues to advance. Researchers at the Broad Institute, again led by Feng Zhang, have already identified – and submitted a patent application for – an interesting alternative to Cas9 called Cpf1. This new enzyme offers scientists greater scope to edit the genes of certain bacteria. While no CRISPR-therapy yet exists, there is talk of a number of trials starting this year. So watch this space.

# Smart solutions to global challenges: the quest of a Turkish inventor

By **Catherine Jewell**,
Communications Division, WIPO

Dr. Özge Akbulut is a materials scientist and a woman determined to use her talents to make a positive impact on some of the major challenges facing the world, one invention at a time. Her inventions range from synthetic models of body parts for surgical training to 3D printing inks and cement. She holds five patents – four in the United States and one in Europe – with an additional application in progress.

Dr. Akbulut completed her PhD at the Massachusetts Institute of Technology (MIT) and then joined Harvard University in the United States for her postdoctoral studies. In 2012, she returned to her *alma mater*, Sabanci University in Turkey, as an assistant professor.

She talks to *WIPO Magazine* about her work and the challenges of innovation in an emerging economy.

***When did you start inventing?***

Becoming an inventor was really a natural consequence of being an engineer. But I was always a very curious child and had very supportive parents. What really inspires me is how science and technology makes it possible to find solutions to tackle some of the major problems facing humanity. It is only with innovative solutions that we can solve these problems.

As a scientist, I think it is critically important to invest in finding solutions to the technological challenges facing society. After all, my research is supported by taxpayers' money. People fund research because they believe scientists will produce something that will improve their lives. Society-driven research is really important to me.

I started making surgical models through pure chance. In my postdoctoral work at Harvard, I focused on medical applications of materials science to develop tools and techniques for resource-limited settings. A few years later, I met a thoracic surgeon who

→

Photo: Courtesy of Surgitate

Dr. Akbulut is a materials scientist and a woman determined to use her talents to make a positive impact on some of the major challenges facing the world, one invention at a time. Her inventions range from synthetic models of body parts for surgical training to 3D printing inks and cement. She holds five patents with an additional application in progress.

asked if I could make models of breasts to train surgeons in oncoplastic surgery (reconstructive surgery after a lumpectomy). Breast cancer is a global problem – it affects one in eight women – so this really caught my attention. And with new diagnostic tools, many younger women are being treated for breast cancer so it is really important that they can adapt and continue their lives. I really liked the idea of being able to have an impact on global health education.

To cut a long story short, I was lucky enough to meet a brilliant visual artist, Ece Budak, who together with her local women's group helped me create the molds. When she presented me with a full box of breast models, it was one of the best engineering moments of my life. That's how we started. We worked very closely with surgeons to develop the models according to their specific needs. Beta testing of the first model involved multiple iterations and took six months.

I co-founded Surgitate with Barkin Eldem MD in 2014. We specialize in making realistic models of tissue and organs so trainee surgeons can practice their surgical technique. Our product portfolio includes a range of skin pads, vascular and breast models which closely mimic the experience of cutting into, dissecting and suturing human tissue. We are also working on breast models for ultrasonography training as well as for bronchoscopy, tracheostomy and sentinel lymph node dissection. We are currently working on a unique micro-surgery model for surgeons to be able to improve their intricate suturing skills.

We've been getting some very good feedback from the surgeons we work with and our models are now being used in Australia and United Kingdom. Our skin model is available from Amazon UK and is already being used in more than 20 countries!

Photo: Courtesy of Surgitate


Dr. Özge Akbulut co-founded Surgitate with Barkin Eldem MD in 2014.

***How did you go about protecting your models?***

We have registered a trademark for them. We submitted a patent application but it didn't pass. We went about it the wrong way and learned a great deal from the process. We are the only company in the world to produce stand-alone breast models, and the surgeons we work with, who played a key role in the development of the models, are strong advocates of their use in surgical training. As a startup we are very responsive to the needs of our users, and committed to providing affordable and accessible models through cost-controlled design and fabrication. That gives us an edge. But in the end, the need is so great that the more people who develop devices like these, the better for everyone. Although we didn't succeed in getting a patent for these models, we are developing and using almost 50 different formulations of silicone in our products, and have developed intellectual property (IP) strategies around these. IP rights are an important part of our business strategy.

