



SOLENT SPACE

On a Mission to Create a Space-Enabled
Future For All



INTRODUCTION

Space is a booming industry for the UK. The nation has 5.1% of the global space sector, with an income of £16.4bn (2018/19); a direct contribution of £6.6bn to UK GDP; and at least £360bn of UK economic activity now supported by satellite services¹. It's become a vital part of the UK's economy and is set to become still more important in multiple facets of our everyday lives as it moves towards the Government's target of 10% (~£40bn) of the global sector to be in the UK by 2030.

The South East (excl. London) is an essential part of the UK's success, with the region having the largest number of space companies of any region at 460, or 24% of the UK total¹. The Solent is an important contributor, containing big corporations like Airbus and BAE Systems and smaller, but equally high-quality space businesses, like Spur Electron. This success is built on a rich history in the region including the High Down rocket test site on the Isle of Wight which, in the 1950s and 60s, was used to test the rockets Black Knight, and Black Arrow that carried the Prospero satellite into orbit. Over time, this legacy has developed into many defence and aerospace businesses being built in the area.

Public perceptions often focus on upstream space such as rockets, spacecraft, and satellites. But much of the excitement is around downstream space, using satellite data for communications, navigation, and Earth observation. Overtly space-related businesses are just the tip of the industry iceberg. Space science and data science are closely linked, and South Hampshire has many downstream space companies which are data-based organisations, consuming satellite data.

The Solent also benefits from non-commercial strengths in space such as the Universities of Portsmouth and Southampton, plus expertise at the Defence Science and Technology Laboratory. The University of Portsmouth is also home to the South Coast Centre of Excellence in Satellite Applications, while inspirational astronaut Tim Peake is an alumnus.

This all adds up to the Solent area being a key player in the UK space industry and an essential part of national ambitions to grow the sector.

Source: 'Size and Health of the UK Space Industry 2020'.



View of Spinnaker Tower from Camber Dock
© Jo Fairwood, University of Portsmouth

VISION FOR THE REGION

The Solent Region is a leading light in the UK space industry, but it has ambitions to become an internationally recognised hub for space manufacturing and innovation. The region aims to offer world-leading capabilities that benefit the space sector, attract other space businesses to the region, and bring economic benefit to South Hampshire and the UK. It is set to achieve this through growing world-leading innovators, start-ups and entrepreneurs, developing the next-generation of space sector specialists, and being home to cutting-edge facilities, research and education.

The region already has many organisations developing, building and creating world-leading technologies. An important area for both the space industry and for the region is satellite remote sensing, navigation and communications. And it has ambitions to grow the already strong network that links businesses, universities, and the public sector to deliver ongoing sustainable growth of the space sector. The South Coast Centre of Excellence in Satellite Applications (SCCoE) is a prime example, based at the University of Portsmouth.

But it is not without its challenges. Brexit has resulted in the loss of some European partnerships and reduced access to some EU research funding programmes. Crucially though,

the UK remains part of the European Space Agency (ESA). However, there is a shortage of a trained and skilled workforce and there is a gap in commercial businesses. Much of the value derived from the UK space sector comes from a small number of multinationals and a large number of very small specialist and start-up companies. But there are few self-sustaining medium-sized companies, very little dedicated, long-term capital, and almost no exemplar entrepreneurs. We need to see businesses scale to fill this gap.

The University of Portsmouth is part of the solution, training and developing people and working with key stakeholders to address this challenge. It also promotes the value of space through research, innovation, outreach, education, and collaboration. South Hampshire's space industry embraces the spirit of enterprise and forward-thinking and with each of these challenges, there is a new opportunity to embrace. The region is building its space businesses impressively and is an exemplar for the rest of the UK.

Space technology can be characterised as looking up and looking down. At the Institute of Cosmology and Gravitation (ICG) we have established an international reputation for our abilities to look up at the cosmos and interpret incredibly complex astronomical data. In contrast, satellites that look down from Space have enormous benefits for our lives on Earth. They deliver navigation and communications across the globe, while Earth observation has an enormous range of applications from logistics to agriculture and healthcare. Here at the University of Portsmouth, we are applying our world-leading expertise in space observation to realise the many benefits that satellites can bring to our world and are committed to continuing to play a key role in supporting and growing our region's Space industry in all its diverse forms.

Professor Graham Galbraith

Vice-Chancellor, University of Portsmouth



3 major Sea Ports.
Solent confirmed as 1
of 8 new UK freeports.
Multiple commercial
and mixed use harbours.

Served by Gatwick
and Heathrow airports.

4 Local Enterprise
Partnerships.
4 enterprise zones,
at >10 sites.

Innovation and test
bed assets include
marine, digital,
agricultural, cyber, 5G.

Array of space
research and
engineering facilities.

