

DTI Global Watch Secondment

5 months staged over a 12 month period

Final Report

Dr James Young

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Executive Summary

This report summarises the work programme, objectives, benefits, knowledge gained, and positive impact on the employing company of the secondee (Applied Photonics Ltd – APL) during a DTI Global Watch Secondment to the United States. Dr Jim Young (Technical Manager for APL) was seconded to BNFL Instruments Inc at their offices in Santa Fe, New Mexico, USA. Starting with an outline of APL's business strategy in the context of this secondment, the report continues with a summary of the objectives of the secondment together with the work programme which was developed to meet these objectives, the benefits and lessons learned during the secondment, how the acquired knowledge was put to good use by both the secondee and APL, the conclusions and some recommendations are offered for other small companies considering using this scheme. The report concludes with our acknowledgements and a brief list of references to technical presentations given at three international conferences attended during this secondment.

Strategy

The company's mission is *"To be the UK's centre of excellence for the advancement of industrial applications of Laser-Induced Breakdown Spectroscopy and related photonic technologies"*. In order to achieve this, we must continually strive to develop and expand our in-house expertise and capabilities in this field of technology. Accordingly, we must be aware of scientific and technological advancements in this area of technology, in particular the work of the many research groups throughout the USA who are at the forefront of this field. A key area of application of this technology is within the nuclear decommissioning and clean-up industry and hence it is also necessary for us to increase our awareness and understanding of this market area. Our company has a long-standing relationship with BNFL and so when the opportunity arose to team with a BNFL subsidiary company based in the USA (BNFL Instruments Inc.), the possibility existed for us to achieve both of the above objectives. However, it was only with the financial support of the DTI that we were able to send two senior members of staff to work with BNFL Instruments Inc by way of a Global Watch Secondment.

Objectives and Work Programme

Over the last 5 years, Applied Photonics Ltd (APL) has gained considerable experience of deploying its LIBS technology within various industrial environments. During this period, approximately half of the company's business was with the UK nuclear industry. The unique nature of APL's products and services as applied to the remote chemical analysis of radioactive materials, together with the operational experience gained within the nuclear industry, have helped to stimulate interest from outside of the UK and the U.S. nuclear industry in particular. APL believes there are significant market opportunities for their LIBS technology within the U.S. Department of Energy (DoE) funded programme of decommissioning and clean-up of redundant nuclear facilities. The cost of this programme has been estimated by the DoE to be in excess of \$200 billion.

Although APL has considerable experience of the UK nuclear industry, it is unfamiliar with the technologies used and the working practices employed by the U.S. nuclear industry, especially in the area of decommissioning. Accordingly, an objective of this secondment was to learn about the way in which the U.S. nuclear decommissioning programme operates and the technologies currently used to remotely analyse radioactive waste materials. Our host company within the U.S., BNFL Instruments Inc. - a leading supplier of radiometric instrumentation and services to the U.S. nuclear industry, was ideally placed to help us learn about the U.S. nuclear industry.

The principal objectives of this secondment, as set out in our original application to the DTI, may be summarised as follows:

- Gain knowledge about the U.S. nuclear decommissioning programme and how it functions
- Learn about the technology currently used to analyse and characterise radioactive materials (radiometric instrumentation)
- Learn new business skills in bid preparation, technical presentations, dealing with US organisations and customers, and best practice in quality assurance
- Learn about the work of the various US research groups active in the field of LIBS

The work programme, which was produced during the initial period of the secondment, may be summarised as follows:

Month 1 (September 2002)

- Introduction to staff at BNFL Instruments Inc (BII), general familiarisation etc
- Preparations for LIBS 2002 conference (to be held in Orlando, Florida in Sept. 2002)
- Continue to transfer knowledge as outlined in the work programme in the secondment application
- Attend LIBS 2002 conference at end of September 2002

Month 2 (December 2002)

- Work with BII staff as and when required to assist with their proposal writing, technical papers etc. and to learn about radiometric instrumentation as used to characterise radioactive materials
- Help prepare a joint APL / BII technical paper for submission to Waste Management '03 conference (Tucson, Arizona)
- Visit Los Alamos National Laboratory to meet with Dr David Cremers and his LIBS team
- Help prepare a joint APL / BII technical paper for submission to the International High Level Radioactive Waste Management Conference (Las Vegas, Nevada)