***Did you get any support from your university?***

Yes, without the support of Sabanci University's Technology Transfer Office I would not have been able to survive as a researcher. They provided a wealth of invaluable advice and support in terms of developing a business plan and an IP strategy for the various technologies I have been working on.

***As a researcher, why do you think it is important for universities to have an IP policy?***

The well-being of society and its advancement depend on science and technology, but how do we ensure that they produce concrete outcomes? The IP system offers universities and researchers an incentive to invest in developing solutions that enable society to make progress in tackling global problems. IP and IP licensing offer concrete opportunities for them to generate wealth, create jobs and really make a difference through science. So IP is extremely important.

Technology licensing is still quite new in Turkey. We really need to strengthen university-industry links for if it to take off. We need our industrialists to be more open to working with scientists, and *vice versa*. Investment in research and development is gaining traction but remains low compared to other countries. Scientists also need to focus at least part of their research on solving societal problems. If we are to move forward, we all need to simply roll up our sleeves and get on with the work of developing products that are better than existing ones and acquiring IP rights to protect them. If these products fulfill a market need, the financial rewards will come. Sabanci University has very strong links with industry and really encourages spin-offs. Around half of my fellow faculty members have their own company. In fact, the University has topped Turkey's innovation and creativity index for some years now. We are very proud of that.

→

Photo: iStock.com/kali9

Breast cancer affects one in eight women and is a global problem. The models produced by Dr. Akbulut enable surgeons to perfect their surgical technique when treating women with the disease enabling them to adapt and continue their lives.

***What challenges did you face in establishing your company?***

I was very lucky to find two pre-revenue investors. That was critical. The first is the Arya Women Investment Platform, which is the first of its kind in Turkey. It was founded by the president of Turkey's leading plastic auto parts manufacturer, Farplas, who is very committed to supporting female entrepreneurs in Turkey, where fewer than nine percent of entrepreneurs are women. We rely on Farplas's expertise in process development, molding and painting for the mass production of our models. The other investor is Inovent, Turkey's first technology commercialization accelerator and seed funding company. Inovent helps us connect with potential investors and customers, and handles our business and marketing plans.

With the support of my University and investors, we managed to pull it off. But many of my fellow researchers have a hard time dealing with all the red tape associated with setting up and running a business. Bureaucracy just kills creativity. Thankfully I was able to learn from their experience.

Another big challenge is linked to the fact that most of my clients are outside Turkey. The duties associated with exporting our products place a heavy burden on the business. My hope is that in future Turkey will become more open and better connected to global markets. This would make life a lot easier for Turkey's small businesses to thrive.

***What other projects are you working on?***

As a materials engineer, my work is wide-ranging. My aim is to mobilize collective brainpower wherever I can. So in addition to the surgical models, I am developing inks for use in additive manufacturing or 3D printing. Most 3D printing inks include three or four different chemicals and can only be used in a controlled environment. My technology works in a totally aqueous environment. Anyone can use it anywhere, and very safely. I think it will revolutionize 3D printing in the sense that if you give people something they can use in their homes or in public maker spaces then more of them will start using it. That is why it is so important to make sure technology leaves the lab and gets into public spaces. We submitted our patent application for this technology in September 2016 via WIPO's Patent Cooperation Treaty which streamlines the process of getting patent protection in multiple countries.

