

ARC.

Advanced
Research
Clusters

Your window into the world of ARC.
Business, science, partnership and
thought leadership from our growing
innovation community

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Spring 2022

ENGAGE CLUSTERS

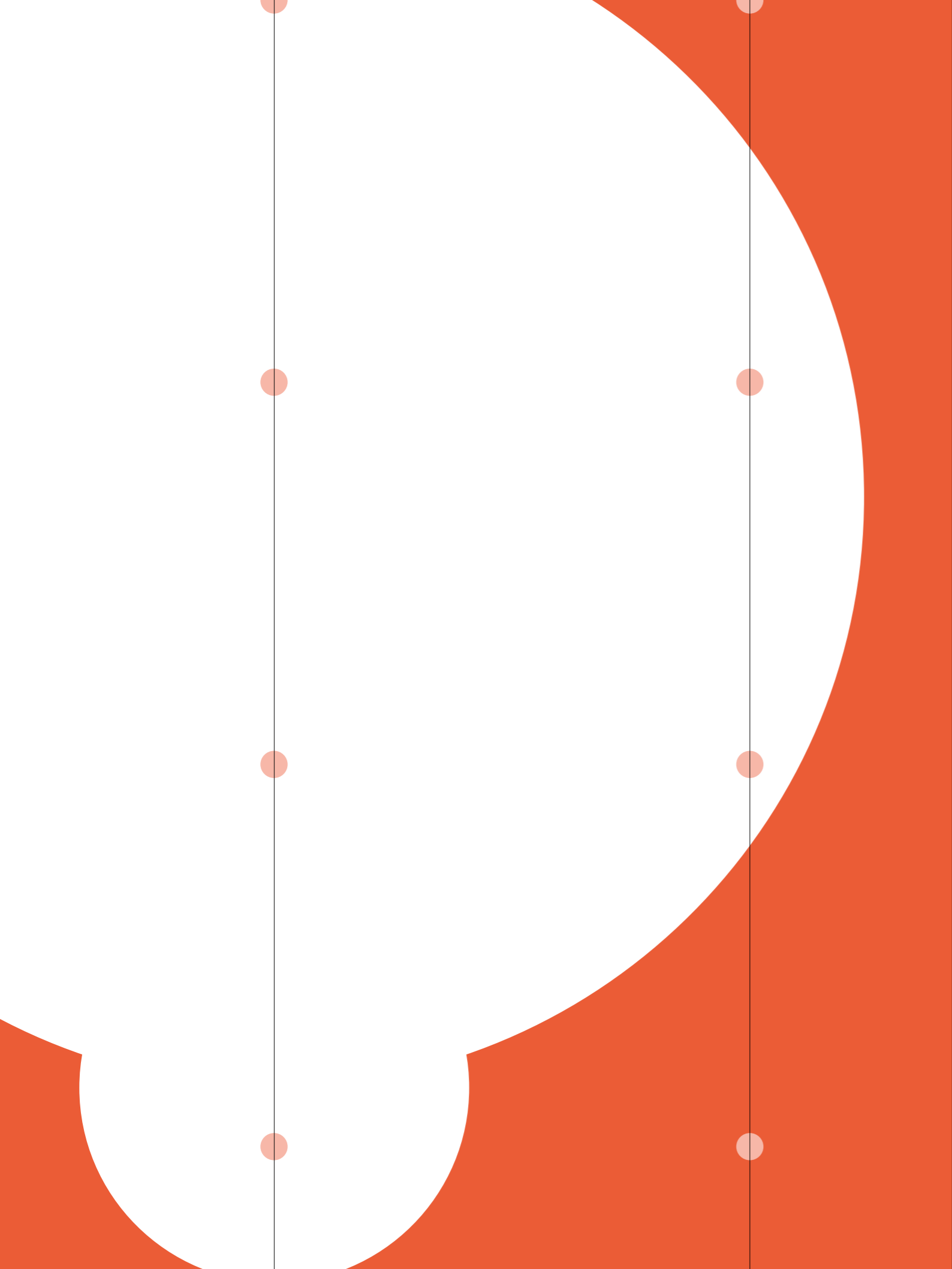
Why science and innovation
love company

SMARTER PARTNERS

ARC looks after the people
behind the science

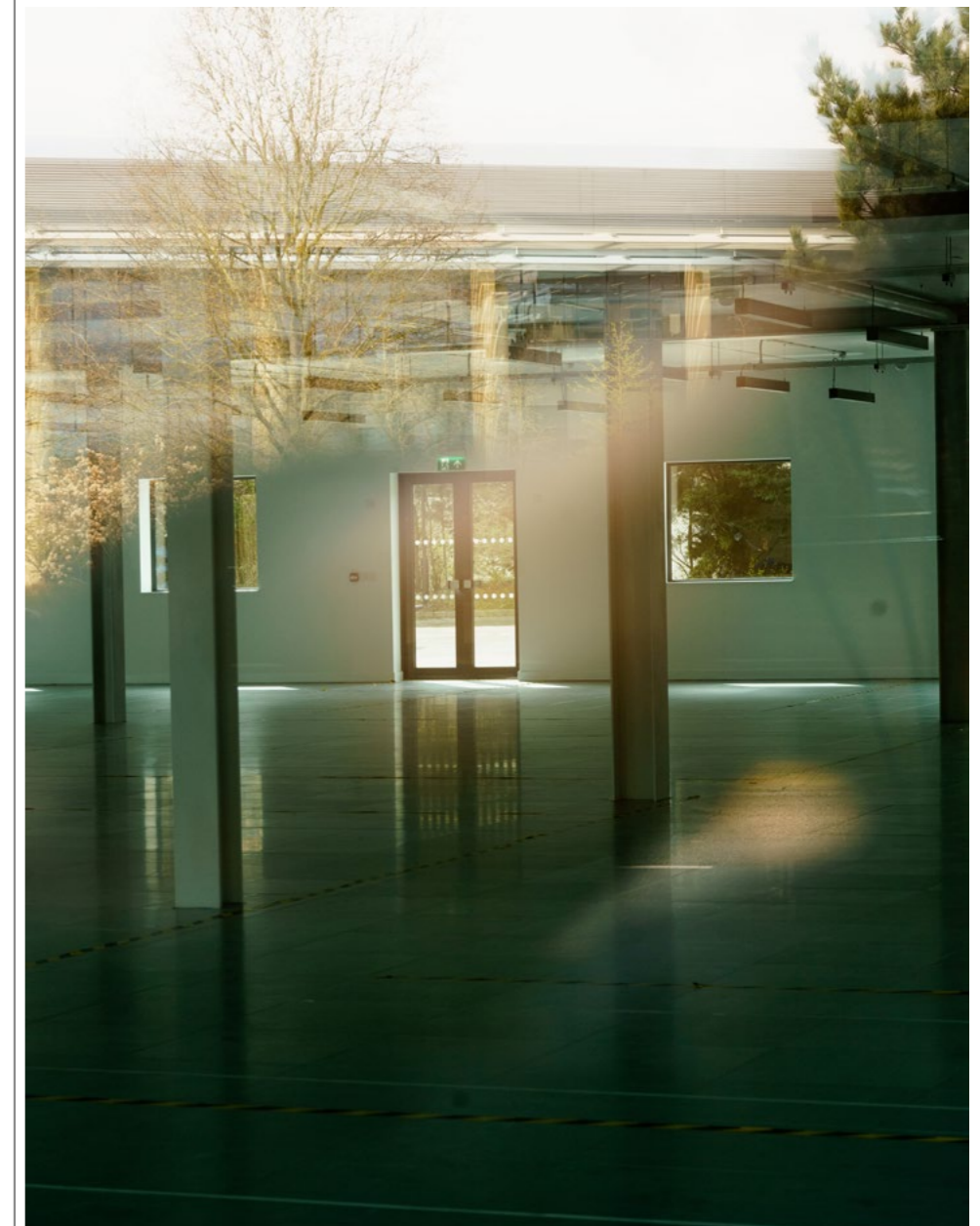
ALOK JHA

Colonising Mars, digital healthcare
and the fusion-powered future



The world of science and innovation is more important than ever. From studying the tiniest particles to photographing the tallest solar flares, novel ways of investigating the universe around us are opening new avenues into the unexplored.

