The Development of Explosives Competencies, Training and Education in the UK

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Abstract

Competent explosives workers in the Armed Forces and in the civil sector are critical to the safe production, testing and use of explosives. Moreover we need competent explosives specialists to combat the challenge from terrorism and clean up the planet from the explosive hazards that are the legacy of past conflicts. Unfortunately many countries are witnessing a significant loss of capability in this area and are looking at ways of replenishing vital expertise.

This paper describes the work done in recent years by the authors and others in the UK to establish numbers of people working in the sector and to consider the skills and knowledge required to carry out their work. It outlines the concept of national occupational standards and the framework of professional and vocational qualifications that are available or are being developed for explosives specialists. It also describes some of the educational and e-learning programmes designed to support this initiative. Ultimately the aim is to address the professionalism of all personnel who deal with explosives in order to reduce the incidence and consequence of accidents and maintain national capability.

Introduction

Explosives confront humanity with some significant challenges. Accidents involving explosives continue to claim many lives whilst terrorist and insurgent use of explosives represents a major threat to civilian populations and to our Armed Forces. Added to this is the challenge of clearing the legacy of conflict in the form of land mines and other unexploded ordnance. Tackling these problems requires people with a sound understanding of explosives science and technology. This same knowledge is required to sustain the successful and legitimate development, manufacture, use and disposal of explosives. Several nations have expressed concern about the availability of explosives specialists and there are a number of initiatives being taken around the world to address this problem.

At the 32nd DDESB Seminar in Philadelphia the progress being made in the UK in developing competencies for explosives workers in both the civil and military sectors was reported (reference 1). Competencies, or in this case Occupational Standards, have been developed for workers across the sector and progress is being made to develop qualifications based on these standards. This paper describes three related initiatives that build on this ground breaking work. The first of these relates to the methodology that has been developed to determine the numbers of engineers and scientists that will need to be trained in order for the sector to maintain its high safety standards and to sustain successful business activity. In the case of the Ministry of Defence it needs also to maintain its intelligent customer and responsible owner role in managing the acquisition, storage, testing, maintenance and use of explosives ordnance. The second explores how this cadre of engineers and scientists could achieve professional engineer status through changes in the status and role of the UK engineering institutions. The third initiative explores how e-learning could be used to help regenerate the population of explosives engineers and scientists required in the UK defence sector.

Manpower Planning

If qualifications are to be developed for explosives workers then it is prudent to establish the numbers of candidates that might wish to pursue them. Currently there is a broad estimate of the numbers of workers in each occupational grouping based on the occupational mapping process described previously (reference 1). However the occupational map is a snapshot in time and does not reflect the changing nature of the explosives workforce in the UK. Concerns have been expressed in the UK and in Europe (reference 2) that there is a demographic trough and that both industry and government are likely to see a shortage of suitably qualified and experienced explosive specialists to sustain their activities. What is needed is a more accurate assessment of the skills needs of the sector to inform recruitment decisions and training needs.

Several methods for establishing the required information were considered, which included a more detailed questionnaire than that used in the original occupational mapping process. This would be sent to all staff in major employing organisations to capture detailed information about their specialism, age, grade, employment history, promotions etc. It was concluded that this approach was impracticable because it was thought to be too intrusive and detailed.

An alternative was to build a staff and grade profile from data contained on corporate human resource information systems. Using the MOD civilian sector as a pilot a methodology was developed which gave a profile of the likely staff numbers over the next ten years. A spreadsheet was developed which gave the population of people in each grade band in different age groupings as shown in Figure 1.

