What does the future hold for physics based businesses in Scotland?

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Outline

• The ubiquity of Physics

• Physics and Education

• Aerospace, Defence and Marine

• SELEX Galileo

• Conclusions
The Ubiquity of Physics!

- The reliance of society on technology represents the importance of physics in daily life

- Most engineering industries are underpinned by physics
  - Electronics
  - Aerospace
  - Oil and Gas
  - Communications
  - Computing, including computer games

- Growing contribution in areas not traditionally associated with physics
  - Bio-technology
  - Medicine
  - Finance!

- Extends and enhances our understanding of other areas
  - Agriculture
  - Environment
  - Geology
Physics as a critical enabler for economic growth

• National capacity for physics correlates with economic performance – viewed as a critical enabler for sustainable growth by the UN and World Bank

• Future priorities for Scotland will exhibit a strong underlying dependency on physics
  • Healthcare
  • Renewable energy
  • Sustainable economic growth via ‘knowledge’ industries
  • Transport (low carbon footprint)
  • Environment
  • ‘Smart’ Cities

• Physics based businesses are important - is Scotland planning for success?
  • Education
  • Research
  • Infra-structure
  • Business Culture
Physics Education

• Given the importance of Physics are we educating people correctly?
• The Curriculum for Excellence has many strong points but has adequate resource and investment been made available to deliver the hoped for outcomes?
• The early narrowing of the curriculum will reduce the numbers taking Physics
• Less Physics will reduce the numbers able to take science, engineering and medical courses in FE and University
• What can we in Industry do to publicise the benefits of a strong Physics element within secondary education?
• What is the general perception of Physics within Society?
Aerospace and Defence business is big and global

- Some international metrics – top 6 defence spenders in 2010
  - US $691B More than everyone else together!
  - China $91B
  - Japan $57B
  - UK $55B Significant despite the economy
  - France $53B
  - Saudi Arabia $49B Attractive export market!

- Over 1/3 of expenditure in Western Nations is R&D and Procurement (note UK has highest R&D budget in Europe)

- A big employer – some 333,000 people are employed directly in Aerospace and Defence in the UK, generating some £48B sales

- A very significant contributor to UK exports (£23B); note that UK is no. 2 in world in terms of defence exports (behind the US), with a 22% share of the global defence export market
• ADS (Scotland) estimate that there are 842 businesses active in the AD&M sector in Scotland (note some businesses operate in multiple sectors)
• ADS also estimate that employment in the AD&M sector in Scotland is ~ 40,000
• Total turnover generated by the AD&M sector in Scotland is ~ £5.2B p.a. (Source SE AD&M Industry baseline study 2010)

• Thus the AD&M sector is a major contributor to the Scottish economy, despite a low profile and little political support (defence is a reserved matter)
Scotland’s Defence Strength

- Engineering Tradition – skills and expertise
- Company research base (this factory is 1/5 of Scotland’s BERD)
- Universities- high quality graduate output and strong research base
- Complex military shipbuilding/system integration & MRO
  - BAE SYSTEMS, Babcock Marine…
- Defence electronics
  - SELEX Galileo, BAE SYSTEMS, Thales, Raytheon…..
- Defence Aerospace MRO
  - Rolls Royce, vector Aerospace, Boeing….
- Space Systems
  - Clyde Space, Raytheon…..
- Innovative indigenous SME base with aerospace and defence capability
  - Aardvark clear mine, Dreampact, Prismtech, Helmet Integrated Systems, Luichart technology, Missile & Space Batteries, Penman Engineering, Sarkar Defence Airborne Solutions, Thistle Garments…..
Challenges facing the UK (and Scottish) Defence Industry – SELEX Galileo perspective

- Real term budget cuts in the equipment budget for the foreseeable future due to past over commitment – little discretionary monies available for new programmes

- No new major manned air platform planned post Typhoon and JSF

- The future is unmanned – Medium Altitude Long Endurance (MALE) and Future Combat Air Systems (FCAS) programmes are in their formative stages

- Transfer of defence spending from ‘traditional’ defence to security and resilience – convergence of defence and security

- Cyberspace and cyber security – a growth area

- Importance of export recognised as a sustainers of National Capability

- Anglo-French Defence Cooperation – what will it mean?

- Scottish Independence?
SELEX Galileo - Radar & Advanced Targeting Systems

Ferranti > Marconi > BAE Systems Avionics > SELEX Galileo

Electro-Optics
- Spitfire – Gun Sight
- Tornado / Harrier - TIALD
- IRCM
- Apache – Laser

Radar
- Lightning – AI23
- Typhoon - Captor
- C130 – Seaspray 7500
- Next Gen AESA
Radar and Advanced Targeting Systems in Edinburgh

- Complete capability for design, manufacturing and support for airborne radar and EO sensors
- ~ 1950 employees
- ~ 60% workforce are engineers or specialists
- Turnover ~ £500M (2011)
- Five year plan predicts slow, but sustained growth
- ~ 8% sales invested in new products technologies, market development and infrastructure
- Queens Award for Enterprise in 2010 & 2011
- Excellent relationship with Scottish Public Sector
LINES OF BUSINESS
Radar & Advanced Targeting
# Key Technologies