Scientists imagine what could be and make it work for real — they develop new sources of energy and even lengthen lives. That's why ARC supports the people behind the science, creating environments and networks to help them succeed. If innovation is about the future, we must first make a better future for innovators.



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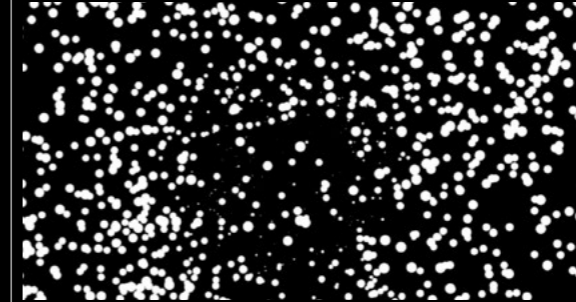
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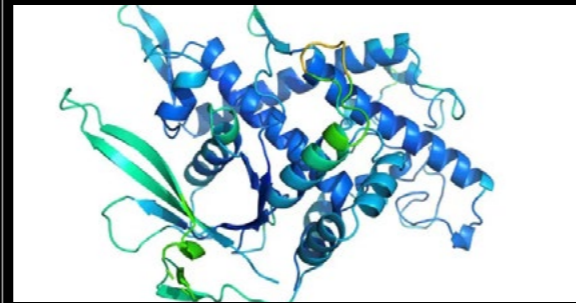
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IMAGINATION PARTNERS

ARC stands shoulder to shoulder with the Institute of Imagination to arm science's next generation

PARTNERS ACROSS

A better future depends on science and innovation — and they're team sports. Success comes from meaningful relationships that build bridges between sectors, disciplines and specialisms.

ARC's unique knowledge of real estate, science and business fosters new partnerships and communities. It's why our members are members of the future.



SPACE

*+ energy + life sciences + quantum + tech + health

TIME AND C E*

**WE'RE ARC.
THE SMARTER REAL ESTATE
PARTNER FOR SCIENCE
AND INNOVATION**

**WE'RE CREATING A WORLD
NETWORK OF ADVANCED
RESEARCH CLUSTERS**

250 1

250+ member companies

1 growing network that
will one day be worldwide

900

900 acres of green, energising environments

1.6

1.6 million sq ft of office space, labs and R&D
facilities (more than 5 million sq ft of space to come)

4

4 clusters for science,
technology and innovation

Dr. Tim Moonen
The Business Of Cities
Co-Founder & Managing Director

THE FUTURE OF WHERE WE WORK IS UNPREDICTABLE

LET'S KEEP IT THAT WAY

Dr. Tim Moonen is the co-founder of The Business of Cities, an urban intelligence firm that helps businesses and cities find common ground and work towards shared success. He argues that the future of the science and innovation cluster is closely linked to its urban context — in physical connections, as well as how it looks and feels.

Aside from the physical transformation of our campuses, clusters and parks, there are three additional elements that can be harnessed for its evolution. Firstly, you've got to create better networks between the organisations that occupy the space, so that people who would otherwise never meet have the opportunity to interact. Secondly, while events and communal spaces can play a key role in achieving that, some places take it a step further with dedicated cluster and community managers. These people know exactly who's coming and going and can identify when fruitful introductions can be made. Facilitating new connections can happen serendipitously, but it helps to have someone usher it along. The final element is building a profile. Such workplaces need an identity that is desirable to be part of locally, as well as a brand that allows them to be understood internationally.

Work looked very different fifty years ago. A typical day might begin by getting in the car and driving to a traditional suburban business park. Through the gate and into a secure and private complex, you'd spend your day in a place walled off from the surrounding area. At 5pm when the workday ends, it's back into the car and out through the gate.

The future isn't a one-size-fits all transformation. What works in Boston won't necessarily work in Birmingham. It takes the desire for reinvention — not only on part of the landlord, who requires the vision to shed the mid-century mentality, but also the local government itself. Both sides need to appreciate the fact that a cluster is not an island, but part of a greater ecosystem. The success of these places contributes to the success of the local area in which they're situated and vice versa. This also means that places like innovation clusters need to be better connected to the city and offer their workers a low-carbon way for getting to work.

But anyone working today knows that our relationship with the workplace has changed. What was appropriate in the 1970s is no longer fit for purpose. Campuses, parks, clusters — these kinds of environments are reckoning with the reinvention of the workplace for the future. Many are competing with dynamic city centre locations, which also means competing for talent on a global level.

When I imagine the innovation cluster of the future, it looks and feels like a piece of city. It's not a place where cafés close and the gate locks as soon as the workday ends. In fact, there isn't a gate at all. Instead, it's a place where, from morning to night, there's life on the ground. Coders, technicians, designers, engineers, artists, regulators and marketers all co-exist. You hear the sound of people going about their days, clinking cutlery from restaurant terraces, the chime of a train or bus in the near distance. It has a mix of labs, studios, culture, retail, childcare and leisure. You feel connected to the city, even if you're outside it.

Our places of work have been through several change cycles already. It's been roughly 35 years since people first stood up and noticed that there were limitations in the physical design and experience of these places. Since then, varying attempts have been made to solve these issues. You might see manicured gardens or even moats. But often that doesn't cover the key quality that these spaces need to stand out and drive change: character. Diversity and unscripted elements of surprise are largely still missing. So how can that be designed in?

Crucially, these will be places where the local community, even those who aren't employed by any of the resident businesses, can get a sense of what's taking place in a way that's visible, tangible and accessible. Rather than seeing a closed off fortress of buildings "where those elites do their science", the community has the opportunity to interact with it. They know what's happening there because they've seen it with their own eyes, become a part of it and learnt the value innovation brings.

It's not a matter of seasonal fireworks evenings or bringing in the food trucks at lunchtime, though there is an element of introducing a new visual vernacular. Instead, it's about letting the unplanned happen. Letting different communities come in and use the space for their own events, and in turn, opening the space up to a more diverse set of users. It's about ensuring young people feel invited and free to express themselves. Ultimately, it's about letting go, and letting it take on a life of its own.

That, to me, is a benchmark of success.

SOCIAL SCIENCE

ARC OXFORD'S COMMUNITY HUBS ARE SPARKING INNOVATION

Where were you when you had your last great idea? On your own? Chances are, you were actively engaging with others. Meeting places designed to encourage frequent natural interaction are more than places to get away from the desk. They're spaces for that most effective of creative stimulants: serendipity.



Some of the world's most revolutionary ideas have come from sideline conversations or passing comments. The people behind Instagram were trying to make a gaming app before talking their way towards something more peculiar and, ultimately, more paradigm shifting. Twitter's founders originally set out to help people find podcasts. It's amazing where imagination can lead us if given the chance to wander more freely.