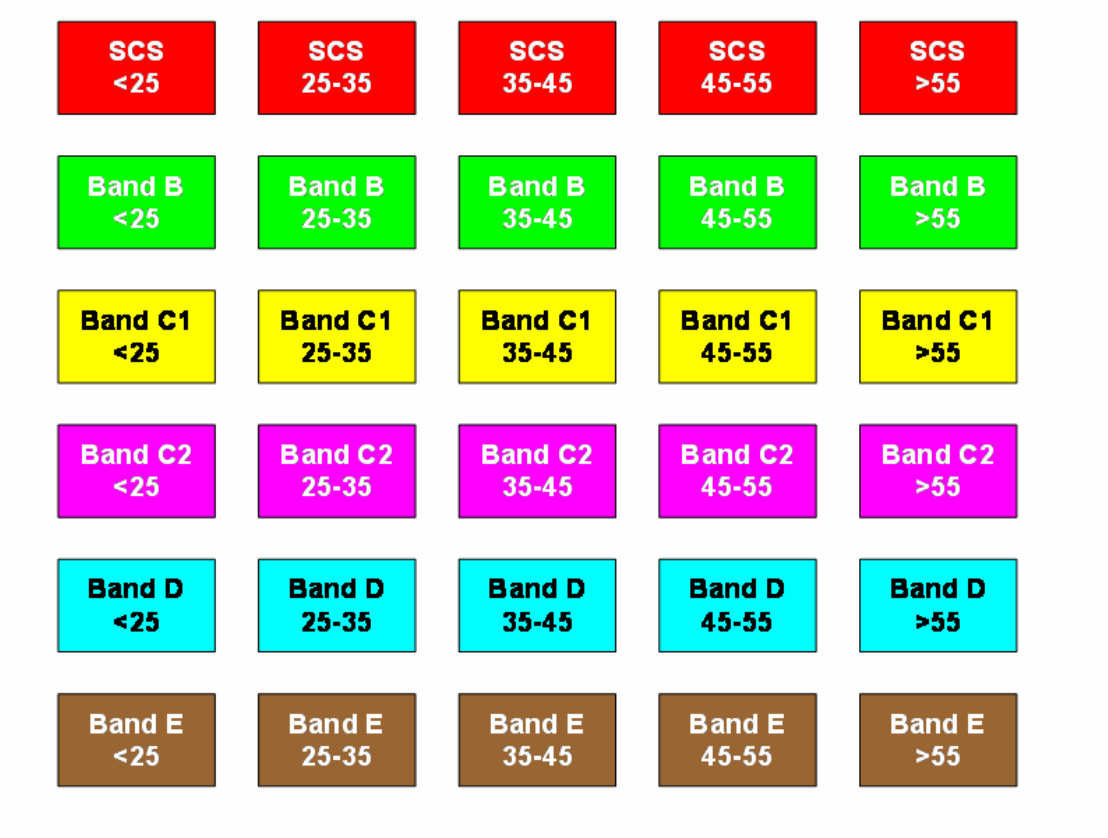

Figure 1 – MOD Civilian Grade Bands

The top band (SCS) equates to the US executive service or military 1 star and the lowest band E is junior technician level.

To populate the spreadsheet over a ten year period assumptions had to be made about recruitment, retirements, transfers in and out and resignations. The process was broadly as shown in figure 2. Starting from the current numbers in any grade new recruits or personnel transferred into that grade in year one are then added. At the same time those who retire, resign or are transferred out in the course of that same year are deducted. By that means the numbers in the grade at year 1 can be deduced.