Multiple adjacent
industries in domains
including energy, defence,
agriculture, health and
manufacturing.

All relevant investor
categories active
in region.
1 space accelerator.

>5 business schools,
most affiliated with
universities with strong
space credentials.

A VITAL CONTRIBUTION

The University of Portsmouth is playing a critical role in supporting space industries in South Hampshire. It is host to ASTA Technology, the UK's only ESA-accredited provider of space engineering training, and is a founding partner of the Horizons 5G partnership, delivering seamless 5G communications through the integration of satellite, terrestrial, and wi-fi technologies. The University continues to be a lead partner of the South Coast Centre of Excellence for Satellite Applications, which promotes the many benefits and uses of satellite data and technology in the region, while supporting business growth in the space sector. The Centre also plays an important role, bridging both industry and academia, ensuring that real world-benefit is derived from university knowledge and talent.

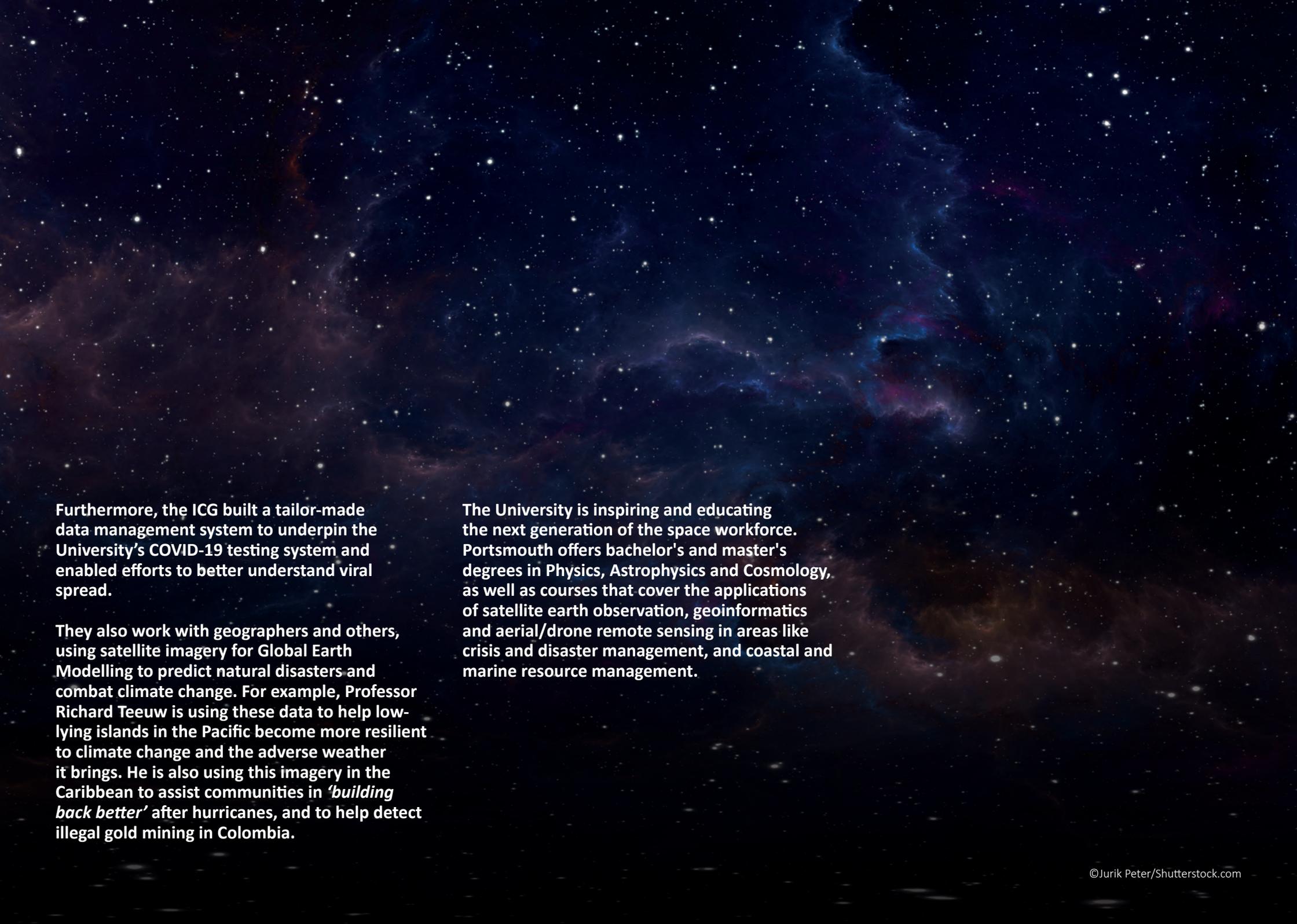
The University participates in an STFC-funded Centre for Doctoral Training, which is designed to develop the next-generation of data intensive scientists. The programme connects businesses with academic expertise providing access to students skilled in particle physics and astrophysics. Furthermore, cutting-edge research takes place at the University's Institute of Cosmology and Gravitation (ICG).

