The UK Space Industry

Introduction

Ask most people about the UK Space Industry, and the most common responses are either 'what space industry?' or 'wasn't that something to do with a Beagle or something'?

The latter statement refers to the UK's Beagle 2 spacecraft, destined to land on Mars on Christmas Day 2003. This mission captured the public's imagination due to several factors; its iconoclastic lead scientist Professor Colin Pillinger, and the mission fundraising links with the musicians Blur and the Lander Operations Control Centre at the National Space Centre in Leicester. This was the first time an active spacecraft mission control centre had ever been visible in real-time to the general public.

When contact was lost with Beagle 2 on Christmas Day 2003 it seemed that the whole nation was caught up in the search effort as scientists tried to pin-point what happened to the brave spacecraft in the final landing phase, after a mission lasting several months covering millions of kilometres of deep space travel to another world. When it became clear that Beagle was lost, it seemed that the general public's awareness of UK space activity all but disappeared.

With no official UK astronauts and manned space programme, unlike Russia, China, several European countries and of course the USA, is it any wonder that the general perception is so ill informed?

The UK Space Industry – our best-kept secret!

In fact the UK Space Industry is one of the fastest growing sectors of the country's economy. Employing nearly 19,000 individuals, in 2006-7 the total turnover was nearly £6 billion and has shown accelerating growth rates over the last five years, from 5% in 2004-5 to nearly 8% between 2006 and 2007. The annual turnover of the worldwide space sector is in excess of $200 billion and is forecast to exceed $1 trillion (thousand billion) within 12 years.

In the UK the space industry is extremely diverse and includes university-based groups such as the University of Leicester's Space Research Centre and UCL's Mullard Space Science Laboratory as well as companies such as Infoterra (supplying much of the information used in services including Google Earth amongst others), Surrey Satellite Technology Limited (SSTL) and Avanti. The trade association for the industry is UKSpace with 22 members and the UK Space Directory lists more than 100 companies actively engaged in utilising space-derived products and services.

The UK has no dedicated 'space agency' along the lines of NASA. The British National Space Centre (BNSC) is a partnership of seven Government Departments, two Research Councils, the Met Office and the Technology Strategy Board. It co-ordinates UK civil space activities and represents the UK at the European Space Agency (ESA). The Director-General reports to the UK Minister for Science and Innovation.

What relevance does space have to our everyday lives?

It has been 51 years since the launch of the world's first artificial satellite, the Soviet Union's Sputnik1, in 1957. Driven by the geopolitical ideological struggle between the systems of communism (USSR) and capitalism (USA) known as the 'Cold War', advancements in technology and applications proceeded at breakneck speed.

Project Apollo succeeded in putting humans on the Moon only eight years after Yuri Gagarin's historic 1961 flight into space. In the half century of the Space Age, nearly 500 humans have orbited the Earth, travelling more than five miles every second as they go round the planet every 90 minutes. Thousands of unmanned satellites have been launched into myriad orbital paths around our home planet. Robot spacecraft have explored most parts of the solar system and the great space observatories such as the Hubble Space Telescope have peered out to the edge of the visible universe and back in time to the dawn of creation, nearly 14 billion years ago.

There is no doubt that the scientific discoveries of the Space Age have transformed our understanding of not only our place in the universe but of our own planet itself. Beyond the science, though, what relevance does space have to our everyday lives in the twenty–first century?

Telecommunications

In 1962, the world's first telecommunications satellite, Telstar 1 was launched. Until then, global TV/radio communication was largely non–existent. In the intervening 46 years the situation has been transformed beyond all recognition. Orbiting the Earth, 22,000 miles above the Equator, is a 'ring system' of more than 300 active telecommunications satellites. It's more than just Sky TV and the World Cup that gets beamed down from these. The majority of global finance transactions and an increasing amount of global internet traffic use this network. This network of telecommunications satellites has led to the phenomenon of the 'global village', one in which political events on one part of the planet can have global consequences within hours.