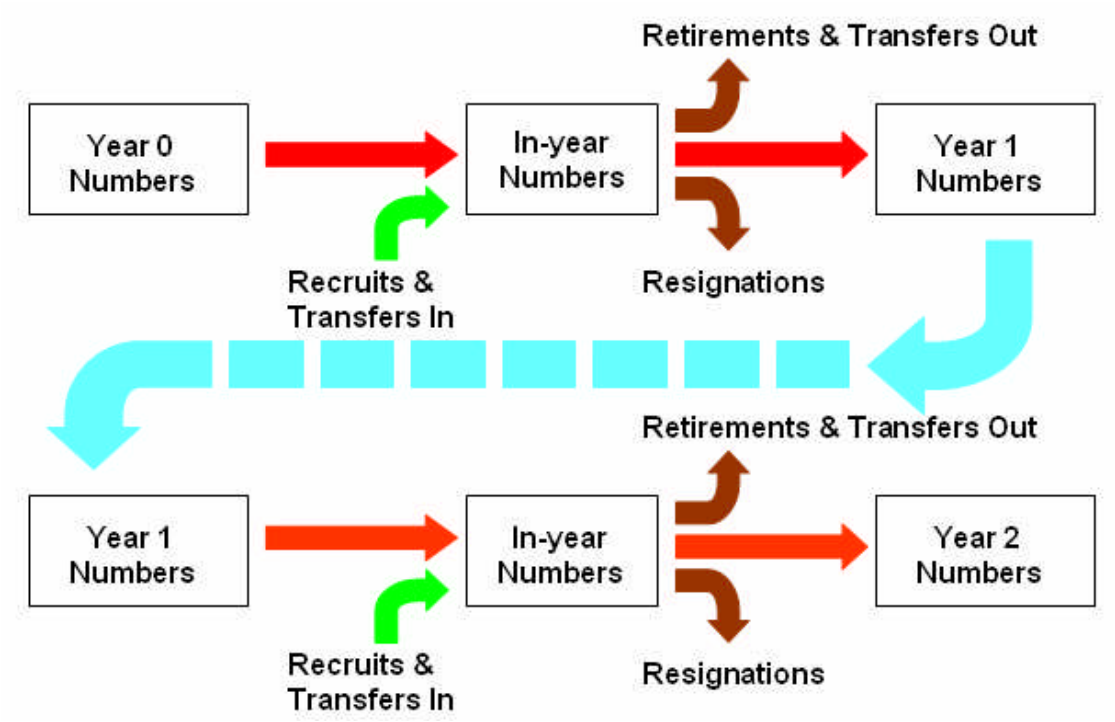

Figure 2 – Development of staff profile with time

The process is repeated up to year 10. However it does not account for age or for promotion. By doing so a more accurate picture can be created.