The ICG is a world-leading astronomy centre with an international reputation for research excellence that covers theoretical cosmology, observational cosmology, extragalactic astrophysics, and gravitational waves. The ICG's work mostly focuses on large facilities launched by NASA and ESA, including telescopes like Hubble. The ICG has also been heavily

involved in designing future experiments, most notably Euclid, a space mission to map the Dark Universe.

The ICG leads extensive outreach and public engagement activities in the region including their schools programme, an annual stargazing event, and 3D-printed tactile images of galaxies to make astrophysics accessible to the visually impaired.

ICG scientists are also turning their expertise at analysing astronomical data to problems on Earth. For example, AI algorithms used for detecting exploding stars are being developed to spot significant features in medical images and their changes through time.



Furthermore, the ICG built a tailor-made data management system to underpin the University's COVID-19 testing system and enabled efforts to better understand viral spread.

They also work with geographers and others, using satellite imagery for Global Earth Modelling to predict natural disasters and combat climate change. For example, Professor Richard Teeuw is using these data to help low-lying islands in the Pacific become more resilient to climate change and the adverse weather it brings. He is also using this imagery in the Caribbean to assist communities in *'building back better'* after hurricanes, and to help detect illegal gold mining in Colombia.

The University is inspiring and educating the next generation of the space workforce. Portsmouth offers bachelor's and master's degrees in Physics, Astrophysics and Cosmology, as well as courses that cover the applications of satellite earth observation, geoinformatics and aerial/drone remote sensing in areas like crisis and disaster management, and coastal and marine resource management.

INNOVATING FOR A BETTER WORLD, EMPOWERED BY SATELLITES



The Technopole in Portsmouth, home to the South Coast Centre of Excellence in Satellite Applications © Helen Yates, University of Portsmouth

Businesses
Engaged

143+

Bids
Submitted

23+

Total
Awarded
Grant Value

£8.2 million+

Events
Organised

27

Universities
Engaged

4

Student
Placements Hosted

2

The South Coast Centre of Excellence in Satellite Applications (SCCoE) is striving to create a thriving regional space community, building strong integrated networks that tap into the national ecosystem. Its mission is to promote the continued exploitation of satellite data and technology to allow the South Coast region to gain a competitive advantage in a global market. SCCoE also promotes the South-East as a fantastic place to do business.

Satellite technologies play a vital role in a wide range of industry sectors, transforming businesses. SCCoE is especially keen to embed and grow satellite applications in transport and logistics, autonomous systems, and offshore

assets while utilising cutting-edge technological developments in artificial intelligence, earth observation and navigation, and communications.

Working closely with businesses wanting help and advice to break into the satellite applications industry, SCCoE aims to minimise innovation risk for SMEs. It helps develop collaborative projects, link expertise, share information, and provide network opportunities. It also identifies and attracts funding, with over £8.2million of project funding awarded. There has been a continual growth in the space sector over the last few years and SCCoE have worked with over 140 local businesses in the last three years to assist with this growth. For example, SCCoE supported

Airborne Robotics, Bentley Telecom, Ocean Infinity and the University of Portsmouth on the 'Dr-Suit' (Drone Swarm for Unmanned Inspection of Wind Turbines) project.

The centre provides assistance with consortium building, project development support, bid review, and application preparation. SCCoE has also helped MercariRisk with accessing SPRINT funding for their project '*Satellite enabled digital insurance ecosystem for small farm-holders: Colombia*'. Furthermore, it has worked with Enterprise M3 Local Enterprise Partnership to develop a regional Space cluster in Surrey and Hampshire, which was funded by UK Space Agency.

SCCoE is funded by the Satellite Applications Catapult, the UK Space Agency, and the University of Portsmouth, which is also the lead partner and host of the centre. This integration within the University means SCCoE can access facilities, knowledge and services at the University as well as signposting businesses to University expertise and promoting opportunities for collaboration.

Support by a large consortium of academic, industrial, government and third-sector organisations ensures SCCoE responds to the needs of all those that engage with it and reflects the wide range of sectors benefiting from the space community.

The Solent region has more than 80 companies operating in the space sector.



South Coast
Centre of Excellence in Satellite Applications

UK SPACE AGENCY

CATAPULT
Satellite Applications



SATELLITE IMAGERY

Tackling Climate Change, Disasters, Deforestation and Illegal Mining

Satellite imagery that shows land-cover changes can be used for climate change resilience, urban planning and policing of illegal mining. Richard Teeuw, Professor of Geoinformatics and Disaster Risk Reduction at the University of Portsmouth, is working on a range of projects that use this imagery.