This is why places with spaces designed to encourage this kind of working rhythm generate more ideas. An acute awareness of this fact was behind the curation of ARC Oxford's central hubs — Oxford Works and Oxford Factory — both of which are overseen by Community Manager Jodie McNamara.

"Oxford Works is our collaborative work space, but it has so much more bolted on. It's a space to come together outside of the normal office environment to develop ideas, network, and innovate. You can hire a desk for anything between an hour and a day, and we have quiet spaces, yoga classes, board rooms and even a seminar theatre. It's deliberately not your typical office environment because it's meant to spark creativity."

"An extension of the Oxford Works is the marketplace, which is an open lawn area where

we have our summer events. We've got table tennis, we've got our Oxford Workshop, which is another food and beverage provider; it's like a pod there. In summer, we make it an actual meeting space too."

Swapping weekend stories over the lunch table, mingling before an open-air cinema screening, enjoying something fresh and green together after a challenging yoga class. It's in these unremarkable interactions that remarkably useful information often crops up. We uncover who's working on what, where the snag lies in a problem they're trying to solve (a snag we may have the answer for) and what latest software or tool has proven timesaving. Compared to streams of messages footered with an insincere 'thanks', there's surprising potential for inspiration in even the most unexpected of exchanges.

"IT'S DELIBERATELY NOT YOUR TYPICAL OFFICE ENVIRONMENT BECAUSE IT'S MEANT TO SPARK CREATIVITY"

"We realised people work best in teams when they know each other. Our events — from biodiversity talks to Winter Wonderland — give more opportunity to connect and get to know colleagues as human beings. They take this back into the office with them and it builds better working relationships. It's so clear to see when it happens the way it should."

Oxford Factory is the gastronomic sister space to Oxford Works sitting under the same roof. The space tips its hat to its past life as the old Morris Motors factory with a bit of industrial charm — low-hanging copper lighting and exposed brickwork make this feel a world away from the cafeteria of a soulless business park. Long tables encourage ARC's members to mix, with conversation fuelled by plates of tacos and the doughy Neapolitan crusts of their signature pizzas.

"Oxford Factory is our on-site restaurant, and another space to give people a chance to step away from the office. We have daily menus, themed nights and locally sourced produce. It's run by The Jam Factory, owned by Andrew and Nick — both huge foodies — who have strong links to the city centre."



Book a space at
Oxford Works today
hello@oxfordworks.com



See what's on the menu
at Oxford Factory this week
www.oxfordfactory.co.uk



The best working environments are about balance. Glueing ourselves to the same spot for eight hours is hardly a recipe for stimulation. Like the Large Hadron Collider, when we're encouraged to collide in more spontaneous ways the results are impossible to predict. It's a context that ideas thrive in. Any curation of space that lets us behave as we instinctively do — socially and openly — is a space that sees the sparks of imagination fly more freely.

“Our members are making history with the work they do, so we wanted to give them a choice of where and how they work. We all need the problems they're solving to be made history sooner, and sometimes the smallest things we do for them can make a world of difference.”



“There's a great community feel here. It really does bring everyone on the park together, which I feel is hugely important.”

— Bridget Gaughan,
FM Team at Oxford Biomedica

“There are always activities going, which encourages engagement. They encouraged me to come into the office so much more than I would have ever done.”

— William E. Arinze, Animal Dynamics

Perspectum



A picture of health saving lives

In conversation with (clockwise from left):
Dr. Rajarshi Banerjee (Banjo), CEO and founder
Dr. Sarah Larkin, Head of Laboratory Sciences
Alice Eadle, Global Head of Talent
Alan Blunt, Global Head of Estates

Thanks to Perspectum, patients with liver disease can now be diagnosed faster, more accurately and more comfortably. When he founded the company in 2012, Dr. Rajarshi Banerjee, more widely known as Banjo, wanted to map inflammation without needing to do biopsies. By developing new imaging technology Perspectum has successfully pushed the limits of health science to make what was once impossible not only possible, but convenient, painless and (like so many others within the ARC community) lifesaving.



Perspectum at a glance

Perspectum delivers digital technologies like advanced imaging to help clinicians provide better care for patients with liver disease.

Founded:	2012
Employees (HQ):	190
Research partners:	115
Locations:	Oxford, Singapore, Portugal, Dallas, San Francisco

Why do we need Perspectum?

Sarah It's becoming very clear that medicine is a personal thing, so we need to develop innovative tools that can give personalised diagnoses, treatment and recommendations.

Alice Without Perspectum, patients will carry on having a far longer, more uncomfortable diagnosis journey. We're here to do real good for patients.

Alan The work that Perspectum does is truly remarkable. I saw first-hand what was 'just an idea' develop into actual CE-marked, FDA-cleared medical devices. For example, we recently developed CoverScan, a study to map how Covid-19 impacts the health of multiple organs.

Banjo Perspectum, amazingly, is now one of the largest AI healthcare developers in the world, on par with Microsoft and Google in the landscape of medical innovation.

What can you tell us about what you're working on right now?

Banjo We're developing new ways of assessing cancer so we can inform a surgeon what operation they should carry out. This has the potential to totally change outcomes in cancer care and we've developed it right here at ARC Oxford.

Sarah We're working on sample handling for several clinical investigations, covering liver disease, oncology, diabetes. Our lab is going to become the central hub for processing and analysing samples for those studies.

How do innovation companies like yours like to work?

Sarah Collaboration is at the heart of it. I'm a great example of that — I first entered Perspectum on a collaborative venture from Oxford University. If people are working in isolation they're never going to get the best out of everybody's endeavours.

Banjo Innovation in the life sciences is hard, but it's thrilling when it works. To get there as fast as we can — because the kind of discoveries we make matter — we need to collaborate, not just with other scientists, but other organisations, cities, councils and patients.

What's it like to work here at ARC Oxford?

Alice The environment here matters massively, especially when we have visitors. It's nice to have the option to take them out to lunch and not have to travel miles away. And the fact that we can get coffee right outside our office, plus the frequent social events, means we get that positive work-life balance even when at work.

Alan Having space to grow is also important. Moving to ARC Oxford meant we had the space to build a laboratory and community diagnostic centre where we can house external medical scanners, which enabled us to add an entire new arm to our business and the service we offer.

Before we came here, we looked at the big tech and pharma firms who we wanted to work with and be compared to and asked: if the likes of Microsoft or GE were opening a new HQ in Oxford, where would they look? ARC Oxford was ideal as it not only had good-sized office space, facilities, transport links, but was also home to other companies working in similar fields.

What are the most acute challenges you've faced as a business?

Banjo To transform healthcare we need to demonstrate that new pathways work and that they're cost effective and beneficial to patients. So, the biggest question for us has always been "how do we interact with patients?" — especially through a pandemic where people were literally separated.

ARC and Perspectum combined with the local hospital infrastructure to build, from scratch, a new community diagnostic centre that was opened here in November 2021. This is the toughest thing I've done here and also, the source of greatest pride.

Alice On the talent front, the biggest barrier now is that it's a very candidate-driven market. We're constantly battling with other companies to be the employer of choice. It's not just about the salary anymore, it's also the culture, what it's like to work here and what the people are like.

How can real estate be a better partner to businesses like yours?

