Space Academic Network (SPAN) Response to Industrial Strategy Green paper

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The Space Academic Network (SPAN) (206 members from 57 universities representing an academic view on space policy and funding) welcomes the Government plans for an Industrial Strategy (IS).

(SPAN represents academia on the Space Partnership Board)

As a high growth sector, worth £18.9bn growing at +2.7% (Size and Health of UK Space Industry 2023) Space is **hence a critical sub-sector *to the eight industrial strategic sectors identified in the industrial strategy green paper*,** and uses and drives those industrial sector capabilities in its delivery. Space R&D exploits those sector capabilities and helps or requires generation of new capabilities and methods from them.

Although it links to all, in particular Space links strongly to three, namely advanced manufacturing, defence and digital & technologies. Advanced manufacturing relates to the upstream side of Space, namely manufacture of spacecraft, sub-systems, instruments and components, rockets and launch in particular along with emerging capabilities in terms of in Space manufacturing. **Defence** benefits from the dual use nature of Space and potentially the coordinated actions across defence and civil interests along with such aspects as in-orbit servicing, rendezvous and proximity operations, space surveillance and tracking, and in-space manufacturing**. Digital and Technologies** relates to downstream in terms of information and data analysis, fusion, exploitation and mission operations.

Space uses a unique integrated combination of Industry, Academia and Government to deliver, with each providing critical and fundamental roles to the overall success of this sub-sector. Space is part of the National Critical Infrastructure and hence features high on the national risk register because of potential effects of Space Weather on the UK infrastructure and economy. **Space underpins 16% of the UK's GDP (Size and Health 2022 and 2023) and space derived services affect the lives of all citizens**.

Space also has key roles in Government aims of NetZero and Economic Resilience and Diversity. Space enables monitoring of carbon emissions and the possibility of Space Based Solar Power, it supports resilience by providing the capability to monitor the Earth's environment and is a thought leader on the Space Environment and its sustainable use, and diversity.

Space is fundamental to the modern economy (both monetary and knowledge) using and interacting with many areas of industry, its knowledge base and techniques. R&D underpins Space with the end products being information and intelligence via know-how. All of which feed back into Space, industry and R&D enabling growth (a virtuous circle). The derived knowledge set and approaches having applications elsewhere in other sectors and sub-sectors. Capabilities are the key to Space and its growth. These are derived by R&D both knowledge economy and monetary and via commercial products. It is also an industry of the future as Space capabilities evolve in areas such as In-Orbit Servicing, Manufacture, and Assembly (ISAM) a predicted large growth area, noting that these "future" areas will be underwritten by **both** academic and industrial developments. The global space sector is currently nearly $500Bn and is expected to grow to over a $1Tr in the next 5 years (Global Space Report 2023) and

provides a large return on public investment with a quoted rate of £9.8 for every £1 invested for communications in ESA.

Academia underpins industrial growth along the supply chain in the three sectors via:

- Fundamental Research that helps develop and understand next generation manufacturing techniques and new data analysis and processing techniques and their application, including Defence. This includes proposing ideas that will need new methods and technologies driving their development followed by application to other areas.
- Via applied research leading to application and commercialisation including early TRL development work, working with directly with industry and organisations (such as DSTL) on development, via spin-outs, demonstrating the utility of new capabilities, knowledge exchange etc. This includes academia leading and conducting studies on future products, e.g., Radioactive Isotope Power Supplies (RPS) for use in Space, that are then commercialised.
- Enabling a highly skilled workforce by using cutting edge research in training and increasingly providing Continued Professional Development (CPD) for professionals entering Space or needing to upgrade their knowledge base.
- Acting as the anchor institutions for space clusters and regional growth.
- Demonstrating and building UK supply chain capabilities via demonstration components, instruments through subsystems to satellites and via partnerships with other countries. Academia does and can play a key role in building bilateral and multilateral international partnerships that can be a first step in international co-operation and business development.
- Universities and academia becoming more interventionist via initiatives such as NESST at Newcastle, Prism at Portsmouth and Leicester Space Park, building on their activities in applied research etc. and as anchor institutions for clusters (see above) to enable organic growth in UK SMEs through scalability. These activities are critical to the success of commercialisation and scalability.
- Providing expertise on aspects such as law and regulation, policy, ethics and business development

<u>Academia consequently needs to be able to provide input to Government and Industry on Industrial strategy.</u>

We note the proposal of UKspace (Space industry trade body) for a so-called National Space Enterprise (NSE) which will "dock" with the National Industry Strategy Council. In SPAN's view the NSE should be built around selected members of the Civil Servants National Space Board supplemented by members of academia, industry and UKRI to **enable a joined up coherent policy based around long term planning** overcoming the issue and damage of short-term and "silo" based thinking and enabling efficient use of funding. The membership should be based around existing organisations such as UKspace, SPAN, Space Universities Network, UKRI Space Co-ordination Group. This Enterprise providing complementarity and building on and providing work of and to the Space Partnership which will examine policy details, and also gather inputs rather than derive the overall strategy. This concept will ensure new technologies enabled by Space act additively rather than disrupt plans.