Month 3 (February / March 2003)

- Continue working with BII at their Santa Fe offices to learn about radiometric instrumentation, Quality Assurance, bid preparation and working with the US nuclear industry
- Attend Waste Management '03 conference in Tucson, Arizona (late February 2003)
- Visit Catalina Scientific Corporation while in Tucson to learn about their Echelle spectrometer systems
- Attend the International High Level Radioactive Waste Management Conference (Las Vegas, Nevada, late March 2003)

Month 4 (July / August 2003)

- Continue working with BII at their Santa Fe offices to learn about radiometric instrumentation, Quality Assurance, bid preparation and working with the US nuclear industry
- Visit various LIBS research groups throughout the US

Month 5 (November 2003)

- Continue working with BII at their Santa Fe offices to learn about radiometric instrumentation, Quality Assurance, bid preparation and working with the US nuclear industry
- Further visits to LIBS research groups
- Produce Final Report for the DTI

Benefits and Lessons Learned

To help describe the benefits and what has been learned as a result of this secondment, each of the four principal objectives will be considered in turn as follows:

The U.S. nuclear decommissioning programme

By working with BII on bid preparations, technical presentations at conferences and by attending meetings with various organisations currently involved with US nuclear decommissioning work, much was learned about the technical requirements of the industry and the ways in which BII provides its products and services to this market. From an early stage, it became evident that much emphasis is placed on “selling” ones products and services and so considerably more effort is expended on proposal writing and bid preparation than in the UK. It was very interesting to work with a company who have a notable track record of success in this area and hence much was learned from them. The US way of conducting business in nuclear decommissioning seems to be more focussed on teaming with other companies in order to meet the requirements of, for example, a Request for Proposal (RFP) from the US Department of Energy (DoE). The DoE appears to favour a multi-disciplinary and multi-organisation approach to tackling what are often very demanding technical challenges in the nuclear decommissioning arena. The teaming approach to winning contracts is not something we have experience of in the UK and so the lessons learned from BII in this regard are very valuable to us as we would not have had the opportunity to experience this method of working from our operations in the UK. To further increase our exposure to the US nuclear industry, various meetings and technical tours were conducted including:

- A meeting in Las Vegas with a group from Bechtel (a leading contractor to the US DoE) who are working at the Nevada Test Site
- A technical tour of the Yucca Mountain Waste Repository Project (within the Nevada Test Site)
- A meeting in Albuquerque with SEA Inc. – a company involved with various DoE funded projects

Radiometric instrumentation (BII’s technology and services to the US nuclear industry)

BII is a leading provider of radiometric instrumentation to the US nuclear industry. Their products and services span a broad spectrum of technologies including gamma spectroscopy, neutron (active and passive) techniques, alpha particle detection and beta radiation detection. The relatively short duration of this secondment did not allow for a complete familiarisation of all of BII’s technology but a good overview of the capabilities of the more regularly used types of radiometric instrumentation was obtained. A good example of this is BII’s RadScan system which is a transportable gamma detection system integrated with a video camera so as to allow real-time detection of “hot-spots” within a radioactive environment. The system operates by monitoring the gamma ray emissions of radioactive materials and superimposing the location of the emitting material with the colour video camera display. This makes it very easy for an operator to scan across a room or area of plant and produce a recordable video image of the environment together with a colour-coded map of the radioactive materials present within that environment. RadScan is also able to determine the type of radioactive material by recording the spectrum of gamma rays being emitted by the material and conducting an isotopic analysis of the data. There are many parallels between RadScan and APL’s LIBS technology and the potential exists for integrating the technologies to produce a system capable of detecting the radioactive materials (RadScan) and also the non-radioactive materials (LIBS). The techniques used by RadScan to analyse the gamma ray spectra are analogous to the techniques used within APL’s LIBS technology to analyse the atomic and ionic emission spectra derived from a LIBS measurement of a material. By working with BII’s software development team, we were able to glean useful information on the preferred methods of system control and spectral analysis.