Banjo Scaling can be very difficult for businesses. The initial proof of concept may only take two or three years and require 20 to 40 people but, subsequently, an organisation may double, triple or even rise tenfold. Scaling



“PERSPECTUM, AMAZINGLY, IS NOW ONE OF THE LARGEST AI HEALTHCARE DEVELOPERS IN THE WORLD”

Dr. Rajarshi Banerjee,
CEO and founder

requires a good real estate partner who can move with you through tough times as well as good times.

Alan Asking what kind of person will work here and what they would want in terms of facilities is fundamental to building a successful workplace. Having someone onsite at ARC Oxford who shares our vision, is willing to trust us and is responsive to our needs and requests, has made the last few years of continued growth possible.

What's the future of health science? What advancements do you predict?

Sarah It's going to be more integrated. Instead of separate pieces of equipment all over benches, there are going to be completely automated solutions that will allow samples to be analysed more quickly and more thoroughly.

Banjo In the future, we'll deliver care closer to people's homes. As life expectancies grow, we have to create new technologies that can come closer to them. This is why having physical environments that suit healthcare and change with innovation is so important to the future of our patients and to our children.

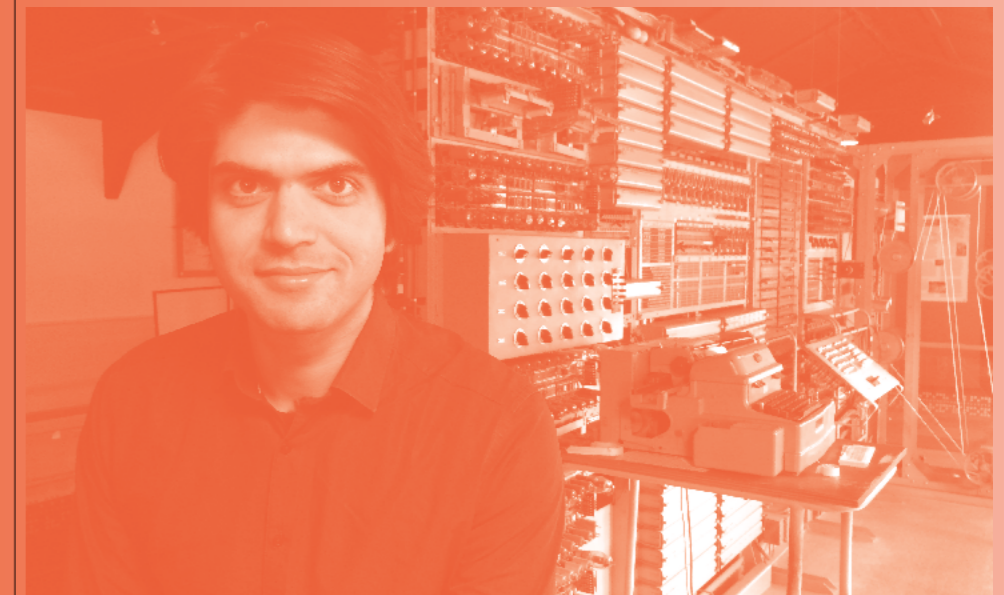
FUTURE

with Alok Jha

TRENDS

If the Covid-19 pandemic has taught us anything, it's that trying to predict the future is a tricky game. No one foresaw the spillover of the SARS-CoV-2 virus into humans in China at the end of 2019. And neither did anyone predict that a vaccine against that virus would be developed, trialed and administered to millions of people less than a year later. Sure, some domain experts might have suspected that these things were theoretically possible, but the twists and turns of the past two years show there will always be surprises around the corner. These surprises can be bad (the spillover) or good (vaccines) — the important thing is to be prepared for both.

Preparation, of course, demands lifting your eyes up to gaze at the horizon. What follows is not a set of predictions about the future of technology. Think of them instead as a set of intriguing ideas somewhere off in the distance. Here are some things that might prepare you as we face off those inevitable future surprises.



mRNA VACCINES: THE POWER TO PERSONALISE TREATMENTS

Nothing in recent years can lay as much claim to the title of “most immediately world-changing technology” as the mRNA vaccines for Covid-19 developed by Pfizer-BioNTech and Moderna.



Within the human body, mRNA (which stands for “messenger ribonucleic acid”) are small molecules used to communicate within cells. The Covid-19 vaccines are made with synthetic mRNA molecules that tell the cells they are injected into to make copies of pieces of SARS-CoV-2, the coronavirus that causes Covid-19. Those pieces of virus are harmless, but because they are foreign material as far as the cell is concerned, they elicit the body’s immune response.

The technology behind mRNA might seem to have come from nowhere during the pandemic, but the research behind it had in fact been ongoing for several decades before SARS-CoV-2 ever spilled over into humans. The pandemic has comprehensively proved that mRNA is a safe platform for vaccines and drug companies are already thinking about what comes after Covid-19. Potential diseases that could be tackled with this type of vaccination include influenza, chikungunya, Epstein-Barr virus, Zika, and respiratory syncytial virus. There is even an HIV vaccine in the works by Moderna, while BioNTech is working on an

mRNA vaccine for malaria with trials due to start in a few months’ time.

Looking further ahead, mRNA could become a useful tool in making cancer treatments more personalised. Because these vaccines are relatively fast to make — Moderna made the first version of its Covid-19 vaccine in just seven weeks — doctors could identify target proteins in a person’s tumour and then make individualised mRNA vaccines to attack just those proteins.

STARSHIP: NEW HORIZONS FOR SPACE EXPLORATION

In 1973, the final Saturn V rocket took off from Kennedy Space Center in Florida. Taller than the Statue of Liberty and able to push 140 tonnes into orbit, the Saturn V is the rocket that took humans to the Moon and holds the record for the biggest ship ever flown. Now, almost 50 years later, SpaceX’s Starship is on the verge of smashing that record. Built with gleaming stainless steel and standing 10 metres taller than the Saturn V, it will be able to carry some 150 tonnes into space. Its size, however, is not even Starship’s most exciting quality. Because the hardware is designed to be entirely reusable, it should make launches much cheaper and therefore could completely transform the space industry — while existing rockets cost billions of pounds per launch, SpaceX reckons it can reduce that to a few million pounds. This means that five Starship flights could put more stuff up into space than the whole world managed in 2021 with 135 rocket launches.

If SpaceX succeeds, and it’s still an “if” right now, pending test flights and environmental assessments, Starship would open up new vistas for a space industry that has become used to slicing every possible gram off the things it sends into orbit. Scientists are already salivating at the prospect of not having to fit complicated observatories into the confines (geometric and mass) of current rocket systems. NASA already plans to use Starship to land astronauts on the Moon. But scientists are already dreaming of possible fleets of rovers sent to Mars fitted with more sophisticated scientific laboratories. SpaceX knows what it wants to do in the immediate future with Starship: launch thousands of satellites for its Starlink broadband internet system. In the longer term, SpaceX’s boss, Elon Musk, wants Starship to take the necessary materials to set up colonies on Mars. You really can’t say he doesn’t have ambition.



● Starship SN15 High-Altitude Flight Test © Space X

NUCLEAR FUSION: CLEANER POWER FOR THE PLANET

The Sun is a giant nuclear reactor. Not the kind familiar on Earth, nuclear fission, in which heavy atoms are split to release energy; but rather nuclear fusion, in which light atoms are forced together under intense pressure. During this process inside stars, the atoms fuse and release energy. We know that energy as sunshine.