The CommonSensing project, funded by the UK Space Agency, is using freely available satellite imagery to map hazardous terrain for hundreds of populated islands in the Pacific that are at risk from climate change. CommonSensing aims to improve the islanders' resilience, using Data Cubes containing archives of satellite imagery covering the past 40 years.

Richard explains, *'In the tropics there's a lot of cloud cover, which makes it harder to see how an area has changed over time. Search engines and*

machine learning are being used to pick out the cloud-free bits of satellite imagery in any given year, which are then joined together to produce a single cloud-free composite image. It is then possible to see changes over many years, such as coastal erosion or deforestation.'

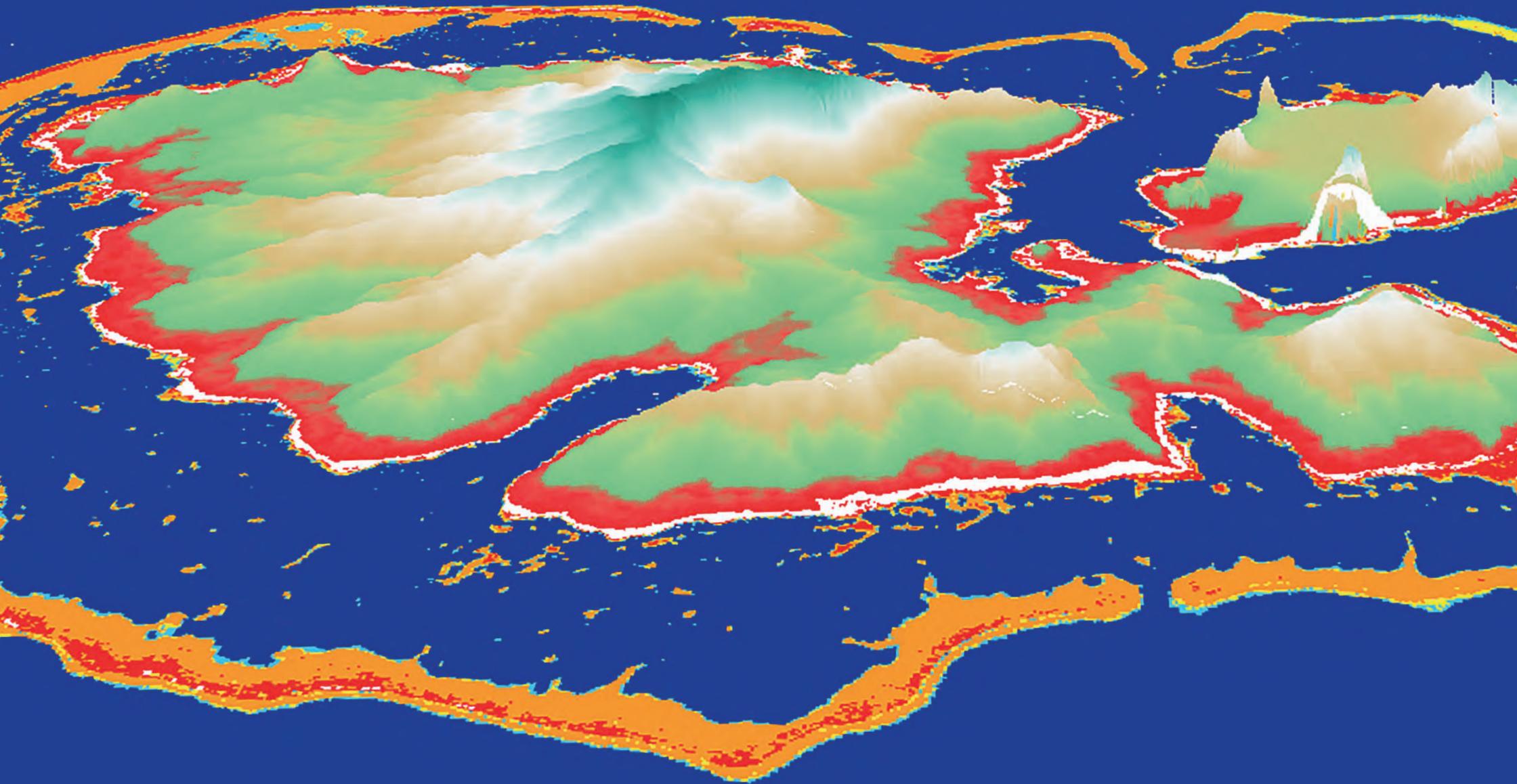
Richard is advising on new satellite-derived data for the Data Cubes, such as elevation maps highlighting areas of steep slopes or flood zones. Another useful dataset is coastal water depth, which can now be automatically mapped from satellite imagery, highlighting coastal communities susceptible to tsunami or storm surge flooding.