Conducting business with the US nuclear industry

This has been touched on above but also extends to Quality Assurance procedures, costing of individual work packages and complete work programmes, report writing, and the provision of manpower at a nuclear site. It is now clear to us that conducting business with the US nuclear industry is greatly facilitated by teaming with a US-based company and preferably a company with experience of the

industry. To attempt to win contracts with the DoE etc from the UK would, in our view, be extremely difficult. Safety is of paramount importance when conducting work for the US nuclear industry, both on and off nuclear sites. A company with anything less than an excellent safety record is unlikely to be considered as a potential contractor to the DoE. For most projects, appropriate Quality Assurance standards are an essential prerequisite for winning business in this area. APL currently does not have ISO 9000 accreditation whereas BII do (they also have other nuclear-specific QA procedures and accreditation). BII were agreeable for us to learn about their ISO 9000 QA procedures and so the opportunity was used to learn from this in order to update and expand APL's existing QA procedures with a view to applying for ISO 9000 accreditation in the near future.

US research groups active in the field of LIBS

Compared to the UK and Europe, there are a significant number of research groups active in LIBS throughout the US. The majority of these groups are known to us and we have met many of the scientists and technologists during our past attendance of international conferences (eg. LIBS 2000 conference held in Pisa, Italy in September 2000 and also LIBS 2002 conference held in Orlando, Florida in September 2002). A brief summary of the visits conducted during this secondment now follows.

1. Visit to Dr David Cremers and his LIBS research group at Los Alamos National Laboratory, New Mexico. After obtaining the necessary permits, a full day was spent with Dr Cremers to see at first hand his laboratories and to be briefed on the current research projects of his team (application of LIBS for a Mars rover vehicle to conduct chemical analysis of the martian planet surface, use of LIBS for analysis of soil to assess carbon sequestration).
2. Catalina Scientific Corporation (Tucson, Arizona). Manufacturer of Echelle spectrographs for use with LIBS. Met Dr Burt Beardsley and spent a full day at their facilities to learn about the capabilities of the spectrograph and also the software used to control the device.
3. Department of Chemistry, University of Florida, Gainesville, Florida. Met with Prof. Jim Winefordner and Dr Ben Smith, toured laboratories and learned more about their current research (use of LIBS to analyse hazardous waste, heavy metal contamination in soil etc)
4. Department of Mechanical Engineering, University of Florida, Gainesville, Florida. Met with Dr David Hahn and colleagues to tour his research facilities and learn more about their current research (use of LIBS for analysing particulate pollution in atmospheric air, detection of heavy-metals in wood).
5. Ocean Optics Inc., Dunedin, Nr Clearwater, Florida. Manufacturers of optical components including optical spectrographs applicable to LIBS. They are very interested in LIBS and have recently been awarded a grant from the US military to develop a highly-portable LIBS instrument suitable for detecting hazardous materials in the field. A tour of their facilities plus meetings with key research staff and the Sales Director, Dr Leeward Bean.
6. Department of Chemistry and Biochemistry, University of South Carolina, Columbia. Met with Dr Mike Angel and colleagues. Tour of facilities followed by giving a presentation to their research team on APL's work on LIBS.

The knowledge gained and lessons learned from the above have been put to good use within APL. It should be noted, however, that the above is an ongoing process for APL and this secondment has acted essentially as a catalyst to stimulate further dialogue and working relationships with people from many of the organisations we have interacted with, in addition to BII. Relevant aspects of the working practices of BII have been introduced to APL. By way of example, we now put much more effort into our proposal writing and, based on what we have learned from BII, have a more structured approach to calculating the costs and profit margins for our contract work in the UK. Since BII is part of a much larger organisation (the BNFL Group of Companies) but being relatively small itself is still able to relate to the problems and challenges faced by small companies such as APL, we developed a very good working relationship with BII during the secondment. This relationship is set to continue beyond the secondment period.

In summary, the secondment has given Dr Young and APL a unique opportunity to gain technical and commercial knowledge directly relevant to the business aspirations of the company. Dr Young has personally benefited greatly from the secondment, in particular the opportunity it has given him to interact with various research groups throughout the US.

Applying the Knowledge

As Dr Young is APL's Technical Manager, it is appropriate that he places more emphasis on gaining technical knowledge during his period of secondment (Dr Whitehouse, APL's Managing Director, is also on secondment to BII and will be concentrating more on the commercial aspects of working in the US). To assist with the transfer of technical knowledge to APL, Dr Young has produced a report which reviews all the US LIBS research groups known to us, paying particular attention to those visited. The report summaries the research work of each group, provides references to their scientific publications and gives names and contact details of the scientific staff.