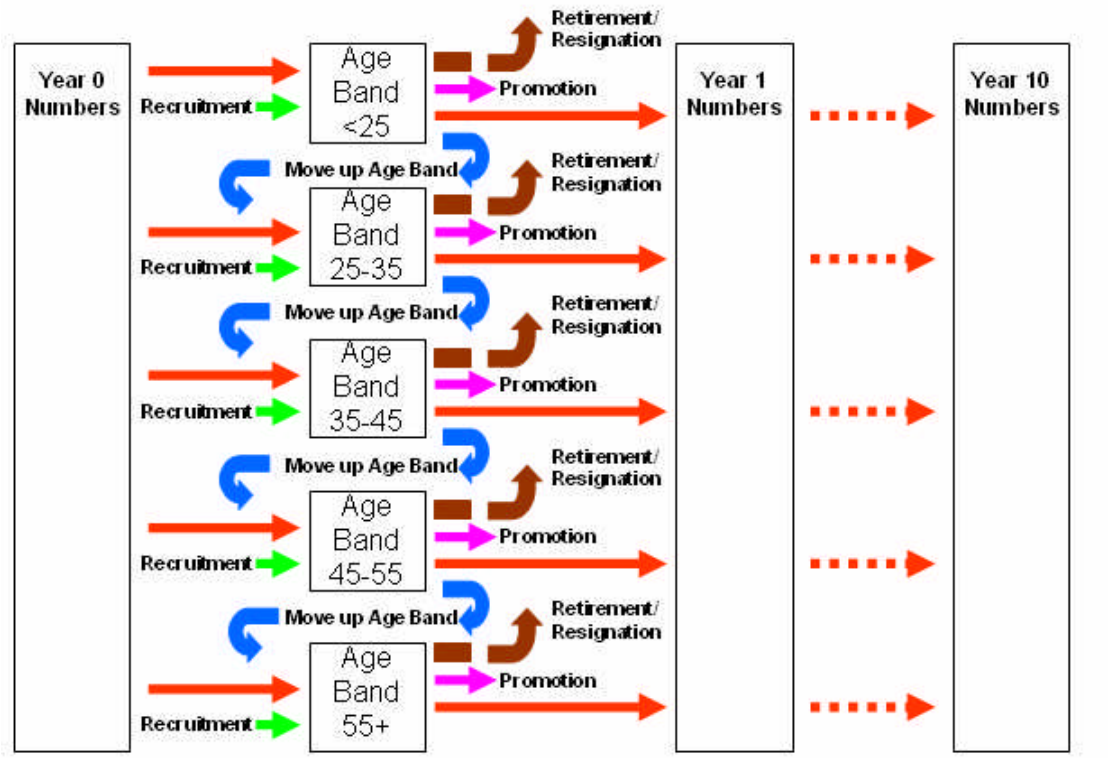

Figure 3 – Accounting for Age

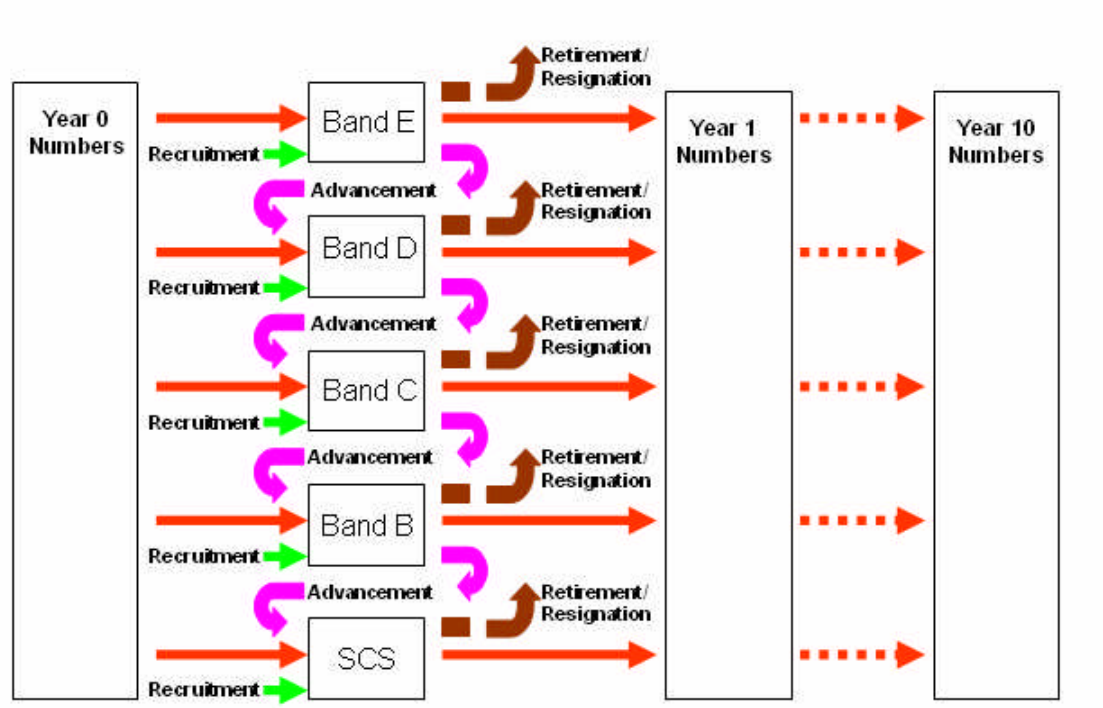

Figure 4 – Accounting for Advancement

Once the spreadsheet is populated the forward looking profile can be seen and how it will be influenced by recruitment, promotions, transfers etc.

Assuming typical recruitment, promotion and resignation rates figure 5 illustrates how the staff profile will change over the next ten years.