Space technologies are also being used in Dominica to guide hurricane resilience. Funded by the Natural Environment Research Council, Richard's team used satellite and drone imagery to map damage from Hurricane Maria. *'Build*

Back Better' recommendations include avoidance of hazardous terrain and constructing bridges designed to cope with deadly debris flows.

Furthermore, satellite remote sensing is enabling detection and monitoring of illegal gold mining in Colombia. Funded by the UKSA and the Economic & Social Research Council, Richard's team used Sentinel radar imagery for weekly monitoring of illegal gold mining and associated deforestation. This helped policing of mining districts, with the radar-based maps giving communities and environmental NGO's evidence for court cases.

We are living in a golden age of freely available detailed satellite imagery, which can help combat many impacts of climate change, reducing risk of disaster, and even assist policing of mining in remote rainforests.



Top left: Bathymetry imagery of Viti Levu island, Fiji: ESA Sentinel 2 © Disaster Risk Reduction team SEGG

Above: Bathymetry and elevation imagery of a Pacific Atoll, ESA Sentinel 2 and PALSAR DEM © Disaster Risk Reduction team SEGG

MAPPING THE DARK UNIVERSE

Euclid is a space telescope designed to explore the dark Universe. Due to launch in 2022, Euclid will map the 3D distribution of up to two billion galaxies and the dark matter associated with them. The ESA mission aims to understand the properties and nature of dark energy and dark matter and why the expansion of the Universe is accelerating.

With a mission time of six years, Euclid will measure this expansion as well as the strength of gravity on cosmological scales. The evolution of the Universe over the past 10 billion years will be investigated. This will allow Euclid scientists to understand the true nature and influence of dark energy on the shapes and locations of galaxies across the Universe.

Nearly 1000 scientists from 100 institutes form the Euclid Consortium, an international collaboration formed to design the Euclid concept and to construct the instruments. The Consortium comprises scientists from across Europe, including France, Germany, and the UK, as well as Canada and a US NASA team of scientists. The scientists of the Euclid Consortium will analyse and interpret the data

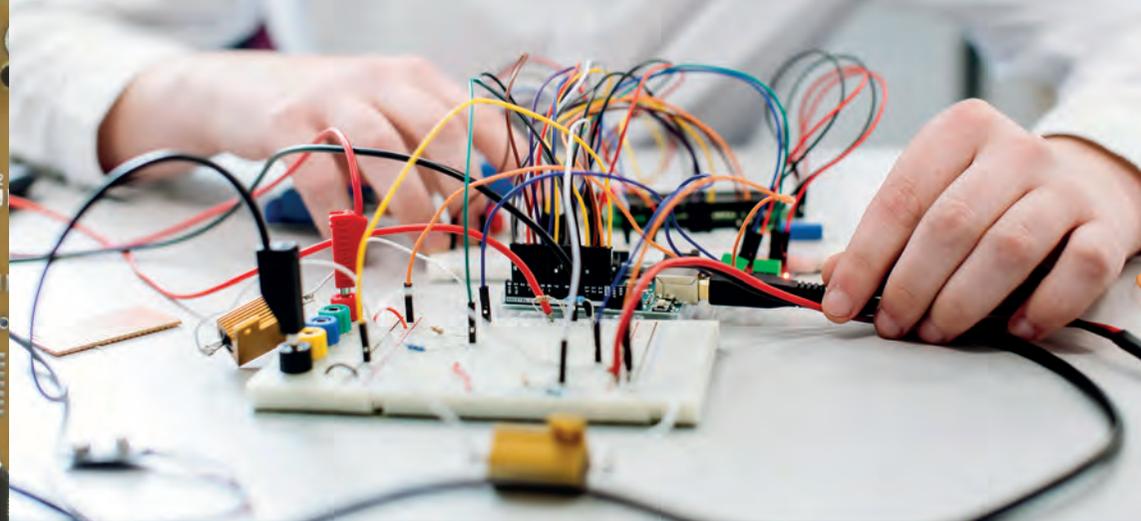
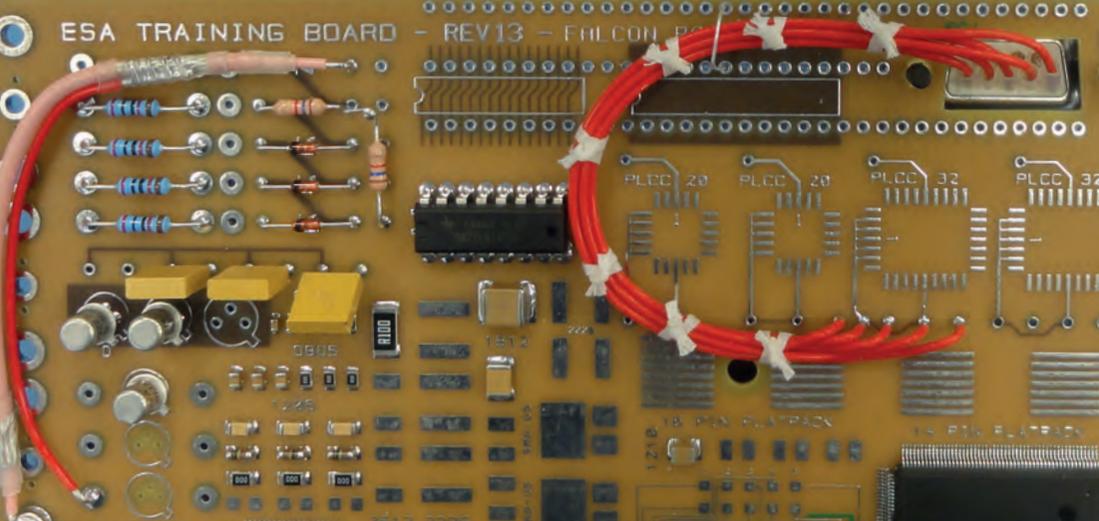
from Euclid. The telescope will observe about 10 billion sources and the complete survey will create hundreds of thousands of images.