It’s been the dream of physicists for decades to be able to recreate nuclear fusion on Earth in a controlled way so that it could become a source of electricity. It’s an attractive prospect — there is a limitless supply of fuel on Earth and the fusion process itself is relatively safe and produces no greenhouse gases.

Artificial fusion is hard and the global government-funded effort is currently tied up with ITER, a gigantic €20bn laboratory under construction in France. Here, scientists hope to prove that fusion can be controlled and, eventually, turned into a power station. Even if it works, however, this project isn’t expected to lead to fusion-powered electricity before 2050.

But in recent years, a new hope has emerged from the private sector. Using a variety of engineering designs (a couple similar to ITER, a nuclear fusion megaproject) more than a dozen

companies have raised billions of dollars and their collective claim is that they can beat ITER into creating electricity from nuclear fusion by several decades. It’s worth taking them seriously. Not just because ITER was designed decades ago and therefore has not been able to take full advantage of the many advances in materials, artificial intelligence and superconducting magnets around which some of the high-tech private-sector designs are based. But also because, if one of these private companies can get fusion to work a few decades earlier than the lumbering government-funded ITER, it would become a central tool in the fight against the climate crisis. And the sooner it arrives, the better for everyone.

A CLINIC ON YOUR WRIST: WHY HEALTHCARE’S FUTURE WILL BE DIGITISED

The Covid-19 pandemic accelerated the digitisation of many parts of everyday life — meetings, shopping and watching events online have all become mainstream. The same goes for remote medical consultations, and a new generation of wearable health monitors will help patients receive better care and practitioners to provide it.

At the consumer end, wearable devices such as Apple Watches and Fitbits have already become popular for those wanting to keep track of their fitness. Apple’s Watch has already received

medical grade approval for features such as its electrocardiogram heart monitor and also its ability to measure atrial fibrillation. In coming years, expect to see an increased blurring between consumer and medical uses for new versions of wearable devices. Future versions of Apple's Watch will include new light-based sensors that can measure everything from body temperature to glucose or alcohol levels in the blood, or even carbon monoxide poisoning.



Full medical approval for many of the new functions could take many years, but before that, the new smart watches could provide useful data to be used in conjunction with the now-familiar remote consultations with clinicians. These gadgets could help with general health monitoring and also to provide early clues of problems, which could then be investigated further by approved medical devices.

GRID BATTERIES: BETTER WAYS TO STORE RENEWABLE ENERGY

The problem with renewable electricity is that it is intermittent. The sun stops shining for at least half of a 24-hour cycle (and often much more in the UK), the wind sometimes stops blowing and the tides can remain calm. It's a hard fact that we need more and better ways to manage these rises and falls in electricity production — that means better ways to store energy.

One of the most intriguing ideas right now is new types of batteries, built at scale, made from iron. Also known as "grid batteries", some designs under development should be able to store excess renewable energy for up to five days. And that's just the start. Given that iron is one of the most abundant elements on Earth, the hope is that these batteries could become much cheaper per kilowatt hour than the lithium-ion batteries that have become ubiquitous in laptops and mobile devices over the past decade.

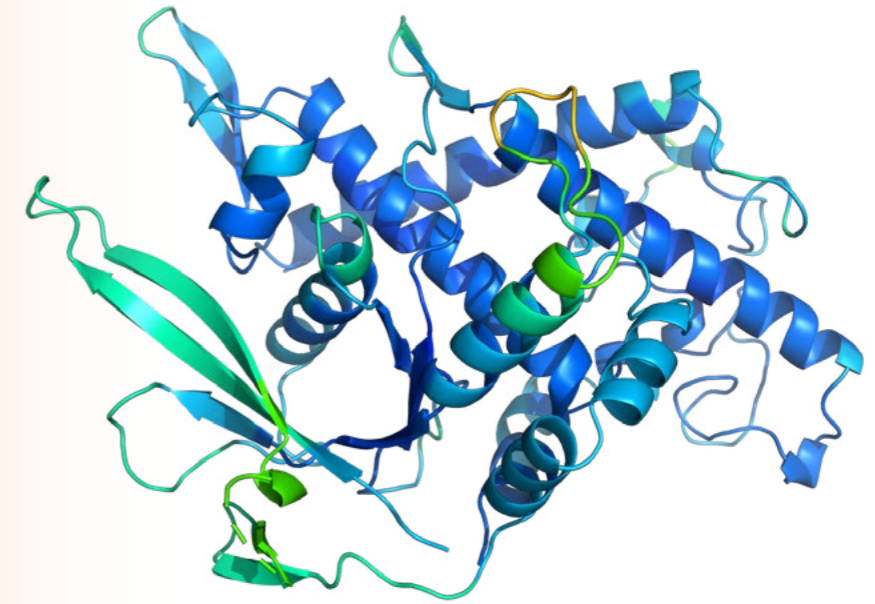


AI FOR SCIENCE: ALGORITHMS BEFORE ANIMAL TESTING

It is unfortunate that the term artificial intelligence (AI) has become hijacked by marketing teams who're looking for ways to describe their mysterious secret sauce of whatever they are trying to sell you. Because the most exciting frontier for AI is in basic science, in using clever computing to help researchers speed up their work or even create entirely new knowledge.

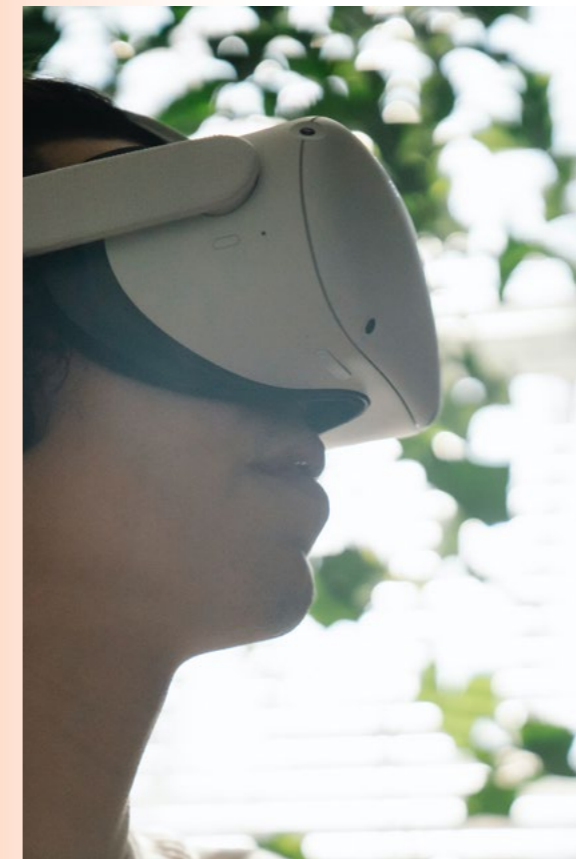
A good example is AlphaFold2, an AI built by DeepMind. It can predict the shapes of proteins, which are often composed of hundreds (or even thousands) of atoms arrayed in complex 3D structures. The shape of a protein determines how it functions within the body and many people before have tried to write software to help predict shapes. But AlphaFold2 was the first whose results were able to match the current scientific gold standard — X-ray crystallography. This process can take months (or years) and involves crystallising proteins and then shining X-rays through them. The resulting diffraction patterns allow scientists to try to infer the protein's structure.