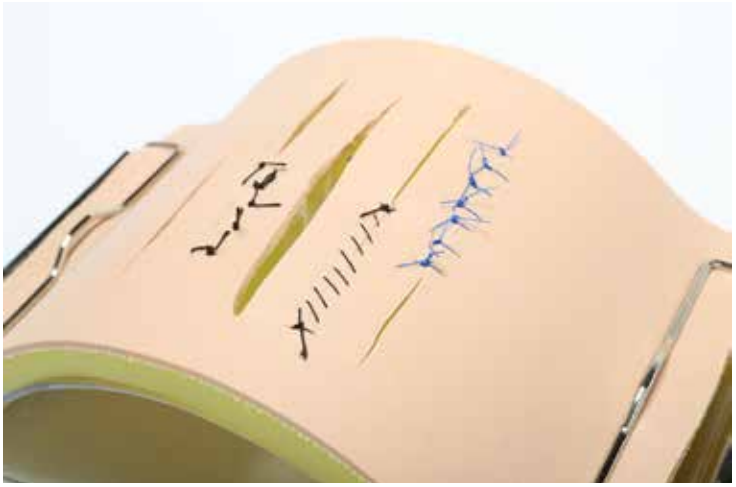


Photo: Courtesy of Surgitate

Surgitate's product range includes skin pads (left), vascular and breast models which closely mimic the experience of cutting into, dissecting and suturing human tissue. The surgeons the company works with to develop them are strong advocates of their use in surgical training.

I also have a patent on controlling the flow properties of cement! When working with special-purpose cement like calcium aluminate cement, once it has been mixed, you only have a very limited time to cast it before it hardens. Our technology prolongs that time, thereby expanding opportunities for its use and generating significant cost savings. These types of cement are highly resistant and can withstand extreme temperatures, seawater and more. There is a lot of commercial interest in our technology, and we are currently in talks with a global leader in the field.

***What message do you have for policymakers?***

If policymakers want to leave a legacy, they have to take a long-term view supported by scientific data. That is the only way humanity will advance. They have to think about future generations because what they decide today will have a huge impact on them.

***And what message do you have for young girls with aspirations to invent?***

Inventing is good. Women are very tough and very driven, and if we want something we usually get it. That mindset is a key part of the invention process. Science and technology – with a good dose of IP – offer you the chance to make a difference. Developing an innovative solution with the potential to improve people's lives is extremely fulfilling. Inventing is a lifestyle and I would like women to have equal opportunity to make that lifestyle choice. Whether you are a man or a woman, being an inventor can be tough. But if at first you don't succeed you just have to dust yourself off and move on.

***Did you face any particular problems as a woman inventor? Why are there so few women inventors?***

No. I am an inventor first. I really like being a scientist. That is where I can make a difference. The fact that I am a woman is incidental. My bosses, both male and female, have always been very supportive, as has my family.

There are many more male inventors because their number in science, engineering and technology is higher to start with. If only 15 or 20 percent of researchers are female then women will only be responsible for 15 or 20 percent of inventions. It's a numbers issue, not a quality issue. Women are just getting started. And I am grateful for those persistent women who refused to take no for an answer and who became the first women scientists, engineers, doctors. Women like Mildred Dresselhaus, known as the "queen of carbon science," who was the first woman to secure a professorship at MIT, and who sadly passed away just recently. We are here because of them.

# Catalyzing applied research in Peru

By **Catherine Jewell**,
Communications Division, WIPO

Photo: Courtesy of PUCP

Peru's Pontifical Catholic University (PUCP) is leading the way in its strategic use of IP to strengthen its applied research activities and support business development.

Universities in all countries play a key role in pushing the boundaries of scientific and technological development. But translating research results into practical applications that benefit society can be a challenge, particularly in developing countries where national innovation ecosystems are in their infancy. Developing and implementing an institution-wide intellectual property (IP) policy is an essential first step in strengthening the focus of universities and their researchers on the practical application and commercialization of their work.

Recognizing the significant benefits that can flow from the strategic use of IP, Peru's Pontifical Catholic University (PUCP) has been at the forefront of efforts to strengthen its applied research activities and to encourage other national universities to follow suit. Making IP a strategic priority is enabling it to harness the value to its research results and bolstering its reputation in international research rankings. It is also supporting efforts to strengthen Peru's national innovation ecosystem.