Such is our dependence on satellite telecommunications that some commentators have calculated that if the satellites were all switched off, the global economy would grind to a halt in less than a day! Inmarsat and Avanti Communications are two UK–based companies that are world leaders in this field.

Earth observation

The data collected by meteorological satellites saves tens of thousands of lives each year. Earth observation satellites have given us unique perspectives on the impact of human activities on the state of the atmosphere, land and oceans as well as insights into potential solutions. Humanity has woken up to the challenges posed by climate change and industrial pollution – many of our key discoveries have been possible only through the use of space–borne observation platforms. Leading UK companies in the Earth observation field include Infoterra and Surrey Satellite Technology Limited (SSTL).

Global Positioning System – it's not just 'SatNav'!

Satellite navigation systems rely on precise time measurements from several 'constellations' of satellites, most notably the US Global Positioning System (GPS). Originally developed for use by the military, the last few years have seen an explosive growth in applications of GPS technology. The UK's leading expert in this field, Professor Terry Moore of the University of Nottingham's Institute of Engineering, Surveying and Space Geodesy (IESSG), predicts that within 15 years applications of GPS technology will be as essential to our everyday lives as the 'world wide web'.

The importance of STEM subjects in this sector

Contrary to stereotype there is no such subject as 'rocket science'. Roles within the space sector range from pure scientific research to geographical, engineering, electronics and chemical applications. A key skill sought by employers is a background in a numerically–based discipline such as electronic engineering, mechanical engineering, physics, chemistry or maths but this list is not exhaustive. The ability to apply a wide range of scientific and mathematical skills to complex projects is what is desired along with general business and communication/ presentation skills.

Case Studies – EADS Astrium Graduate Trainees – Ed Bean and Martin Garland

EADS Astrium is the largest satellite manufacturer in Europe. A wholly–owned subsidiary of EADS, the company that builds the A380 'superjumbo', Astrium has over 12,000 employees across Europe with nearly 3,000 employees based in the UK – mainly at Stevenage, Portsmouth and Poynton.

Specialising in the design of satellites, Astrium is involved with telecommunications satellites, earth observation satellites, navigation and military systems, space telescopes and robot explorers destined for other planets in the solar system.

There are two primary routes into the company for young people:

- *Graduate Development Programme (GDP)*
  The GDP is designed for students who have graduated from university with either a Bachelor's degree or a postgraduate qualification. It is a two–year programme tailored to the needs of the individual. Graduate trainees are given an overview of how the company operates and improve their technical knowledge and skills through real work challenges and projects. There are opportunities to work in various technical disciplines and on other sites, including those outside of the UK. Specialised leadership training is built into the GDP in addition to any necessary technical training to develop the future leaders of the business.

- *Apprenticeship*
  The apprentices employed by Astrium tend to have vocational backgrounds, having joined the company after gaining GCSEs, A Levels or a vocational qualification such as a BTEC. The scheme involves spending a year at college full time, before rotating around different engineering and manufacturing departments for a further two years. Apprentices work towards a Foundation Degree in Electrical and Mechanical Engineering and at the end of the Apprenticeship there is an opportunity to study further on a day release basis for a degree.

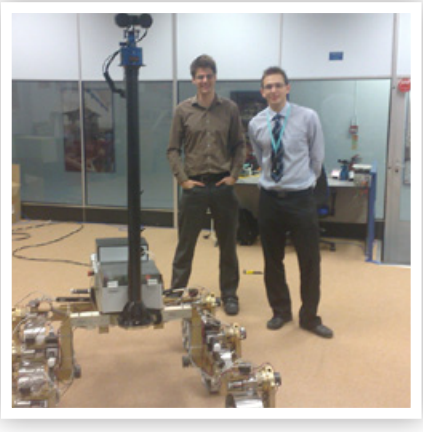
Two of Astrium's GDP trainees, Martin Garland and Ed Bean have, as part of their roles, been involved in showcasing Astrium's work on the ExoMars mission to students at the National Space Centre, Leicester. This is part of Astrium's commitment to supporting STEM education initiatives and the company is proactive in seeking solutions to the workforce supply concerns that are manifest in many parts of the UK science industrial sector.