The UK has led in the design and building of the visible camera, a key instrument in Euclid. This was possible thanks to exceptional talent in the UK industry and the country's space sector maintaining UK leadership in these pioneering technologies.

The University of Portsmouth's Institute of Cosmology and Gravitation (ICG) has been involved with Euclid since the early design days of the mission. Whilst working at the University, Bob Nichol, Professor of Astrophysics, held several leadership positions including sitting on the Euclid Consortium Board. Meanwhile Adam Amara, Professor of Cosmology, led the science of the precursor mission concept, DUNE: the Dark Universe Explorer, between 2005 and 2008 and was the Euclid project scientist between 2008 and 2011. Because of their significant contributions to the early stage of the mission, Bob and Adam are recognised as Euclid Consortium Founders.

University scientists continue to work on the project today. For example, using Euclid to test new theories of gravity beyond Einstein's theory of general relativity, and using the accurate measurements of a billion galaxies to better understand dark matter and dark energy. They are also working on strong lensing which happens when massive objects like galaxies distort the light of objects behind them; Euclid will discover more new systems than all previous systems combined. The University has also contributed key parts of the experiment's main data analysis pipeline for the spectroscopic instrument.

As one of the international community's flagship cosmology missions for the next decade, Euclid is expected to revolutionise what we know about dark matter and dark energy. The ICG will be at the forefront of these new discoveries.



Electronic ESA Training Board used by ASTA Technologies © ASTA Technologies

Electronic engineering at the University of Portsmouth © Helen Yates, University of Portsmouth

MISSION CRITICAL

Satellites are among the most complex machines ever designed, but in key respects they are still hand-made. A single satellite can carry high numbers of printed circuit boards (PCBs) and soldering is an essential skill to assemble devices onto PCBs, all of which have to go on working perfectly throughout many years in space. Failure is not an option. European Space Agency (ESA) approved certification centres and certify solderers to ensure they have sufficient ability to work on electronic hardware for challenging space missions.

ASTA Technology is the sole accredited ESA certification provider in the UK, and one of only seven in Europe. It provides a range of specialised certification courses for space electronics manufacturing and quality assurance personnel to ECSS (The European Cooperation for Space

Standardization) standards. This is an important element of the fully audited quality chain that must be maintained in order that a space manufacturing organisation may supply electronic sub-systems for an ESA space mission.

Certification to global standards ensures reliability and quality for mission-critical space applications. ESA certification is also recognised beyond the boundaries of the space sector, which is a mark of the training quality being provided. This all adds up to ASTA Technology being uniquely positioned to support the development of skills for the production and quality assurance of high reliability hand-built electronic assemblies for the whole of the UK space industry.

A subsidiary of the University of Portsmouth, ASTA Technology shares a building with the

Faculty of Technology. This has several benefits: University staff and students can access ASTA's specialised facilities; it promotes the space sector to the users and visitors of the building; and it provides access for ASTA to the wider engineering infrastructure and expertise that exists in the building.

Going forward, ASTA technology is striving to unlock access to certification to a wider audience. It is engaged with apprenticeships programmes supported by the (aero)space industry as well as outreach activities to enable these people to gain certification so they can work on ESA programmes, gain experience and contribute to the industry.

