The Naval Engineering Workforce
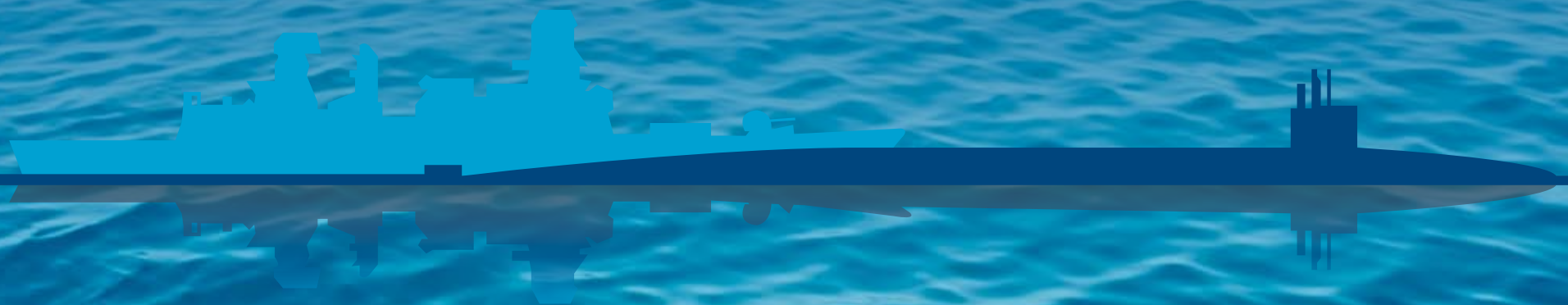
A UK NEST Review

July 2013

1 Skills in the UK: The long-term challenge, December 2005
2 Jobs and growth: the importance of engineering skills to the UK economy, Sept 2012
3 Engineering UK Annual Reports on the state of engineering in the UK
4 The United Kingdom's Naval Shipbuilding Industrial Base – The Next Fifteen Years

The Naval Engineering Workforce
A UK NEST Review

Executive Summary

The engineering management and production workforce across the Naval sector is characterised by a high proportion of employees in the 50 – 65 age range and a distinct dip in the numbers within the 35 – 45 range. There is evidence that industry has begun to recognize the potential loss of experience through increased employment of engineering apprentices and graduates. However, the potential loss of over 200,000 man-years of expertise in the management workforce over the next decade cannot be solved through graduate recruitment alone. Additional, more radical actions are required to both enable the knowledge transfer from the older age group employees and to attract and re-train appropriately competent mid-age range candidates from other sectors.

The graduate recruitment picture is encouraging except in the core subject of Naval Architecture where the Naval sector is recruiting over 50% of the available candidates with the requisite UK national status. This will not be sustainable with the growth of other sectors including Oil & Gas, Renewables and the attractions of offshore opportunities such as those in the pacific rim countries.

Introduction

Over the last decade numerous reviews and analyses, including the Leitch Review of Skills[1] and those by the Royal Academy of Engineering[2] and Engineering UK[3], have highlighted the growing need for more STEM graduates, and particularly those from the engineering disciplines, to resource the future needs of industry. In 2003, the MoD commissioned the RAND Corporation to undertake a study of the domestic capacity for naval ship construction[4]. The review focused on three fundamental questions relating to the ability of the industrial base to meet future demand, the numbers and types of facilities and finally, the numbers and skills of the work-force. Of the many conclusions from the review, those relating to the workforce were particularly concerning as they highlighted the potential shortage of sufficient work-force with appropriate skills to meet the peak demands posed by the ship-building programme. Further, the review identified that the age-profile of the sector was biased towards the over 50 age group that would lead to a considerable loss of experience over the life-span of the new-build programme.

The UK NEST forum was established in 2005, partly in response to the concerns about the future sustainability of the work-force in the Naval sector. In particular, attention was focused on attracting more, better qualified, graduates into the sector and a specific Working Group, the Training, Education and Development (TED) team was established to lead initiatives in this area. One of the major successes of this Working Group has been the emergence of the FutureNEST team formed from graduates entering the sector.

Since the RAND report, the landscape of the Naval sector has changed. Programmes have been scaled back (only six Type 45 destroyers, compared with the planned eight), delayed (QEC, Astute, MARS and FSC – now Type 26 GCS and MHPC) and the overall size of the Fleet reduced.

The purpose of this report is to document a "thumb-nail" survey that has been conducted by UK NEST to establish an outline understanding of the "health" of the work-force in the Naval sector in order to compare with that reported in detail through the RAND report. It does not address

the detail, neither does it make any forecasts against the current understanding of the warship and submarine build programmes. However, there is a tacit recognition that the work-force requirements will remain relatively high over the next decade to service the completion of QEC and Astute and the design and build of both the Type 26 and the Successor submarines. Further, the industrial workforce required to service the support of the Fleet is expected, at best to remain relatively constant, or at worst, to increase as the aircraft carriers enter service.