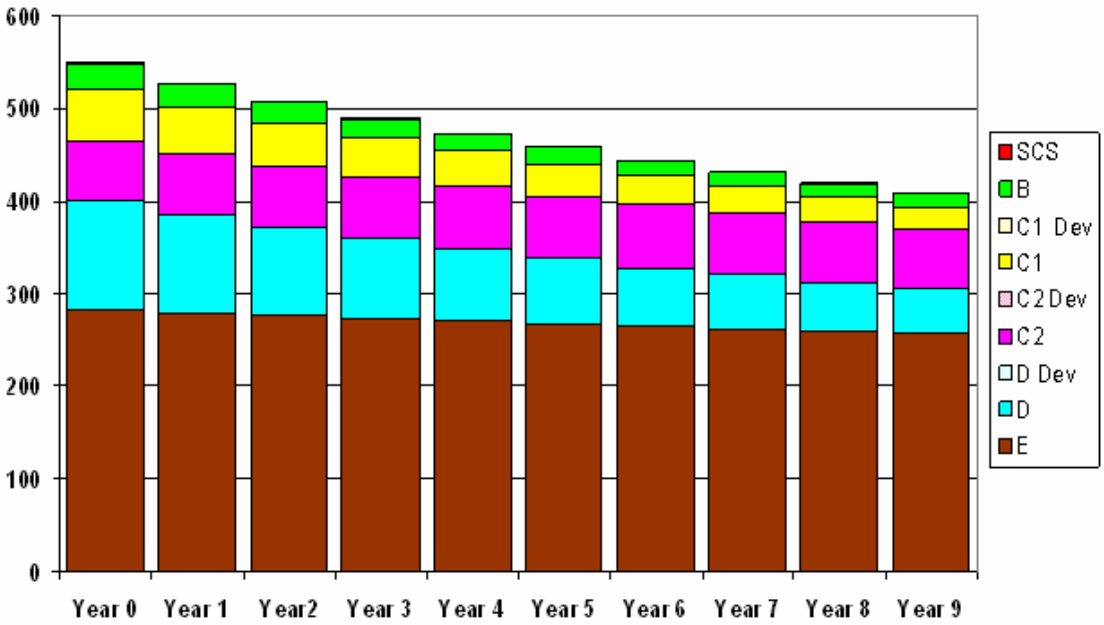

Figure 5 – Potential Future Staff Profile

On the assumption that the business will require roughly the same numbers of people in ten years time that it does today it is clear that typical recruitment, transfer and advancement rates will fail to satisfy the needs of the future business especially in the D and C1 bands. There will therefore have to be some management intervention to achieve the required staffing profile for future years. The business requirement for staff may be met by a number of methods such as the introduction of a development programme which fast tracks individuals through training and job placement schemes. Alternatively cash incentives may be used to encourage retention and recruitment into the explosives sector.

The methodology that has been developed is based on data held on corporate HR systems, is inexpensive and simple to use and allows a range of "what if" scenarios to be played out. It can be applied to all businesses in the explosives sector and could provide a more accurate picture not just of individual business needs but of whole sectors or nations. This information will be essential to inform an accurate assessment of training needs.

Professionalising the Explosives Sector

The Engineering Council of the United Kingdom (ECUK) is the organisation responsible, under its Royal Charter, for licensing engineering institutions to allow them to assess candidates for inclusion on its Register of professional engineers and technicians and to accredit academic programmes and professional development schemes. There are 36 such institutions in the UK including the The Institute of Mechanical Engineers, Institution of Civil Engineers, Institute of Nuclear Engineers, etc. In addition there are 14 Professional Affiliates that are organisations recognised by the ECUK often linked to the licensed bodies. The affilliates also support the development of engineering professions in a specialist sector.

There are three levels of professional recognition in the UK:

- Chartered Engineer (CEng)
- Incorporated Engineers (IEng)
- Engineering Technician (EngTech)

To gain such status candidates must satisfy the relevant institute that they meet the necessary level of competence appropriate for that level of recognition.

In the explosives sector in the UK there is no single institute or affiliate with powers to award professional status to explosives engineers or technicians. The UK's Institute of Explosives Engineers (IExpE) has evolved from being a trade association to something that now resembles a professional body. With a membership of around 1000 the IExpE is now well placed to become either a member of the Enginneering Council or a Professional Affiliate and hence be able to award professional status on those members that meet the appropriate professional standards.