## PUCP'S IP STRATEGY: DIVIDENDS

The University's IP strategy began to take shape in 2004 and was formally adopted in 2009. In the same year, it established an IP office which offers a range of IP support and business development services to researchers across the campus.

Photo: Courtesy of PUCP

PUCP researchers working on a novel, cost-effective and environmentally-sound mining technology to extract precious metals from refractory ores. Peru is a one of the world's leading exporters of minerals like copper and gold.

"The University's IP strategy establishes a solid basis to promote innovation and creativity across the campus," says Melisa Guevara, who heads up PUCP's IP office. PUCP's IP strategy also sets out arrangements to reward researchers for their commercially successful inventions. "This has been a very effective way to get the buy-in of researchers," notes Ms. Guevara. "Royalty payments create a very useful additional income stream for researchers."

"Clear rules are always a good thing. Having clarity about what you own, what PUCP owns and what is shared makes things much easier," says Adolfo Pillihuaman, a researcher in the University's engineering department. "PUCP's support and commitment to applied research and IP is having a positive impact on the University's researchers and their outputs. It has fired the creativity of everyone and is helping us to demonstrate the value and quality of our work."

Mr. Pillihuaman's research team, which includes Edmundo Alfaro and Manuel Shishido, is working on a novel, cost-effective and environmentally-sound mining technology to extract precious metals from refractory ores. Peru is a one of the world's leading exporters of minerals like copper and gold, accounting for around 60 percent of the country's exports.

PUCP's IP office has its own budget and is fully autonomous. Its multi-disciplinary team of IP experts is responsible for evaluating the patentability of any new technologies developed on campus, and for developing appropriate IP strategies for their commercialization. This is having a "decisive impact on the development of patent-protectable technology in our laboratories," says Ms. Guevara. The office also offers researchers support in negotiating licenses and other business contracts with third parties. And it has specialized translation services to help young researchers access research results published in foreign journals and support the subsequent publication of their work those journals.

The final decision about whether or not to protect a new technology falls to PUCP's Intellectual Property Commission, which is made up of professors and leading scientists. The Commission is also responsible for shaping the University's internal IP policies and handles any tricky IP-related issues that arise. "The Commission's structure ensures that we have the required interdisciplinary vision to evaluate new technologies rigorously. It also gives us a market perspective and helps us connect with and transfer our research results to third-party businesses," explains Ms. Guevara.

→

> "You have to see opportunities where you see problems, and you have to try to solve them every chance you get. You can never give up!"
>
> Mónica Abarca, co-founder of qAIRa, a PUCP spin-off.

**ENGINEERING A SHIFT IN IP AWARENESS**

PUCP's IP strategy is bringing about a perceptible shift in the way its researchers approach their work. "There is now a much stronger IP awareness among our researchers. Although publishing their work in academic journals remains important to them, they now recognize the advantages of protecting their work with IP before going public with it," says Ms. Guevara. The University's internal rewards policy, which recognizes both academic publication and patents, is largely responsible for this change.

"It has not been an easy process, but we are getting very good results which are having a favorable impact on our international ranking and mean we can transfer new technologies to industry more easily. We have already established a number of strategic business partnerships," she notes.

Peruvian investors are beginning to bet on the University's technology-based spin-offs and startups. "This would have been unimaginable a few years ago," says Ms. Guevara. But support from the central government and industry, and a more favorable business environment, mean that in addition to the emergence of a growing number of university spin-offs, there is greater interest in the University's work among established businesses. "Peruvian investors are showing much greater interest in the joint development of technology-based businesses, either directly with our University spin-offs or with startups to whom we license our technologies. This is a whole new experience for us but is generating good results. At PUCP we are developing technologies that specifically address the realities confronting Peruvian companies. That's the difference."

**CHANGING MINDSETS AND SUPPORTING BUSINESS GROWTH**

IP has become part of PUCP's daily life, and while it has strengthened its applied research portfolio, transferring its research results to the market remains a persistent challenge.