Without recognition of Space as a sub-sector then interventions that are required e.g., long term funding for R&D, investment in skills, revision in regulation (currently underway) that are required for

Space growth will not happen and the UK will be impacted by industrial revolutions happening in space related sectors.

We agree with interventions proposed by UKspace to aid growth, namely:

- Long term planning (see National Space Enterprise above)
- Regulation in particular AI and machine learning, data science, energy, launch and propulsion technologies, engineering biology, quantum, robotics, novel materials, nanotechnology, sensors. Noting academia will play a key role in developing these technologies and also regulating them via "the soft sciences" side of academia.
- Co-ordination of skills development with a shop window for training from apprentice to CPD level (including micro-credentials).
- Government as an Anchor customer, please also see comments on Moonshot proposals below.
- An Infrastructure strategy
- An SME and Cluster Strategy

Please see the UKspace submission to the IS consultation for further details on the above.

The UK has many strengths in Space where academia as well as industry has a key role, spelled out above. These link to the three identified strategic industrial sectors from the IS, AM- advanced manufacturing, D&T – data and technologies and D- defence and include:

- Space Science and Exploration. (AM, D&T) UK is 2nd in the World for Space science publications behind the US. Over 60 universities engage in space science and over 40 in ESA science missions. The UK is a leader in instrumentation, mission hardware, technology development and operations as well as theoretical, computational data analysis and related laboratory-based studies. The UK is also a leader in instruments, technologies and rovers for planetary exploration. This includes substantial R&D in robotics and advanced materials linking directly to the IS. Membership of ESA is critical for these activities.
- Earth Applications: Space Data Assurance (D&T, D). The UK is recognized for its leadership in reference standards and trusted information and data quality. A coordinated and near seamless portal to data is required. We note the academic EO data hub commissioned by the National Centre for Earth Observation and the Dynamic Space Portal from the Crown Commercial Services. The lag in using data is noted along with the suggestions from UKspace: for Government to use UK data sources to enhance working practices; the need to raise the status of UK data suppliers by data validation and verification processes; review of the possible over classification of data; the need for a EO data Policy; and the need to counter deep fakes, malicious use of AI and counterfeiting. Again, academia is and can play a major role via R&D.
- Earth Applications: Global Environment Early Warning Systems (AM, D&T, D). There are multiple academic institutions, UK companies and centres at the forefront of the next generation of weather, climate data collection, and monitoring of clean industries, along with disaster and extreme weather and humanitarian crisis management. With data collection from satellites manufactured (upstream), operated and analysed (downstream) within the UK. Understanding of the background science behind the observations is critical to their application. Membership of ESA and Copernicus are key components for this.
- Global Satellite Communications (AM, D&T, D). The UK is host to a number of key players Viasat/Inmarsat, Sky and BT, Intelsat, Avanti, Arqiva, One Web in upstream and downstream activities which relate to the three identified industrial sectors. Satcom underpins £112bn or

5.4% of GDP (AstroAgency Evaluation of UK Global Leadership Feb 2024). This area is supported by academia in terms of new technologies and techniques e.g., next generation quantum, optical communication, on-board and ground based processing as well as satellite, subsystem and component technologies, AI and cyber security. Membership of ESA is critical for R&D activities associated with this.