ExoMars is the first European mission to land a rover vehicle on the surface of Mars and forms part of a much larger solar system exploration strategy called Aurora. The UK is the prime contractor for the ExoMars rover which will traverse the Martian terrain searching for signs of water and life.

The ExoMars rover also carries a drill, the first time such a device has been taken to another planet, which will obtain samples from two metres below the surface because scientists think there may be ice or water buried deep in the rock.

The mission is due for launch in 2016.

Interview – Martin Garland



What interest did you have as a child/ teenager in space/science?

From an early age I was into Lego, (age 18 months I owned my first Lego blocks). This progressed on to more complex parts as I got older; I used to make challenges for myself like design a Lego vehicle that could climb stairs.

I've always been good at building things. In Year 7, my Lego skills were applied to radio–controlled model cars, boats and gliders (made from balsa wood). In the same year, I entered a Young Engineer's competition for best invention, where I made a hovering car model and won first prize for my category.

But it wasn't until Year 10/11 that I discovered a flare for computer programming. At this age IT was taught at GCSE and I had just received a Lego Mindstorms kit (robotic Lego) for Christmas. At this time I also received my first telescope and I often used to look at the moon and be inspired.

What A Levels did you do?

Because of genuine interests and strengths in these subject areas my choices were physics, computing, maths and geography.

What degree did you do?

Degree in Design Technology for Robotics at Staffordshire University.

I would highly recommend this course to anyone who likes a hands–on–approach to learning robotics. Unlike many robotics degrees it is one where students get the chance to build robots in their first year, continuing to do so throughout the course.

For my final year project I made an eight–legged walking robot with terrain adaptation (scratch built) and programmed using a PIC chip. Little did I know that the servos used in my model radio–controlled cars and gliders would become the building blocks for my future robotics projects. The project was highly successful and I won an Institution of Engineering and Technology (IET) competition at the end of the year as well as an award for overall best final year project at Staffordshire University (in engineering and technology).

At university I also had the opportunity to become involved with Staffordshire Setpoint where I helped to develop a Lego activity where children could design and program a Lego rover to collect a mars bar. I also had the opportunity to be a technical judge at the UK national FIRST Lego League final 2007, through Setpoint.

When did you become aware of Astrium's scheme – and how did you become aware?

The first time I heard of Astrium was when I attended a graduate recruitment event at the NEC, Birmingham, in my final year of studies. I had just assembled my eight–legged walking robot and had it walking at this point, so I took it to the event. I showed it working to companies to demonstrate my skills, and soon a lot of employers wanted to talk to me.

I was invited by the event organiser, as a VIP guest, to another graduate recruitment event and this was when I first met Astrium. I was drawn to their stand by a large Mars rover model, and spoke to Paul, who I now work with. Up until this point I still was unsure where I wanted to go with my robotics skills, but as soon as I learnt about Astrium and what they do, and what Paul does for his job I knew I had found it.

My application was successful and I was invited to an interview where I took my now finished eight–legged walking robot, demonstrating terrain adaptation, which I believe played a large part in me securing a job at Astrium.

Staffordshire University was so impressed with my robot that they offered to buy it from me so that they can use it for further development and research. Of course I accepted but asked them to pay me in robot parts so that I could not only make a second but also develop one or two other ideas I had.

When at school, were you aware of the UK space industry?

At school I was very aware of NASA, but did not know about companies such as Astrium or Thales. Because of my specific interest in robotics I have only recently been introduced to such companies.

What have you done since being on the scheme in terms of training?