Photo: Courtesy of PUCP

Researchers in PUCP's Engineering Department (above). "PUCP's support and commitment to applied research and IP is having a positive impact on the University's researchers and their outputs. It has fired the creativity of everyone and is helping us to demonstrate the value and quality of our work," notes Adolfo Pillihuaman, a PUCP researcher.

"We still have a great deal to do to further strengthen our ties with business actors," explains Ms. Guevara. Changing perceptions that foreign technology is superior to homegrown solutions is a constant struggle. "This is a challenge we face as an institution and as a country," Ms. Guevara says, noting that it is further compounded by the risk-averse culture that exists among Peruvian businesses.

But she remains optimistic. "Little by little with the support of government, we are creating the space and attracting the funds necessary to develop and consolidate our ties with the business sector. Strengthening ties with industry will allow the university to identify research priorities that enable its startups and other small businesses to anticipate market trends and to evolve," Ms. Guevara explains. "Our entrepreneurs, most of whom are small business owners, need to become less risk averse and more proactive, and need to work to strengthen and consolidate their business associations to support the expansion of Peru's technology market. Peru's business community also needs to recognize that together they can achieve much more than by competing with each other. We need a long-term vision."

With investors from Silicon Valley knocking at the door, the PUCP's IP office is now focusing on the international transfer of its technologies. "We could not have imagined that this would be possible a few years ago," says Ms. Guevara. And it all stems from the University's foresight in developing and implementing an institution-wide IP strategy. "Putting our IP strategy into place and giving it political importance across the University has created a fundamental change in mentality and is beginning to create some really interesting opportunities for innovation. We hope that our experience will inspire other Peruvian institutions to follow suit, so that together we will be able to contribute to the development of our country."

But not content with simply putting an IP strategy into place, PUCP is also leading the way in developing a business incubator and actively encouraging its researchers to take the entrepreneurial route. "We were the first university to establish an IP office in Peru, and we were also the first to set up a specialist business development and incubation unit to support spin-offs. That's why many public and private institutions seek our advice and guidance when developing their own IP policies and technology transfer processes," Ms. Guevara explains.

→

Photo: qAIRa

qAIRa, a PUCP spin-off, is designing and building drones to fly over large areas and at high altitudes to gather air quality data so that mining companies, in particular, can better monitor the impact of their operations and improve their environmental credentials.

Photos: qAIRa

qAIRa, a spin-off established in 2014 by PUCP research student Mónica Abarca, together with Carlos Saito and Francisco Cuéllar, develops drone technology using big data analytics and robotics to map air pollution.

**QAIRA: A PUCP SPIN-OFF**

qAIRa, established in 2014 by PUCP research student Mónica Abarca, together with Carlos Saito and Francisco Cuéllar, is one such spin-off. The company uses drone technology to tackle air pollution, a major concern in urban areas as well as within Peru's extensive mining communities. Air pollution is also a global concern in that it contributes in a big way to climate change and causes respiratory and cardiac diseases that claim some 7 million lives worldwide every year, according to the World Health Organization.

Current practice for air quality data collection relies on static stations that cover small areas and are expensive to establish and maintain. "These stations need to operate over extended areas to collect sufficient data for big data analyses. Under the current set-up, big data analyses were not going to be possible any time soon, so we decided to develop an alternative and more cost-effective solution," says Ms. Abarca.

"qAIRa uses big data analytics and robotics to digitize and democratize air quality information in a real-time global pollution map," she explains. "We design and build drones to form a ubiquitous network. The drones fly over large areas, and at high altitudes, to gather data about the quality of the air we breathe. We use these data to create a global contamination map, so that companies – especially mining companies – can better monitor the impact of their operations and improve their environmental credentials."

Ms. Abarca filed for a utility patent with Peru's IP office, INDECOPI, in 2014. "We understood at an early stage that it was important for us to protect our technology. This will mean we can license it out, if and when the opportunity arises," she notes. "The IP system is increasingly used in our country, with positive results. IP allows us to add value to our technology, but the patenting system needs to become much faster because the technology is developing so quickly and the time it takes to acquire an IP right affects its value in our negotiations with potential clients. As a small startup, we would also like to see it become cheaper to obtain IP protection."

