UK Space Exploration Review

Economic Analysis

London Economics

Dr Charlotte Duke

Organized by

European Commission
Enterprise and Industry

esa

Synergies, technology transfer, innovation

Business opportunities from future space exploration investment

- Support to the UK Space Exploration Review
- UK Space Agency 2009

http://www.ukspaceagency.bis.gov.uk/Publications/Space-exploration-reports/13440.aspx

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Objective

- **Identify synergies between space sector investments and non-space sector industries**
- **Important because space requirements due to hostile and remote environments, drive technologies that are low weight, have low energy requirements and high reliability.**
- **Space technologies can supplement or replace humans in terrestrial activities**
- **Likewise space technology can improve performance of physical capital resources**
- **The requirements for space are also requirements on earth in our increasingly sophisticated societies that depend on increasing technology and are faced with constrained resources**

“Spin it in and spin it out”

- **Transfer of technology and knowledge from space sector to non-space sectors can drive productivity in non-space sectors.**
- **Productivity drives competitiveness and leads to economic growth.**
- **The transfer, of course, can happen both ways – “spin-in” and “spin-out”**
- **The transfer is an additional benefit: but can lead to technological leaps (displacement)**
- **Spin-out and innovation is an uncertain by its very nature**

Forecasting future benefits

- **Forecasting is difficult**
- **Estimating the benefits in financial terms of future technology is difficult**
- **However, governments require forecasts of potential benefits and costs for most investments that use public funds**
- **London Economics applied UK Treasury forecasting rules to both space sector businesses and spin-outs to non-space businesses to illustrate benefits to the UK economy of future investment in space exploration**
- **Cost benefit approach: an approved methodology recognised and required by government**

Business opportunities

- Tele-robotic and autonomous drilling on the Moon for scientific purposes and for oil and gas exploration on Earth.
- Low cost launch technology for exploration, terrestrial communications and space tourism.
- In-situ resource utilisation for oxygen production in extra-terrestrial environments and titanium production on Earth.

Business opportunities

- Communications and navigation architecture for lunar exploration.
- Robotics technologies for human exploration and terrestrial food production processes, household/service robots and nuclear decommissioning.
- Medical technologies for human exploration and terrestrial intensive care, acute care and elderly care.

Three examples

1. **Tele-robotic and autonomous drilling on the Moon for scientific purposes and for oil and gas exploration on Earth.**

   Automation: potential to gain access to “high cost”/”impossible” oil reserves.

   Remote operations: drill one-way wells reduces the time to drill, evaluate and trip out (withdraw from the well)

   Self repair coatings: Reduces need to replace drill bits

   Enticing good graduates into a sector perceived as traditionally low tech, possibility of a sponsored astronaut

Forecasting future returns must be stress tested and alternative scenarios modelled. Net Present Values +ve except in extreme scenarios: £4 billion over 30 years.

Examples continued

2. In-situ resource utilisation for oxygen production in extra-terrestrial environments and titanium production on Earth.

Method using inert anodes for separating oxide into pure oxygen and titanium.

Current processes for titanium use carbon anodes generating carbon gases and requiring frequent replacement.

Technology can potentially provide compact, energy efficient oxygen-generation for the Moon and applications for the titanium industry to reduce costs and pollution emissions.

Stress tested: Net Present Value £400 million

Examples continued

3. Medical technologies for human exploration and terrestrial intensive care, acute care and elderly care

Intensive and acute care: Non or minimally invasive telemetry technology and lightweight, robust diagnostic and therapeutic equipment are likely to assist significantly in the diagnostic process.

Ageing population: Physiology of humans in space parallels ageing in terms of bone and cardio vascular deterioration. Hip fractures are a BIG cost per year for many countries.

Stress tested: Net Present Value £400 million

Concluding observations from an independent economist

- Space sector is developed and successful
- There are cross sector relationships, but often informal
- Collect information and data on the magnitude of the synergies when they do happen
- Spin-outs can happen by chance but generally need to be managed
- Need for impact analysis such as cost benefit analyses because space competes for funds with other public sector investments
- While the benefits may be uncertain they are potentially very large