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Radar

• New Generation of Fire Control and Surveillance radars based on common building blocks

• Enabling technology
  • GaAs MMICs
  • Advanced Microwave Packaging
  • Array Design
  • Compact Receivers
  • Signal Processing
  • Autocode Generation
  • DfM, DUPC
Solid State Lasers

- World leader for high power tactical lasers
  - Selected for Joint Strike Fighter, LM Sniper and NG Litening targeting pods and the Apache helicopter sight
  - Potential volume of ~4000+ lasers

- High Energy Laser Sources
  - Diode pumped solid state lasers for rangefinding, designation & Illumination
  - Oscillator / amplifier architectures
  - Optical parametric oscillator for 1.57\(\mu\)m - “eyesafe” rangefinding.
  - Proven solutions for reliability:
    - Cross Porro resonators,
    - Stable opto-mechanical mounts,
    - Laser diode array
    - DfM, DUPC

- Next generation technology under development
Nexsense C/CE Overview

• Selex Galileo are creating a new line of sensing products for military and adjacent markets (Blue light/First Responders, Security, Law Enforcement, Health and Environmental Monitoring)
• Nexsense C utilises the FAIMS sensor technology which, when combined with SELEX advanced signal processing, can automatically detect and identify chemical threats in the air.

• Nexsense C identifies
  • Toxic Industrial Chemicals (TIC’s)
  • Toxic Organic Compounds (TOC’s)
  • Some higher vapour pressure industrial explosives
  • Explosive taggants/markers
  • Explosives precursor materials such as hydrogen peroxide (used in IED’s)
Technology Evolution

• **Emergent Technologies**
  - Difficult to predict – driven by commercial rather than military needs

• **Market Trends**
  - Cost – competitive pressure, particularly in the export market place
  - Size, Mass, Power, Reliability always a challenge
  - Adoption of COTS
  - Need for information rather than data
    - Transition from federated to integrated sensor payloads
    - Sensor data fusion
    - Networked sensors

• **Core Competencies**
  - Systems Engineering
    - Systems design and specification
    - Algorithms
    - Real time signal processing
    - Modelling and simulation
    - System integration
  - RF and Microwaves Design
  - Optical Design, Laser Physics,
  - DfM, DUPC
To address the wide range of technologies we require a wide range of science, engineering and project management skills on site:

- On site approx: 1200 Engineers and Project Managers managing ~250 active projects (~10% are Physicist by tertiary education)
  - 234 Systems engineers (Radar, EO, Laser, IN, etc)
  - 155 Hardware engineers (Microwave, RF, digital, analog, power etc)
  - 148 Software engineers (C++, ADA, GEDAE etc)
  - 154 Mechanical engineers (Design, Stress, Thermal, Environmental etc)
  - 101 Support engineers (Repair, Publications, Training, Field Service etc)
  - 47 Quality engineers (Product support, FRACAS, Audit etc)
  - 36 Technical Specialists (Technologists, scientists etc)
  - 131 Project Managers (project managers, leaders, Bid Managers etc)
  - 50 Programme Services (Tools specialists, Planners, PM capability etc)
  - 39 Graduates engineers (in training)
  - 90 Test engineers (RF, EO, digital, analog etc)

- Majority qualified to PhD/MSc/BSc typically in Engineering, Physics, Mathematics or Computer Sciences
- Many are Chartered/Fellows within the IET, IMechE, IoP or APM
Current Activities with Universities

- **Universities have a critical role in sustaining our competitive edge**
- **Chairs**
  - SELEX fund an established chair in Signal Processing at Edinburgh University - co-funding by the Royal Academy of Engineering
  - SELEX are funding a chair in Laser Engineering at Heriot Watt University, position being advertised, co-funding by the Royal Academy of Engineering agreed
- **Research & Development**
  - SELEX have supported the establishment of the Fraunhofer Centre for Applied Photonics, core funding from Fraunhofer, SE, Strathclyde Uni and SFC
  - SELEX directly fund many PhD’s in universities and Engineering Doctorate students in the company
  - SELEX have an umbrella contract with Heriot Watt covering research in lasers and electro-optics
  - SELEX are a major industrial player in SU2P - a bridging project partially funded by SE between the Scottish opto/laser community and Stanford/CalTech
  - SELEX are exploring how the new Innovation Centres will add value to our business
- **Teaching**
  - Continuing strong demand for talented, motivated graduates
  - Rigorous focus on basics of maths, physics and engineering science coupled with communications skills
  - Special plea for some focus on analogue and RF/Microwave design!
  - SELEX provide paid placements for students from pre university (Year in Industry) through undergraduate to MSc projects, some 30 pa in Edinburgh
  - SELEX staff post apprenticeship are working towards engineering degrees on a day release basis particularly with Napier University and Engineering Doctorates with Heriot Watt and Edinburgh
Conclusions

• Physics is vital to a modern economy

• Scotland has strength in education, research and some areas of the physics based businesses – is it enough for today….. and tomorrow?

• The AD&M sector employs many physicists in a wide range of roles

• Whilst Physics is an important business enabler, it is not sufficient, to guarantee sustainable growth; success requires a holistic approach combining good Physics, with product innovation, financial resilience, efficient and effective operational delivery, and competent management!
Questions