Securing the financial resources needed to develop the technology, buy the components for the first prototype

→


Photo: Courtesy of PUCP

"The University's IP strategy establishes a solid basis to promote innovation and creativity across the campus," says Melisa Guevara who heads up PUCP's IP office.

and keep the company going were major challenges. Financial support from the University and state grants through CONCYTEC (the National Science, Technology and Innovation Council) and Start-Up Peru, as well as the support of angel investor Javier Calvo, kept Ms. Abarca's dreams alive. "The financial support we received from PUCP and the Peruvian Government was critically important," she says.

Now, the future is looking bright for the company and its seven-strong team. "The mining industry is deeply interested in our solution, not only to monitor air quality but for other purposes," says Ms. Abarca, who also foresees applications across a range of industries. "Air pollution is a problem for every industry – oil and gas, agriculture, electricity and many others."

So the hope going forward is that PUCP's decision to implement its IP strategy will continue to inspire its researchers and those in universities across the country, enabling them to realize their huge innovative potential. "Peruvian researchers are ingenious and adaptable, as is our business sector," says Adolfo Pillihuaman. "More effective use of the IP system will enable us to improve our visibility on the international stage as producers of high-quality technologies. It will enable us to add value to the ingenuity and talent of our researchers and our businesses so that the country as a whole becomes more competitive and achieves its economic goals."

*Information about the various ways in which WIPO supports the development of institutional IP policies for Universities and Research Institutions is available at: www.wipo.int/policy/en/university_ip_policies/.*

# Digitizing Singapore's chemical ecosystem: an industrial Internet of things*

Photo: iStock.com/TomasSereda

*This is an adapted version of an article published as part of a special report on Singapore's chemical industry. The full report is available at: *www.gbreports.com*

By **Neha Ghanshamdas**, Data analyst, Global Business Reports, Singapore

Singapore is on an Internet of things (IoT) crusade. The resource-scarce nation is seeking to leverage its formative strength – talent – to transform itself and add value in the global marketplace by building the world's first Smart Nation. The Smart Nation drive aims to leverage IoT technology to improve the quality of life of the country's citizens, infrastructure and industrial sector, in a bid for Singapore to remain one of the most economically competitive and livable cities in the world.

With manufacturing, including chemicals and chemical products, representing close to 20 percent of the country's GDP, the chemical industry factors heavily into Singapore's Smart Nation equation. Applied in this context, the industrial IoT (IIoT) has the potential to increase the productivity, safety and competitiveness of the chemical industry ecosystem. By helping solution providers overcome the difficult "first-adopter" stage, Singapore's economy stands to gain first-mover advantage and to establish itself as the IIoT technology and business hub of Asia.

## THE IOT EXPLAINED

It is the latest technology buzz phrase, taking not just Singapore but the world by storm. But what exactly does the Internet of things mean and how pertinent is the concept to the world of chemicals?

IoT can be loosely defined as a network of physical objects that are linked to one another through the Internet. More concretely, it refers to physical objects, equipment or machinery fitted with various types of data-collecting sensors. Cloud-based applications analyze the data collected by these sensors, enabling machines to communicate with other machines, applications or users. The application of IoT is not limited to any particular industry, device or user; it can be employed in virtually every sphere of life.

As an example, new smart metering systems in homes digitally provide energy suppliers and end users with consumption data. Smart meters automatically send meter readings to suppliers, and show users how much energy they are consuming in near-real time. The availability of these data results in more accurate energy bills and increased energy awareness among consumers, ultimately leading to cost savings and more sustainable living practices. Just imagine what IoT can achieve at scale, for instance within a large chemical facility.

## IMPROVING YOUR BOTTOM LINE

While IoT debuted decades ago, the concept has only recently begun to gain traction in the industrial space. Why? The answer is simple: data. The sheer quantity of data generated within a process plant or mine site is astounding.

Photo: iStock.com/Stephane_Jaquemet

Singapore is seeking to leverage its formative strength – talent – to transform itself and add value in the global marketplace by building the world's first Smart Nation.