I joined Astrium in September 2008.

- Aside from the initial introduction, Astrium provides personal development training for every graduate that aims to improve personal skills for working in groups and self–confidence.
- A mentor has been assigned to assist me through the graduate programme and will help me to become a chartered engineer.
- Much of the technical work I do is learnt from other experienced employees on the same project. I am learning all the time, how to design systems used in space and current technical limitations.

What are your specific roles on ExoMars and other Astrium projects?

My job title is mechanisms/robotics engineer. I joined Astrium in the Mechanisms Department as a Direct Entry Graduate, meaning that I do not rotate between departments every six months. However, if I wish to spend six months in another department then this can be considered. This was the ideal situation for me as I knew that my area of interest is robotics and that mechanisms at Astrium cover any electro–mechanical systems which often are featured on the more exotic missions like ExoMars.

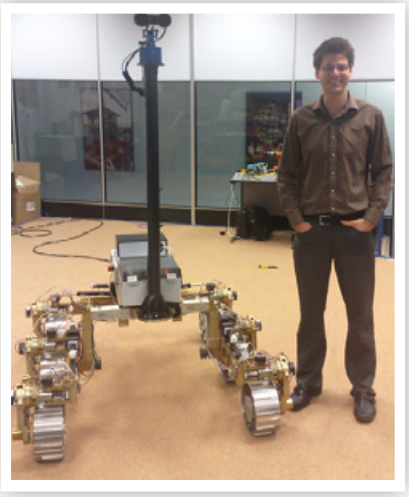
I have recently been involved with the ExoMars team as a result of my area of expertise. So far I have assisted them with general technical issues and PR events. However, my main activity at work is working on a robotics demonstrator project, which aims eventually to lead to a robotics centre at Astrium. The project is currently at stage 1 where off–the–shelf robotic platforms are being developed for later robotics research for missions like ExoMars, Explora and Mars Sample Return. Each day I have the opportunity to work alongside Bridget*, which will later be incorporated into the research and development activity at Astrium.

(* 'Bridget' is the technology demonstrator and test vehicle for the ExoMars rover mission. A six–wheeled robotic spacecraft designed to operate on the Martian surface, 'Bridget' has two robotic test vehicle siblings, 'Bruno' and 'Bradley'.)

What do you see as your potential career path in the next five years?

I would very much like to stay at Astrium and provided that a robotics department or centre emerges there will be a place I will fit comfortably into. Before 2016, I can see myself working on mechanisms for future projects similar to ExoMars and Mars Sample Return. ESA has recently announced that a robotics space centre will be built near Oxford and no doubt the work I will be involved with at Astrium will mean liaising with this centre, further developing my knowledge and expertise.

Interview – Ed Bean



What interest did you have as a child/teenager in space/science?

I was always interested in the unknown, and space and science caught my imagination! One day, I entered a competition to go to Space Camp in America (just like Challenger Centres). It was great fun, and I decided I'd like to do 'space' as a job.

What A Levels did you do?

German, computing, physics and maths.

What degree did you do?

Degree in Physics with Space Science and Space Technology at the University of Leicester.

When did you become aware of Astrium's scheme – and how did you become aware?

I did summer work experience for Astrium during my summer holidays from university after seeing a presentation on Astrium at a science/space conference.

When at school, were you aware of the UK space industry?

I really first became aware of the UK space industry when I was at college and someone mentioned they'd worked at Astrium Portsmouth for their secondary school work experience.

What have you done since being on the scheme in terms of training?

The majority of our training has been personal development. We have four modules which try to make us effective members of an engineering team. I was surprised how heavy the focus is on skills such as communication and team working, rather than engineering itself.

What are your specific roles on ExoMars and other Astrium projects?