- Space Domain Awareness (SDA) (AM, D&T, D). This again is an activity that spans from upstream through to downstream and connects to defense. This requires ground facilities as well as space based and data analysis. SDA is an interest of academia with R&D spanning across the three strategic industrial sectors along with research into Space Weather and we note the possible, and in some cases, actual transition from Space Science to operational missions for SDA. Work that links to this includes next generation sensors and computing.
- In-orbit Applications and Space Sustainability (AM, D&T, D). This includes in-orbit servicing, repair, disposal, manufacturing and recycling. Manufacturing being an emerging capability with the possibility of manufacturing unique products in space from high purity novel alloys to protein crystals for medical and pharmaceutical applications to next generation semiconductors. Such manufacturing has also the advantage of reducing costs and CO2 emissions on Earth. Proposals for data centres located in Space will also help the environment and the push to NetZero. Recycling in Space will enable space sustainability which the UK is a thought leader in. Skills in robotics, sensors and advanced manufacturing within the UK including academia make the UK a natural potential leader here if the barriers in terms of skills and funding (Government and ESA) can be overcome. Understanding the Space Environment and its effects on materials is a key component here. ESA again forms an essential element of this along with UK National and Industry investment.
- Position, Navigation and Timing (PNT) (AM, D&T, D). The economy increasing relies on ubiquitous high integrity PNT particularly for emerging autonomous systems and logistics management. Academia assists industry via R&D into augmented services, testbeds, data merging and fusion and new equipment and techniques for reception and exploitation of services.
- Defence (D, AM, D&T). The UK has proposed the ISTARI constellation to enable the UK to have its own sovereign capability in intelligence, surveillance and reconnaissance (ISR) providing Synthetic Aperture Radar (SAR) via the Oberon satellites, high resolution EO via the Juno satellite for ISR and SDA working alongside the recently launched Tyche (visible imaging) satellite, tech demonstrators such as Carbonite 2 and commercial offerings such as Vivid-i. This capability will sit alongside the Skynet 6 secure satcom system, R&D academic and industry based for future defense systems and capabilities and R&D in SDA, Space Weather and understanding the Space environment, given the cross-links between defense and the other areas of strength described here. Advanced manufacturing and Digital and Technologies are integral to Defense.
- Space Transportation and Launch (AM, D&T, D). the ability to launch medium to small payloads in the near future will give the UK a full capability in Space. With developments in sovereign missions, see above and below, and the need to service industry, and emerging areas such as ISAM (see above), then launch is high likely to be a growth area for the future. It links naturally to advanced manufacturing for example additive manufacture of mass efficient structures, new alloys, defence applications, and subsequent use of data. Academia again assists industry via e.g., future propulsion systems (particularly in-orbit), new materials and manufacturing R&D.

MoonShot Type Concepts

The following are possible large scale Moonshot type programmes to illustrate UK capabilities and hence enable or encourage growth and demonstrate the utility and excitement associated with Space. These are not in order of priority.

A UK Small Satellite Sovereign Programme:
To establish a sovereign national programme for the development of new world-leading Space based research and technology demonstration using small satellite technology and missions to accelerate and demonstrate UK leadership. To help drive growth and where appropriate international relationships, see below. To provide a national route for rapid access to space and collect new and unique data sets and enable in-orbit demonstrations. To enable the sector to compete internationally with other space faring nations with well-funded national programmes and to train the next generation of space scientists, industrialists and engineers feeding the *"New Space"* economy. To feed into new international collaborations for example, through UK contributions to bilateral missions, see below. This programme would support all aspects from science through to EO and technology demonstration and aim to utilise UK launch and in particular rideshare where possible. Cost £25m+ per annum.

An expanded bilateral programme
The current bilateral programmes (Science and Exploration, strategic and business focussed) offer the capability of international working with other countries building relationships via "soft power". At the moment these programmes are based around the UK being predominantly a minor or junior partner. There is a desire for the UK to lead missions for example in Science supplementing the ESA programme and enabling the UK to be a "first mover". This can be based around the small sat programme as detailed above, expanded to include an expanded UK bilateral programme. A combined programme would enable the UK to showcase its capabilities and expand them. An envelope of £100m per annum would be a target.

Build a Dual Use System for Use by the UK

Implement the MOD ISTARI constellation (or even add additional duplicate spacecraft) supplemented by a number of UK EO small (to medium) satellites monitoring aspects such as air pollution, the marine environment, water quality, contributions to climate change (e.g., CO2, methane), fire detection, marine security, city environment and use as a dual use system to monitor and protect the UK and population and also export data for use by others. This would be based around UK technology and spacecraft and data processing and analysis capability. Enable a selection of companies to provide the spacecraft to demonstrate and grow UK companies. Utilise UK launch and in particular rideshare where possible.

Fund ideally two or more UK major contributions to world class missions

These include NASA's science missions such as Habitable Worlds Observatory (aimed at detecting habitable worlds and looking for signs of Life around nearby stars), Icy Giant Mission (exploration of Uranus), fund a complete ISRU system based around UK technologies for a lunar mission plus potentially others. We understand discussions are already underway with Government with respect to HWO which has the possibility of changing our view of our place in the Universe and demonstrating use of advanced manufacturing (sensors, optics, structures, testing etc.) and digital and related technologies as well as capturing the public's imagination. All these projects could be in partnership with other countries under UK leadership.