DEVELOPING SKILLS TO SUPPORT THE SPACE SECTOR

Strong links with businesses across South Hampshire are benefitting students at Fareham College's dedicated Centre of Excellence in Engineering, Manufacturing and Advanced Skills Training (CEMAST). Larger companies including BAE Systems, Airbus, Hamble Aerostructures and Hants and Sussex Aviation, and smaller SMEs such as ATA Aviation, Bournemouth Avionics and 2Excel all enhance students' learning experience. Options for work experience as well as guest lectures from these companies all add up to a well-rounded and insightful education, preparing students for work in the space sector.

Located in Lee-on-the-Solent, CEMAST opened in 2014 and has become renowned as a pioneering state-of-the-art facility. The College offers a diverse range of manufacturing and engineering courses and apprenticeships, supporting learners to develop skills in manufacturing techniques, aerospace, aeronautical, electrical, electronic and

mechanical engineering and design. Industry-leading workshops, technology, and equipment all provide students with an authentic training environment.

One course on offer is the Space Engineering Technician Apprenticeship. Students work on a range of technologies in this specialist role, including satellites, subsystems for in-space power generation, spacecraft attitude control, thermal control, rocket propulsion, communications, planetary landers, and support systems. On completion, students are ready to support the development, manufacturing, assembly, integration and testing of complex, high value space hardware and ground-based equipment.

CEMAST enjoys an ideal location with the campus being based at Daedalus airfield in South Hampshire between Southampton and Portsmouth. This means businesses across the

South Coast have easy access to its excellent training and facilities thanks to great transport links. Plus its airfield location offers the College the opportunity of direct access to a number of bespoke aerospace organisations.

The College is also working with the South Coast Centre of Excellence in Satellite Applications and local SMEs to explore how the College can utilise its expertise in manufacturing and engineering to support learners in developing the skills required to work in the space industry. This will play an important part in supporting the growing space sector in both South Hampshire and beyond.

I have had a really great experience at Fareham College. My lecturers were very helpful and supportive throughout my whole time studying here. The facilities at the College are state-of-the-art and allowed us to work on real aircrafts, enabling us to advance our skills and develop our learning. I will now be going onto study Aeronautics and Astronautics at Southampton University.

Maria James

Level 3 Extended Diploma in Aeronautical Engineering



The Aero department at Fareham College is outstanding! Studying through lockdown was tough, however I still had great support from my teachers. After leaving Fareham College, I am going to study a master's degree in aeronautics at the University of Brighton.

William Hosell

Level 3 Extended Diploma in Aeronautical Engineering

ACCESSING LOCAL TALENT AND EXPERTISE

Strong ties with suppliers and excellent access to talent from local colleges and universities make South Hampshire the ideal location for Farlington-based Harwin PLC. Add to that links with important OEMs and research centres in the area and it's clear that the benefits are extensive.

Harwin specialises in the design and manufacture of electrical connectors for space and other harsh environment applications, shielding products and related PCB (printed circuit board) hardware. It provides the space industry with high-reliability interconnectors that have a proven track record from launch to the International Space Station, performing under the most extreme environmental conditions of use.

The local area provides Harwin with talented engineers to build their capabilities for the future.

For example, University of Portsmouth graduates help fulfil the company's requirement for a steady supply of engineers and technicians who bring new and fresh approaches into the business, which can change product innovation strategy. This helps bring opportunities for Harwin's products to be used in important platforms, with work in space bringing solutions to problems on Earth. For example, Harwin is helping to resolve global problems such as expanding internet coverage in remote areas and providing better data for disaster management and relief.

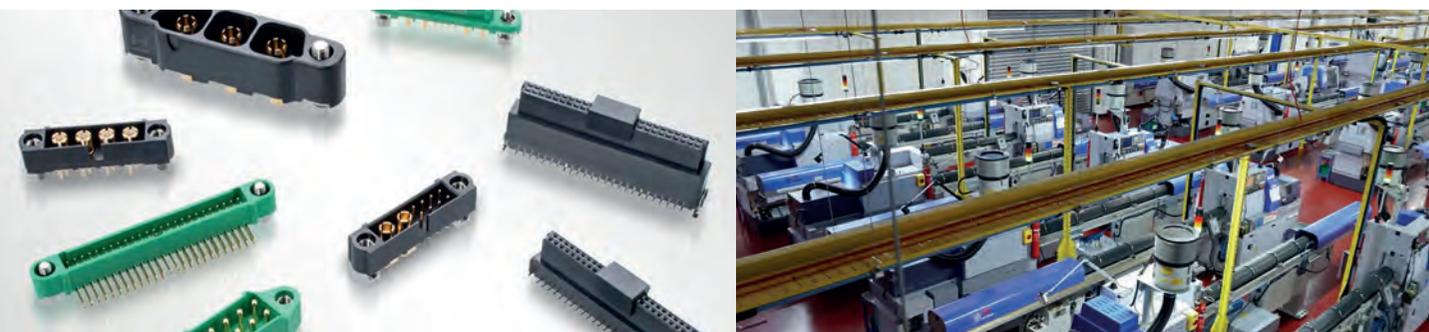
Harwin are passionate about enabling technology and collaborate with the University of Portsmouth on projects, offering sponsorship and support, on projects including:

- Design and test of rocket and propulsion systems

- Micro satellite developments
- Mars Rover challenge
- UAVs and other aerial vehicle technologies

Looking forward, a key area of interest for Harwin is 3D printed technology and material science and working with the University on this will enable them to benefit from expertise and facilities to investigate and validate specific materials for use in some of their manufactured products.