The standards that have to be met by explosives engineers are the generic standards specified for Chartered and Incorporated Engineers and for Engineering Technicians in the UK-SPEC (reference 3). In addition candidates will need to satisfy the Institute that they are are competent in explosives engineering topics. The National

Occupational Standards developed by the UK Standards Setting Body for Explosives Substances and Articles (reference 1) would provide a sound basis on which to judge the competence of explosives workers.

Work is still to be done but the IExpE has taken the first step by seeking to become a Professional Affilliate of the ECUK. The next step will then be to become a licensed member or to link to an existing licensed institute. Ultimately the IExpE will need to satisfy the Council that it has appropriate assessment schemes based on relevant standards to be able to award professional status to candidates from the explosives field. Within the next few years it is hoped that within the UK we will see the emergence of the first Chartered and Incorporated Explosives Engineeers and Explosives Engineering Technicians.

Explosives E-Learning

To become recognised, candidates will need to demonstrate their competence. This would usually require provision of evidence of appropriate qualifications. There are currently few qualifications available for explosives workers. Cranfield University offers Masters programmes in Explosives Ordnance Engineering, Guided Weapon Systems and in Gun Systems Design all of which include explosives modules. These courses are delivered in the UK and require at least one years full time study or can be taken part time over a maximum of five years. Employers are often reluctant to release individuals for extended periods of study hence the total number of students who graduate with these masters programmes is of the order of 40-50 per annum from around the world. The figure for the UK is around 10 per annum which is insufficient to satisfy the needs of the sector.

More recently with the emergence in the UK of National Occupational Standards for Explosives Substances and Articles, new Vocational Qualifications have been developed. These were described in outline at the 32nd Explosives Safety Seminar (reference 1) and have now been launched in the UK. However before these qualifications can be offered to candidates a significant assessment and validation infrastrucure needs to be introduced. The investment costs of doing so are not insubstantial and the financial viablity of an NVQ scheme will depend to an extent on the numbers of candidates who require the qualification. At present there is no accurate picture of the numbers of workers who might embark on the NVQ scheme in the UK.

In the meantime Cranfield has been exploring ways of making explosives education more accessible. Masters programmes consist of discreet modules which can be studied as short courses. Some of these have been accredited by the Institute of Mechanical Engineers and can be credited towards professional recognition. However, at present, these courses require the students to attend the University to complete the course and to have their knowledge assessed. To further extend access work has commenced to develop online explosives courses directed both towards the Masters and the vocational qualifications sectors.

Delivering explosives education online presents a number of problems which have been addressed over the past few months. Firstly course providers must be confident that the student registering for the course has a legitimate requirement to study explosives science and technology. The Defence Academy Campus of the University at Shrivenham has historically security cleared students attending courses at the Campus. This arrangement will need to be extended to include clearance of students from all parts of the globe. The course registration process will require students to provide sufficient information to facilitate clearance.

The second issue with respect to online course delivery is deciding on the technical standard through which the courses are built. The University uses an open source virtual learning environment (VLE) known as Moodle. This is considered a stable platform, however some of the early course material also made extensive use of Flash 8 to generate very high quality animations. This requires that students have access to this software. Whilst home computer users can readily download and install the necessary software, corporate, company and government network systems do not always provide this facility and do not necessarily provide users with the authority to install software locally. A trial showed that a number of organisations were confronted with this problem. Whilst it is technically possible to overcome it was nevertheless decided to avoid dependence on anything other than the most basic software and hardware configurations. Hence the most recent trial has been based on e-learning materials being delivered via HTML.

The next issue to address is that of student online assessment. For qualification bearing courses students will need to be examined either through examinations and/or submission of coursework. The examiners need to be confident that the person submitting the coursework or sitting the examination is indeed the student. For that reason it may be neccesary for students to undertake their online examinations at a university, college or government facility where their identity can be verified.

The first materials and courses have already been delivered whilst others are in development. A page from one of the courses is shown at Figure 6.