According to Accenture's Chemical Consulting Services, 144 terabytes of data are generated in a mine site in just one hour. To record just one terabyte's worth on paper would require 50,000 trees to be pulped. Until recently, these valuable data were not being leveraged. But now companies such as Emerson Process Management are stepping in with IIoT solutions. As Vidya Ramnath, the company's vice president of solutions and lifecycle services, explains, IIoT helps "industrial plants gain huge benefits from data analytics, by integrating and analyzing large amounts of data using smart field devices on plant equipment."

These benefits trickle down to the bottom line. A company with earnings before tax, depreciation and amortization of USD 2 billion can save USD 100 million by implementing digital plant initiatives. By going digital, end users are quickly discovering that industrial IoT (IIoT) boosts operations on two fundamental fronts: reliability and energy efficiency. In today's marketplace, increasing and ensuring both are imperatives for any firm to remain competitive. For example, chemical giant Denka was able to reduce the cost of steam by 7 percent by engaging IIoT and installing sensors on 148 steam traps at its chemical plant.

"In a highly complex and volatile business environment, companies are finding ways to perform, optimize processes and operate more efficiently to sustain growth," says Joseph Lee Ching Hua, head of the new Co-Innovation Center at Japanese electrical engineering and software firm Yokogawa and general manager of its Singapore Development Center.

Another large chemical manufacturer, Afton, recently unveiled a new plant on Singapore's Jurong Island with its sights set on realizing the benefits of digitization. "Afton's plant on Jurong Island has a very high level of automation and utilizes advanced distributed control systems to manage plant process and utilities systems, ensuring ongoing safety, productivity and sustainability. Notably, it is our first facility in the world to have an installed remote machine-human interface, which reduces manual communication and human error, thereby improving productivity," says Sean Spencer, vice president and managing director of Afton Asia Pacific.

How exactly can a chemical plant leverage IIoT to achieve these savings? According to Accenture, four fundamental pieces of the IIoT puzzle need to fit together for change to occur: sensors, data science, a human-machine

→

Photo: iStock.com/Bim

Singapore is embracing industrial Internet of things (IIoT) technology to increase the productivity, safety and competitiveness of its chemical industry ecosystem with a view to establishing itself as the IIoT technology and business hub of Asia.

interface and action. Traditionally, a contractor comes on site to inspect the health of plant equipment, including pumps, heat exchangers, blowers, cooling tower cells and non-process compressors. Manual inspection and data collection are typically conducted a few times throughout the year to ensure smooth plant operation. But there are drawbacks with this conventional process. The first relates to labor. Large teams are deployed to perform inspections, collect data and identify required improvements. Contractors often have to measure the status of dangerous equipment, adding an additional layer of risk to an already costly and time-intensive process. On top of this, many problems are often not detected on time or at all, leading to breakdowns that interrupt plant operations and production, and result in capital losses.

The first and key ingredient in the IIoT recipe, a sensor, automates measurements and performs them more frequently than personnel can. Affixed to assets, sensors can measure variables such as pressure, temperature, corrosion and humidity, and transmit relevant data over a secure network to analytics software. This is where the second ingredient, data science, comes into play, generating reports that reveal the condition of a given asset. Third, an interface between machine and human provides the operator with the information needed to make an informed, cost-saving decision. Analytics can often specify the amount of financial loss associated with the deterioration of an asset, yielding a clear impetus for the fourth ingredient to kick in: action. In this way, leveraging IIoT can result in less time spent on collecting data manually and more time acting on results, leading to improved productivity, increased efficiency and cost savings.

**RENT, LEASE OR BUY?**

Reading this, you may be quickly wooed by the wonders of IIoT. But is it possible to implement such technology in a facility without overhauling the entire plant? And do the purported savings justify the cost?