Giorgio Potenza, Head of Business Development at Harwin adds *'We envisage a future where the greatest advancements in each field are combined to solve the most challenging problems, including climate change. We firmly believe that working together to collect, process and share data is the only way to achieve this. Our role is simply to make this possible.'*



High-reliability connectors like those shown here are ideal for numerous space applications, including small satellites © Harwin

Harwin's advanced manufacturing facility in Portsmouth © Harwin

COLLABORATION SHARING SKILLS AND KNOWLEDGE

Expanding the horizons of the South Hampshire space industry is the vision of Havant-based Spur Electron. Their growth strategy includes collaboration, sharing of skills and knowledge, and working together to showcase the area's opportunities. Put together this will bring many opportunities to the region's commercial space industry and enable more companies to get involved in this rapidly growing sector. Spur Electron is well-placed within the industry to capitalise on this growth and to help other companies that would like to join the sector.

For almost 40 years Spur Electron have been involved in Europe's major space programmes including manned space activity such as Spacelab and Space Station Columbus, and deep space missions including the enormously successful Rosetta probe. They are an independent service provider of expertise and skills to the space

and defence industry and are also a Space EEE Component and PCB Assembly Service Provider.

South Hampshire has proven the ideal location for the company thanks to the proximity of universities and companies such as Airbus and SSTL that provide a good local skills base. There are also many local suppliers of goods and services, resulting in a good supply chain. Furthermore, good transport links in the area help with transportation of work between the UK and Europe.

Spur Electron enjoy strong links with local universities, including the University of Portsmouth. Sharing of knowledge is key - academics have proven invaluable in problem solving and, in turn, the company has delivered technical presentations in the Faculty of Technology. The company also gets involved in

events held at the University, in particular the EMPS (Electronic Materials and Processes for Space) which is held there every few years. Being able to be involved in this important event locally is of great benefit to Spur Electron and the local industry.

Cathy Barnes, Managing Director of Spur Electron, adds *'We've successfully recruited via the University's Careers and Employability Service and now we're offering a 1-year industrial placement for a student to assist us with a new ESA study contract. There have been many benefits to our links with the University and I see this relationship as extremely important to our business.'*





National Maritime Systems Centre (NMSC) which houses the offices of Sirius Analysis
© Scott Brownrigg

INNOVATIVE SOLUTIONS TO SUPPORT THE SPACE INDUSTRY

The thriving business community of South Hampshire provides Portsmouth-based Sirius Analysis with potential clients and collaboration partners across government, industry, and academia. Add to this Portsmouth's defence links with the Royal Navy, wider Ministry of Defence (MoD), and associated defence and space industries, and there are significant collaboration opportunities. This prime location is further enhanced by local organisations such as the University of Portsmouth, National Maritime Systems Centre, and the South Coast Centre of Excellence for Satellite Applications.

Sirius Analysis is a technical consultancy specialising in the delivery of innovative analytical solutions to enable customers to make informed decisions. Customers include the MoD, the UK Space Agency (UKSA), NATO and the Defence Science and Technology Laboratory (the research arm of the MOD). Sirius is an agile SME with core skills in operational research, cost analysis and systems engineering, including data analytics and modelling and simulation.

Within the space sector, Sirius provides analytical support to the Skynet 6 programme, which will deliver the next generation of UK military satellites and their ground services. This has included conducting technical analysis and writing key supporting documents for business cases. Sirius also recently won a share of £2m of funding to help the UKSA's Space Based Positioning Navigation and Timing Programme, specifically delivering cost analysis and estimation for the programme.

The opportunity to collaborate with local higher education institutions has also proved beneficial to Sirius. Enjoying strong links with the University of Portsmouth, they have undertaken several collaborative research projects with the University's Centre for Operational Research and Logistics and the School of Computing. Furthermore, Sirius staff have gained critical business skills from participating in the Business School's Small Business Leadership Programme; and the company has used the University's Careers and Employment service to recruit graduates.

'Our vision is to become a leading technical consultancy with an established national and international reputation for excellent critical thinking and analysis' explains Tom Baldwin, Director at Sirius Analysis. *'Sirius will develop and grow from its core technical capabilities, developing collaborative relationships and exploiting new opportunities and innovative technologies, aided by the strong space sector in the region.'*





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