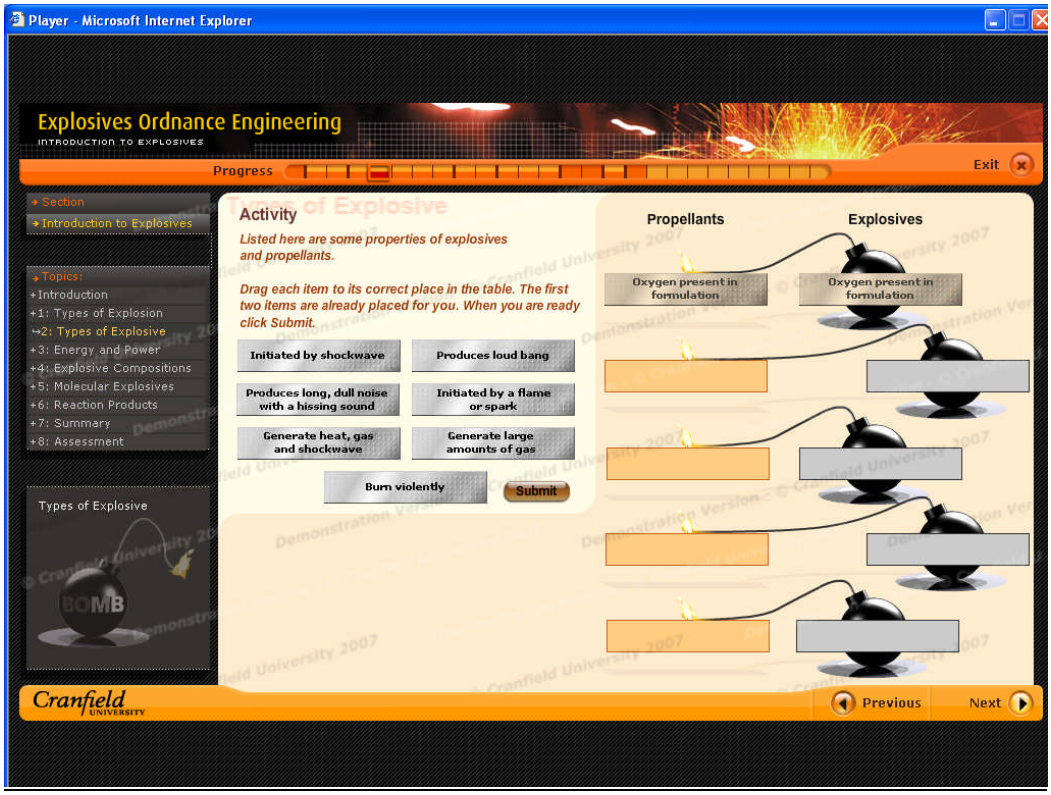

Figure 6 - Example of E-Learning Course Page

Modules of our MSc in Explosives Ordnance Engineering have been trialled and work is in progress to develop online material reflecting the knowledge component of the vocational qualifications. The latter have two components, namely knowledge and skills. Whilst the former can be taught and examined online the ability to apply that knowledge can really only be assessed in the workplace or by some other method of demonstrating application of knowledge. For the purpose of achieving professional status the aim is that the professional institutions will recognise that the students have acquired, through online learning, the necessary knowledge. With regard to skills, candidates will need to demonstrate to the professional body their capacity to apply their knowledge.

Summary

Since the last DoD Explosives Safety Seminar two years ago good progress has been made in the UK to build the support infrastructure necessary to replenish and rebuild our explosives expertise. The occupational standards described previously (references 1,2) have provided a excellent foundation on which to build. The manpower planning methodology helps identify precisely the number of people with the necessary skills and knowledge that we need and the sort of measures we need to take to ensure that they are in place. At the same time by improving the professional status of explosives specialists we hope to be able to attract the most able engineers and scientists. By improving the quality and availability of appropriate training and education we can

help ensure that these workers have the right knowledge and experience to do their jobs safely and proficiently.

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https://dspace.org/

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