The most important finding to date is that of the research work of Dr David Hahn (University of Florida, Gainesville) where they investigated the use of LIBS for the detection of heavy-metals in wood. In September of this year, we were approached by the Timber Research and Development Association (TRADA – UK based organisation) who were interested to learn about the feasibility of applying LIBS to the rapid detection of CCA-based preservatives in wood (CCA – chromated copper arsenate). We have since established that, as a result of recent European legislation, CCA-treated wood waste is to be classed as hazardous waste since it contains significant quantities of hexavalent chromium and arsenic – both are known poisons. We subsequently conducted our own experiments which confirmed that LIBS is capable of differentiating CCA-treated wood from untreated wood. In November, APL applied to the DTI for a research and development grant aimed at assessing the feasibility of applying LIBS for rapid, on-line sorting of CCA-treated wood waste. The key factors influencing the feasibility are i) the speed of the measurement must be sufficient to make the sorting process commercially viable and ii) the reliability of identification. If our application to the DTI is successful, the feasibility study will commence in January or February 2004.

There are many other examples of where knowledge gained during this secondment has had a significant and positive impact on the research efforts and business of APL. Some of these are of a commercially sensitive nature and so cannot be disclosed in this report.

Note

The work programme was conducted to plan with the exception of month 5 which did not take place due to Dr Young leaving APL at the end of August 2003. Hence the secondment was only of 4 months duration rather than the planned 5 months. Dr Young is currently employed as Technology Manager at Leeds University and remains in close contact with his former colleagues at APL. Although Dr Young's departure from APL was a great loss to the company, the skills learned during the secondment have been effectively taken up by APL and we consider that the objectives of the secondment have been fully met. The skills and experiences gained by Dr Young during this secondment will benefit him greatly in his future career.

Conclusions and Recommendations

All the objectives set out at the commencement of this secondment have been met. Dr Young has benefited immensely from this secondment in terms of personal development while APL has likewise benefited from gaining valuable technical and commercial know-how relevant to the business aims of the company. Some of the knowledge gained has already been put to good effect within APL, for example, improved proposal writing, better methods of calculating contract costs and profits, technical report writing and presentation skills, QA procedures, future direction of our internal R&D programme etc.

We would have no doubt in recommending to other organisations that they take advantage of the Global Watch Secondment scheme as we are absolutely delighted with the benefits we have gained from this scheme. For very small companies like ours, however, we would offer the following advice:

1. Do not underestimate the short-term negative impact on your business of sending a key member of staff on an extended secondment. We partially overcame this problem by conducting a staged secondment whereby the secondee spends between 1 and 2 months with the host company followed by a similar period of time back in the UK. The negative impact of this is that the cost to the company increases (eg. apartment rent had to be paid whether or not the secondee was in the US, additional flight costs) and the secondee had to endure significant periods of travelling (in our case, total travel one-way was approaching 24 hours).
2. Allow sufficient time to find suitable accommodation (increased security measures in the US as a result of the terrorist attacks of 11 September 2001 have made it much more difficult for foreign nationals to obtain accommodation). It helps significantly if you have a US Social Security number – this can only be obtained after your visa is issued.
3. Ensure that you have a detailed work programme before commencing the secondment and that the work programme is endorsed by your host company.

Acknowledgements

Our sincere thanks go to Liz Chambers of the DTI who was instrumental in making this secondment a reality. Her friendly and supportive manner throughout all stages of this secondment – from initial application through to preparing the final report – has helped to make this secondment a great success for our company. Our thanks also go to Stuart Fuller, Bill Powrie and Roger Benson of the Small Business Service and also to Craig Wallbank of the DTI, each of whom have provided much-needed advice and constant encouragement throughout all stages of this secondment. We are indebted to our host company, BNFL Instruments Inc., for their generous help and support in providing us with office space and allowing us to become intimately involved with their business throughout this secondment. Last but not least, our thanks go to Rachel Knights whose tireless efforts to keep track of expenditure, manage the logistics and undertake the administrative tasks needed to maintain the smooth and efficient running of this secondment are gratefully appreciated.

References

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Dr Andrew I. Whitehouse
Managing Director

For and on behalf of Dr Jim Young and Applied Photonics Ltd

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