If AI can predict protein structures accurately, it's not hard to imagine how useful it would be for drug companies to be able to quickly simulate how a small-molecule drugs might interact with the protein to predict efficacy or side-effects of medicines; or they could even find or design completely new drugs to solve problems when this new technique indicates that the old ones don't work. And all of this comes before having to do the more expensive work of trying things out in animals or people.



● AlphaFold2 ©DeepMind

METAVERSSES: THE NEW FRONTIER IN VIRTUAL REALITY



Originally introduced as a concept in Neal Stephenson's 1992 novel "Snow Crash", the Metaverse was a persistent, networked virtual world, accessible via special goggles where people could meet, flirt, play games, do business, and much more besides. Almost thirty years later, companies in Silicon Valley are buzzing with plans to build real versions of Stephenson's Metaverse that, at some point, they hope will become the successors to today's internet.

Many of these metaverses are being built using Unreal Engine (UE), a piece of software that powers video games such as "Fortnite". UE's ability to build photorealistic 3D simulations of the real world means it has found widespread use among architects, film-makers, academics and many others. Epic Games, which makes UE, will soon release the fifth version of its software, giving wannabe Metaverse-builders the most sophisticated toolkit yet with which to build the kinds of worlds where people might actually want to spend time talking, working and relaxing.

Metaverses are an important strategy for some of the biggest companies — Facebook recently renamed itself Meta to jump on the opportunity and move away from being just a social media company, and Microsoft and others want to build their own versions too. The future will be virtual.



THE

WORLD

OF

USERS

**WHAT HAPPENS
WHEN WE WORK
TOGETHER?**

FACTOR

NO PERSON IS AN ISLAND...

...and when it comes to making technological and scientific progress, we need one another more than we think. Some of the biggest innovations of recent times have come through multi-disciplinary collaboration. It's time to get out of research silos and cluster up, writes Harwell's Director of Clusters and Campus Development, Barbara Ghinelli.



● Silicon Valley, California
● Barbara Ghinelli

Innovation is a contact sport. You only need to look at how organisations like Diamond Light Source, Rosalind Franklin Institute, Research Complex at Harwell, University of Oxford and Vaccitech, the creator of the Oxford AstraZeneca vaccine, rallied together to help characterise the Covid-19 virus and monitor the different mutations, to see what's possible when people work together towards a single goal. Private and public sector organisations, regulatory frameworks and academic institutions all pulled together under the Vaccine Taskforce to protect the public and seek new vaccines and effective therapeutics. They did it as part of a wider integrated cluster, those based at Harwell and those strategically linked to the UK's leading science and innovation campus. And thanks to them, breakthrough science was accelerated and lives were saved.

The Covid vaccines epitomise the definition of innovation — technology or science adapted into something that can be used commercially for the benefit of society and economic growth. Though the impact from such Covid research is well-known, it's not the only example: clusters are drivers of these kinds of breakthroughs, providing connection, collaboration, and competition that delivers progress that everyone benefits from.

The idea isn't a new one. Alfred Marshall set out cluster theory in his 1890 book *Principles of Economics* — outlining the idea that, while individual organisations might be creative and successful on their own, collaboration with others makes them stronger in the long run. In more recent times, thanks to the work of academics like Michael Porter at Harvard Business School, it's an idea that's come into its own.

From Hollywood to Silicon Valley, or from the vineyards of California to the leather workers of northern Italy, industries thrive when people work closely together. Even though the world is more digitally connected than ever before, the ultimate achievements are reached when there's a critical mass of interconnected businesses and organisations.

At the UK Research and Innovation's (UKRI) main campuses at Harwell and Daresbury, clusters are first centred around specific sectors. Diamond Light Source, for example, the UK's national synchrotron, was critical to understanding and monitoring the Covid-19 virus. Working like a giant microscope, it harnesses the power of electrons to produce bright light that scientists can use to study viruses and vaccines.

“THE BEAUTY OF CLUSTERS IS THEY'RE NOT JUST SINGLE SECTOR SILOS”

The beauty of clusters is they're not just single sector silos — they have the potential to be multi-disciplinary. Diamond Light Source is being used in the development of jet engines and the analysis of fossils. At Harwell, this incredible technology sits alongside many other facilities and supports work by a space cluster, an energy cluster and a quantum cluster too. Suddenly, the concentration of facilities in one place makes this one site an incredible platform for multi-disciplinary innovation.

Innovation in clusters happens in two ways. First there's the serendipitous. Clusters are a fantastic ecosystem where you can bump into the right person at the right time, and where people with the right knowledge can come together to seize the right opportunities. For example, Harwell has a higher concentration of space companies at a walking distance from each other than anywhere else in the world — that proximity makes all the difference.



● Diamond Light Source, Harwell



“CLUSTERS ARE AN ENGINE OF GROWTH FOR THE COUNTRY”

“THE PLACE ITSELF PLAYS A PART IN STIMULATING INGENUITY”

The physical structure of a cluster’s site plays a key part in this. The right amenities are so important in encouraging the connectivity that leads to innovation — yes, restaurants and coffee shops matter. How a cluster is structured is very much dependent on what you want to get out of it. Rather than thinking about buildings merely as offices or laboratories, applying this vision of collaboration transforms the way places are managed. By optimising the use of the space, it means the place itself plays a part in stimulating ingenuity and economic growth.

Secondly, innovation in clusters can be engineered. Beyond the physical space, one of the big differentiators of Harwell’s clusters is the presence of cluster managers who proactively enable connectivity. These people essentially act as matchmakers, bringing a trusted wealth of knowledge of each business and of the facilities, so that industry can come in, do a deep-dive into what’s available and immediately accelerate their organisation’s developments through established networks, and access to expert capabilities.



● Harwell masterplan

Clusters make available what would normally take months, if not years, to actually get together in different circumstances. For large organisations the benefit from cluster communities is access to agile innovation, the knowledge base of scientific organisations (like the Science and Technology Facilities Council), and the ability to work much more dynamically with academia. In clusters, where everybody’s working towards a similar aim, the link to the public sector provides large organisations with better understanding of elements such as policy and regulatory frameworks, all of which are important to developing new solutions and technologies.

Small companies, on the other hand, normally can’t afford the development of or access to large-scale facilities. Clusters provide this — work spaces, amenities, and laboratories — so businesses can get started, grow and become sector experts in that ecosystem. Clusters also crucially connect start-ups to investors so they can scale-up, plus investors find it easier to invest in companies in these ecosystems because it minimises their risk.

This means that clusters are low-risk places to do high-risk things, providing all the ingredients businesses need to achieve ambitious and high-impact goals — facilities, the knowledge to use them, and business support. Ultimately, this enables organisations to focus and deliver, setting them up with the best chance to have a greater impact in the future.

Clusters are an engine of growth for the country, but each cluster is unique, reflecting the ecosystem that supports it. For example, UKRI is developing a space cluster in the north-west of England, with a much wider geographical spread across five local authorities. Likewise, the Harwell Energy Tech Cluster has about 80 organisations based on campus but is connected to a network of over 100 organisations, proactively interacting across the UK.

Innovation is about creating a commercial world where businesses, public sector organisations and academia are able to draw from as wide a knowledge base as possible. Clustering is fundamental to this, creating a collaborative approach, making innovation happen, and seeing it adopted. Ultimately, this is how science and technology moves the world forward: clusters are catalysts for progress.