My role on ExoMars is to integrate the system that gets the picture from the cameras and sends it to the navigation software which generates 3D maps of the terrain. The software then detects dangerous rocks and high gradient slopes and generates a path to avoid them. I've also spent some time on system engineering for the MIRI (mid infrared instrument) on the James Webb Space Telescope, which will be the successor to Hubble. There are 27 different universities and institutes across Europe and the USA involved in this project, and Astrium is helping to manage everyone's efforts to build the instrument. It was a great experience working with people from different cultures.

What do you see as your potential career path in the next five years?

I'd like to return to my home department (mission systems) where we look at concepts for new missions in the future.

Future prospects

In spite of the economic downturn, latest analyses suggest that the space sector will continue to expand, such is its commercial importance. A major issue is that of workforce supply. In the USA, 2008 marked the year in which 25% of the aerospace industry became eligible for retirement. In the UK an equivalent crisis point has not yet been reached, but a recent BNSC–commissioned study highlights the concerns that employers in the UK space sector have about filling future vacancies. For those choosing to forge a future career in the space sector, with the right qualifications, the sky really is the limit.

Mythbuster

The UK doesn't have a space programme!

See above.

How can I work in the space industry when there are no UK astronauts?

It is true that there have never been any official UK Government–sponsored astronauts. The first Briton in space, Helen Sharman, was participating in a programme backed by the Russian government and private industry. Astronauts such as Michael Foale, Nicholas Patrick and Piers Sellers have either had dual UK/US nationality or had to acquire US citizenship to be eligible for selection as NASA astronauts. The European Space Agency (ESA) does have a manned space programme but, as yet, the UK does not participate. This situation may change and is the subject of a current BNSC study.

Although the number of humans who have ever flown in space since 1961 totals less than 500, the global space industry employs hundreds of thousands of individuals. The issue of workforce supply as outlined above are relevant across the world. Many UK individuals working in the space sector find demand for their skills across the world. As a sector, the UK space industry has the most highly qualified workforce in UK manufacturing (BNSC statistics).

We are way behind the Americans in space science

In several areas, most notably small–satellite technologies and Earth observation systems, UK space scientists are world–leading. SSTL is a UK company whose expertise has drawn the attention of NASA in its planning for future robotic spacecraft missions. Astrium's work on the ExoMars rover will make it the most sophisticated planetary lander spacecraft ever built.

Teflon and Velcro were spin–offs from the space programme

Untrue – both were developed many years before the Space Age began!

Find out more

- AEA – www.aeat.co.uk
- Avanti – www.avantiplc.com
- British National Space Centre (BNSC) – www.bnsc.gov.uk
- EADS Astrium – www.astrium.eads.net
- ESA's ExoMars mission – www.esa.int/esaMI/Aurora/SEM1NVZKQAD_0.html
- European Space Agency (ESA) – www.esa.int
- Infoterra – www.infoterra-global.com
- Inmarsat – www.inmarsat.com
- Mullard Space Science Laboratory, UCL – www.mssl.ucl.ac.uk
- National Space Centre – www.spacecentre.co.uk
- Science and Technology Facilities Council (STFC) – www.scitech.ac.uk
- SciSys – www.scisys.co.uk
- SEA – www.sea.co.uk
- 'Size and Health of the UK Space Industry 2008' (BNSC) – www.bnsc.gov.uk/7060.aspx
- Space Academy Partnership – www.spacecentre.co.uk/academy
- Space Research Centre, University of Leicester – www.src.le.ac.uk
- Surrey Satellite Technology Limited (SSTL) – www.sstl.co.uk
- UK Civil Space Strategy 2008–2012 – www.bnsc.gov.uk/assets/channels/about/UKCSS0812.pdf
- UKSpace – Trade association UK space industry – www.sbac.co.uk/pages/43611913.asp
- UK Space Directory – www.ukspacedirectory.com
- University of Nottingham's Institute of Engineering, Surveying and Space Geodesy (IESSG) – www.nottingham.ac.uk/iessg
- Vega – www.vegaspace.eu

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