There are various approaches to plant modernization and the realization of a total digital ecosystem in which sensors, networking and software fit together. An IIoT infrastructure can be installed and parceled within a plant in countless ways. Traditionally, plant owners have invested in purchasing sensors, networks and software to conduct reports autonomously. However, IIoT allows for remote monitoring, and new business models that encourage partnerships and enable less capital-intensive commitments. For example, digital automation provider Emerson installs sensors, networks and software in exchange for zero upfront investment. The firm offers what might be described as an IIoT subscription, charging a monthly fee for the resulting data analytics.

"Pumps, steam traps, and other equipment monitored on-premise, centrally from the corporate engineering center and remotely from Emerson's center of excellence, have enabled our customers to yield huge benefits at the operational level. These real-world implementations are helping industrial facilities to frame their priorities for IIoT investments," says Emerson's Vidya Ramnath.

With capital expenditure considerations also in mind, systems integrator Accenture is offering clients the opportunity to rent or lease equipment, and to launch pilots to test the water before considering building an entire network. "There is also a trend towards permanently leasing and renting, and adopting the use of shared services," says Senthil Ramani, managing director, digital business lead and director of Accenture's newly established IoT Center of Excellence in Singapore. The technology giant is committed to building "custom IoT journeys" for its industrial clients in the region through its IoT Center of Excellence.

Meanwhile, Yokogawa is working alongside its customers at its new Singapore-based Co-Innovation Center to ensure the efficient utilization of data and diagnostics generated by its smart sensors.

But regardless of the chosen provider, by leveraging data science, digital transformation has the potential to maximize the utilization of existing assets, often with little or no capital expenditure.

## EMPLOYING A NEW GENERATION

IIoT is inextricably tied to the workforce of the future. By 2025, millennials, or "digital natives", will make up 75 percent of the global workforce. This implies that to attract and retain talent, existing business models within traditional manufacturing industries such as chemicals or mining will have to evolve and incorporate new technologies.

Incoming workers are quick learners and gear towards efficiency. They are not inclined to read thick instruction manuals to assimilate operational knowledge. "Wisdom needs to be digitized, without which smartness cannot meet wisdom, and younger operators run the risk of working in a plant without sufficient knowledge. Going digital can help solve this issue and accelerate the pace of adoption for the incoming generation," says Accenture's Senthil Ramani. As more and more wisdom is digitized, the results are multifold. Fewer workers are needed to work a plant, and safety levels increase along with productivity. As more processes are automated progressively, workers can engage in higher value-added tasks that are both safe and more technical.

## LEADING THE DIGITAL REVOLUTION

Singapore is evolving into an IIoT global center of excellence, with technology players such as Emerson, Accenture and Yokogawa pioneering new developments in the sector. With the support of Singapore's Government, these players have established, respectively, a Pervasive Sensing Center of Excellence, an IoT Center of Excellence and a Co-Innovation Center. Government agencies are also incentivizing the uptake of plant modernization, digitization and automation, and supporting the development of an innovative industrial ecosystem. These policies are not only in line with goals to improve productivity, but factor in to a greater vision of total transformation.

"Singapore was, and continues to be, a net exporter of chemicals," says Mr. Ramani. "But more importantly, I believe the city-state is on its way to transforming itself and becoming a net exporter of innovation in the chemical industry, with IoT leading the agenda."

WIPO
WORLD
INTELLECTUAL PROPERTY
ORGANIZATION

34, chemin des Colombettes
P.O. Box 18
CH-1211 Geneva 20
Switzerland

Tel: +41 22 338 91 11
Fax: +41 22 733 54 28

For contact details of WIPO's External Offices
visit: www.wipo.int/about-wipo/en/offices/

**WIPO Magazine** is published bimonthly and distributed free of charge by the World Intellectual Property Organization (WIPO), Geneva, Switzerland. It is intended to help broaden public understanding of intellectual property and of WIPO's work, and is not an official document of WIPO.



WIPO Publication No. 121(E)
ISSN 1020-7074 (print)
ISSN 1564-7854 (online)

For comments or questions, contact The Editor at WipoMagazine@wipo.int.

To order a print version of the WIPO Magazine, contact publications.mail@wipo.int.