BRINGING SPACE

HARWELL
SPACE
CLUSTER

BACK DOWN TO EARTH

From lunar expeditions to the race for Mars, space exploration has always been astronomical in its ambition. Now it's helping overcome some of the greatest challenges facing the planet. From connectivity to healthcare, and from climate change to civil security management, Elodie Viau, Director of Telecommunications and Integrated Applications for the European Space Agency, explains how space crosses all boundaries to help make our planet a safer and better place to live.

Space. The final frontier. Mention space exploration and innovation, and, for most of the general public, the image that comes to mind will be something from science fiction or perhaps an astronaut, suited up for a spacewalk. But space is more tightly woven into the everyday of our lives than we think.

"Space is helping to connect the world," says Elodie Viau who is also head of ESA's UK site, the European Centre for Applications and Telecommunications (ECSAT), based at Harwell Campus and part of the space cluster.

"There are inspirational motivations to explore space — to understand the galaxy and where we come from, and perhaps even to find the origins of life on Earth," she says. From monitoring traffic flows to making a bank transfer, from mitigating the impact of the Covid-19 pandemic to securing our digital data, space technologies, research and innovation lead to a lot of very down-to-earth solutions and applications. "We all use space every day to communicate in a resilient manner."

The space cluster at Harwell reflects this breadth and diversity of application. With over a hundred space-related organisations, employing more than 1,400 people, all working within a couple of minutes walking distance from one another, the campus is the ideal place to accelerate the innovation and development of new combined and hybrid space and Earth-bound technologies.

ESA is one of the largest organisations in the space cluster at Harwell. As an organisation with a solid foundation, a long-term strategy, and international standing, they bring knowhow and an international network of expertise and excellence to newcomers, industries and organisations, giving them access and enabling them to work with the space sector.

But it's a two-way street and a dialogue, as Elodie explains: "Big companies need to reinvent themselves to create new ideas and products, and small companies want to enter, evolve and

bring innovative and disruptive ideas. What's beautiful about being part of our cluster is that together, we will form joint ventures that trigger momentum across the full economic and societal value chains."

Key to these ventures are partnerships and relationships. "Partnerships aren't just one-offs. They create new lasting foundations and accelerate innovation and co-financing models."

Applying this logic, ESA helps orchestrate the space and connectivity sectors present at Harwell Campus, the space cluster, and collaboration with the energy, health and emerging quantum clusters. Harwell Campus lends itself to being one of the most important hubs in the UK, Europe and globally for a truly international and cross-disciplinary collaboration.

"It's not just space geeks working with other space geeks," Elodie laughs. She highlights ESA's work on three accelerators that drive Europe's increased use of space and perfectly align with the UK's and Europe's ambitions in space and the cross collaboration ethos on this unique campus.

"The first accelerator — Space for a Green Future — is focused on the green transition creating tools to help achieve decarbonisation," she explains. "The second — Rapid and Resilient Crisis Response — is working on ultra-fast and secure data exchange so that in case of fire, flood, geopolitical conflict or pandemic the right information is available in real-time to steer the system, zoom in on affected zones and thus make a real and immediate humanitarian impact. The third — Protection of Space Assets — is about protecting space, developing and managing satellites in a sustainable way, manage space traffic and avoid space junk."

"We face many crises," Elodie concludes. "The climate crisis, the health crisis with Covid-19, and complex geopolitical challenges. Space offers us unique tools to work closely with various clusters at Harwell Campus and global sectors. We can apply and leverage them jointly and in lots of different ways."

Space has always lifted humanity's eyes up beyond our planet and made us wonder if we are alone in the universe. But, instead of being a far-flung frontier, space research has actually brought the horizon of exploration closer to home and down to Earth. As the work at Harwell shows, the more we look to space together, the more connected and safe we are.

Bulb



An organic chemist by training, Manisha Kulkarni's 20 years in pharmaceutical drug discovery means she understands scientists' needs better than most. Since joining Bulb seven years ago, she's consulted on projects all over the UK, from two-person incubators to large warehouse conversions where the research improving everyday lives is being conducted. Manisha understands that lab design is about more than just providing space, because no two businesses are the same.

Could you tell us a bit about Bulb and your role there? Why is Bulb important?

Manisha Bulb has been delivering labs for over a decade now. My role is to understand client needs, talk to other teams and translate those needs internally. Scientists are so specialised — when construction people talk to them a lot of things get lost in translation because of the terminology that they use. That's where we come in. We're masters of translation as well as construction and creation.

Why is lab design so important? lab just a lab at the end of the day?

Manisha Not for a scientist. The point is why scientific research happens. Scientific research happens because there are unsolved problems in the market or unmet medical needs to address. Those discoveries need to be separated: all are different from one another and therefore the spaces they're solved in must differ too.

How can lab design optimise a company's performance?

Manisha Business performance is about productivity. One of the fundamental factors for scientists is the place they work in: the research lab. These facilities are where their output comes from: where their value comes from. Plus, they're on their feet all day running from one room to the other — if it is not properly planned and designed there will be a lot of wasted time.

We take that pressure off scientists by designing labs that understand their needs.

How have you helped specific companies in the past?

Manisha We carried out a project in Oxfordshire for a company engaged in drug discovery through automation that required a warehouse to laboratory conversion.

Before they approached us they were working with a regular fit-out company without any scientific knowledge. Because their robotic machinery was so tall, they needed specialist services — a warehouse to laboratory conversion is very complex at the best of times, but this made our understanding even more critical. Had we not been involved to deliver such a sensitive laboratory it may have affected their funding and, ultimately, their credibility in a hugely competitive field.

Could you tell us a bit about what you're doing down at ARC West London?

Manisha We are so excited about ARC West London. This is our first incubator facility in London. The location is amazing. West London is a thriving area for life science

Bulb at a glance

Specialists in laboratory enablement, building feasibility, compliant design and performance specifications with unwavering focus on scientific needs. Partners from conception to completion delivering everything from small scale incubators to large scale warehouse conversions.

Founded:	2006
Industry Membership	UKSPA, OBN, RSC, ISPE
Locations:	Reading, Oxford

research because of Imperial College and the general buzz of activity going on. Plus, you have the Thames running right in front of it, which provides such a beautiful setting.

These are incubator labs for small-sized companies — this could be their first home coming out of university. But equally, this could be space for a global business to explore a new idea too. There will be eight different independent units (60% lab, 40% office) designed for containment level two, which is the most common requirement for life science companies.

What makes these labs flexible?

Manisha Life science companies are like small children — they grow in no time!

So, where possible, we've built doors interconnecting the labs. If there are two different tenants the doors will remain closed, but if one tenant expands and requires the space next door, they don't have to go through the outside corridor. This allows ARC to be much more flexible with their members. Members can see the opportunity to scale and therefore the

potential in ARC West London as a long-term home. It's the ultimate flexibility that benefits everyone

In the incubator space at ARC West London, what kind of businesses do you imagine moving in when they launch this year?

Manisha We expect to see biotech companies who are trying to find new applications in the market. They could be diagnostics companies, they could be medical devices companies, they could be drug discovery companies finding new targets. There was even interest from one company working on battery cell technology for vehicles.

Imagine the year is now 2050, you've just completed your finest ever lab design and fit-out project. What does this lab of the future look like?

Manisha Future labs will be completely technology-driven, and I'm confident they will be highly automated. Fewer and fewer people will be in the laboratories themselves. Instead, they will be operating experiments from the office or even from home. One day, someone on the other side of the planet will be able to run experiments here in ARC West London. Imagine what that could mean for the pace of innovation!

The science of lab design

TOMORROW'S SCIENTISTS ARE LETTING THEIR MINDS

The Institute of Imagination, the UK charity whose mission is to unlock the power of imagination among children, is embarking on its first partnership with ARC.

Science and imagination are in fact two sides of the same coin. One of them is firmly rooted in the physical world: in facts, hypotheses and tangible realities. The other is a lofty space in our minds, untethered from those realities. But it takes a lot of creative thinking to be a good scientist, and that's something that the Institute of Imagination (iOi) is looking to instil with the next generation.

Tom Doust is the co-director of the iOi, a UK-based charity with international reach that's working primarily with children from disadvantaged groups between the ages of 5 and 11. "At the heart of what we do," he says, "is championing the power of imagination." Through a series of immersive experiences, the charity aims to equip children with the skills they need to hit the ground running in our rapidly changing world — and job market. Imagination can play a powerful role in that: according to the World Economic Forum, 65% of children now entering primary school will assume professions that have yet to be created. "We need to start now

Institute of Imagination

A children and families charity that designs and delivers creative learning experiences across the arts, sciences and digital technologies to empower children to believe they can build a just, fair and sustainable world.

Founded: 2005

Location: London

Website: www.ioi.london

to understand what those pathways are into their future careers," he says. "And children need to be part of the process to help design what those pathways are."

Doust is in the midst of finalising the plan for the growth of a programme called RE:CODE, which began as a partnership between LEGO and The Mayor of London and is now joining forces with ARC to roll out into Oxfordshire. The programme introduces students from participating schools to social or environmental challenges that our society is currently facing. Participating students are encouraged to come up with design solutions that tackle their given issue using LEGO robotics kits. "It's got a bit of engineering, a bit of creativity, a bit of ideation," says Doust. "When you compare that to a school environment, that's quite a different experience." It's part of iOi's mission to make up for the skills that aren't typically taught in school. Traditional classroom learning usually has children "taught from the front", before writing an exam to evaluate how well that knowledge has been retained. "Our approach is about coming in and learning by doing," says Doust. Rather than the siloed approach of keeping different

disciplines separate, iOi encourages students to blur the lines between disciplines in order to solve problems. For example, with RE:CODE, they might be using LEGO kits to imagine new solutions to tackle air pollution.

Mutually beneficial partnerships like RE:CODE are key to the iOi's success. Doust is keen to work with partners who understand their vision and who can see how imagination and creativity can be incorporated into their own work. "The spectrum is huge," he says. "At one end we're working with puppeteers and arts companies, and at the other end we're working with virtual or augmented reality companies."

ARC has recognised that iOi aligns with their vision for the future of their campuses. By partnering with iOi, ARC becomes part of a legacy of social impact. "In this first step, the partnership is about supporting ARC with an educational programme that compliments the work at ARC around skills and innovation," says Doust. In the future, the partnership will likely evolve to bring the programme to ARC's clusters.

WANDER TODAY



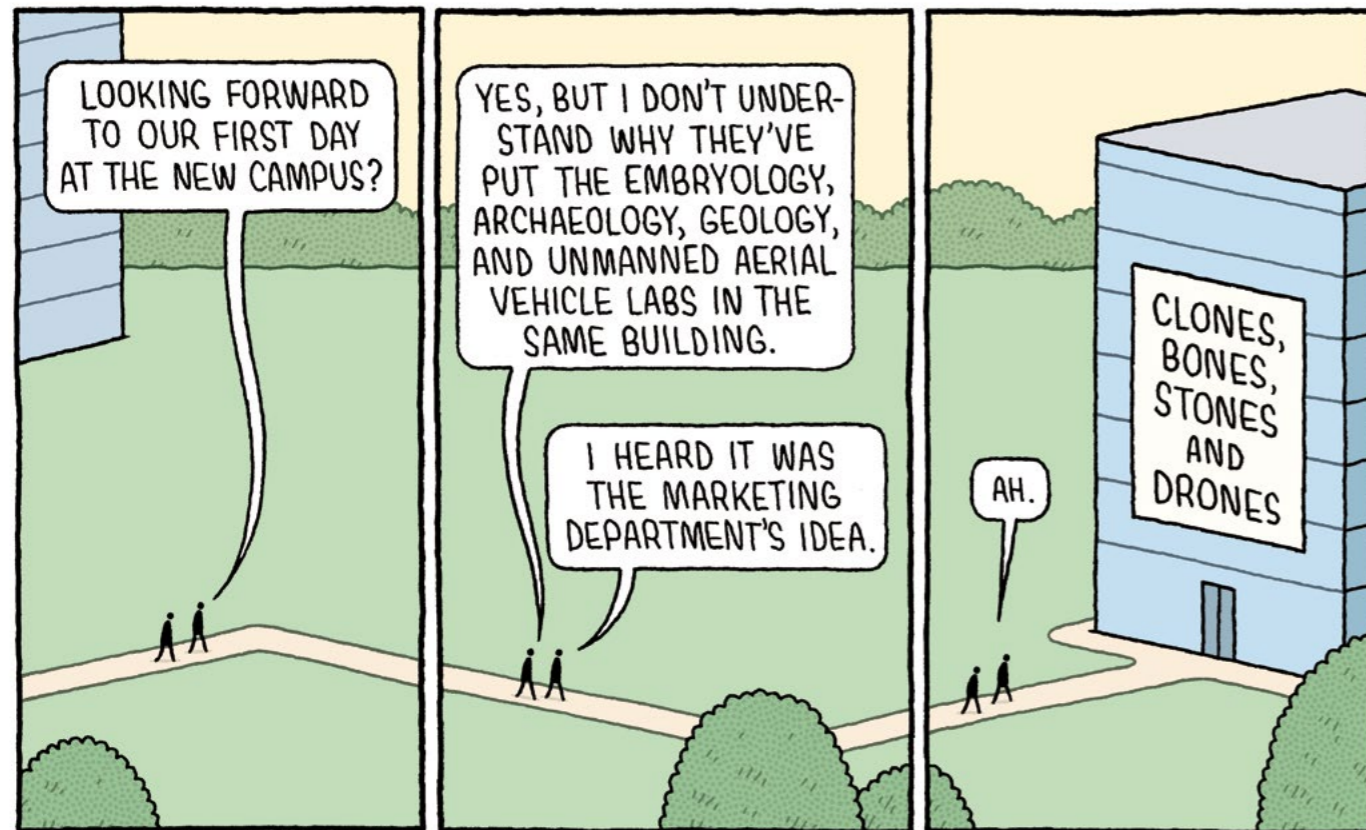
It's possible that the RE:CODE programme will reveal new answers to climate and sustainability challenges. What's certain is that it will empower children to know they have a voice in decision making. It provides the rare opportunity where they are encouraged to let their minds wander — a crucial skill that's often scolded in the classroom. For science and innovation companies, initiatives like this help prime children for innovative thinking — the type of knowhow that could land them at those companies a decade or so later.

Doust acknowledges how tough it is to be a child growing up in 2022. Between the climate crisis, the pandemic and the growing risk of slipping into poverty, his wish for the next generation is to develop resilience. "If we can equip children and young people with the skills to build resilience, to develop confidence, to have the ability to reimagine a future and place themselves within it — that's one of the most important things we can do right now."

“If innovation is about the future, we must first create a better future for innovation”

Thank you to all our contributors	
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Designed and written by dn&co



TOM GAULD for NEW SCIENTIST

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Looking for a new partner?

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