The principal aims of this survey were to:

- Re-examine the age profile within both the Management & Technical and Production workforces.

- Quantify the graduate recruitment over the last five years to understand whether this will address potential losses within the work-force through factors such as retirement and losses to other related sectors: Offshore Renewables and Oil & Gas.

- Identify the key graduate engineering disciplines and the institutions from which they have been recruited

Age Profile

Information has been collected from BAE Systems Maritime Services and Surface Ships, Babcock Marine & Technology, QinetiQ, MoD (Defence Equipment & Support), Rolls-Royce Marine & Nuclear and Lloyd's Register. The data from BAE Systems and Babcock M&T

cover multiple sites in Devonport, Portsmouth, Bristol, Glasgow and Rosyth. In order to present the data, a simple weighting has been applied that reflects the relative orders of magnitude of workforce, between the large and small employers, to create an "average" distribution.

The following figure illustrates the Management & Technical age-profile. Subsequent to this Review, BAE Systems Submarines have confirmed that their profile is very similar and has identical characteristics.
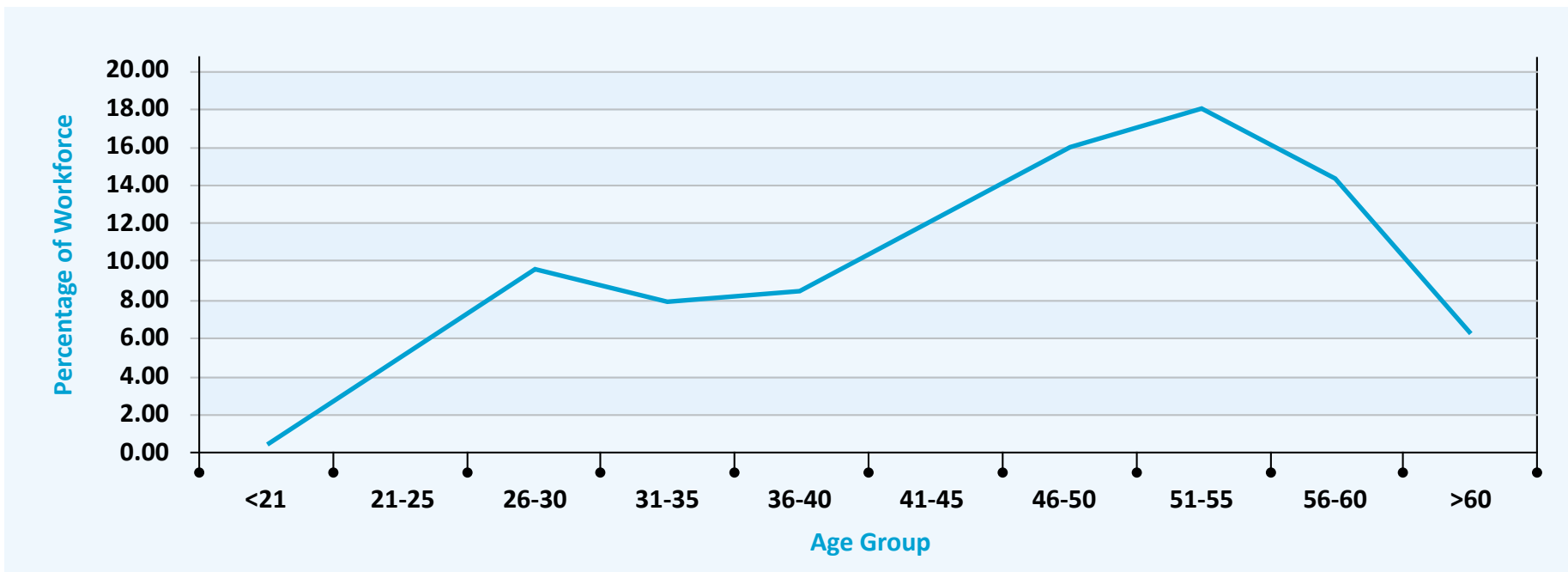
The curve has a number of differences from those reported in the RAND survey (which focused on data from 2003 and was presented for wider age groups) in that there is now a noticeable "hump" in the <30 age band that reflects a growth in graduate recruits and there is a "dip" in the 30-40 age bracket. The maximum has now shifted almost ten years towards the older age-group. However, the up-lift in graduate recruitment has noticeably shifted the average age from ~50 to ~45. This compares with the Royal Academy of Engineering median age of 45 for professional engineers[5].

The current profile suggests that there is significant retention in the higher age-group but that mid-career engineers are leaving the sector but are being replaced, to some extent, by new graduates.

The Production age profile has a similar profile although the numbers of both ends of the age-spectrum are greater. The mid-life "dip" is also evident.
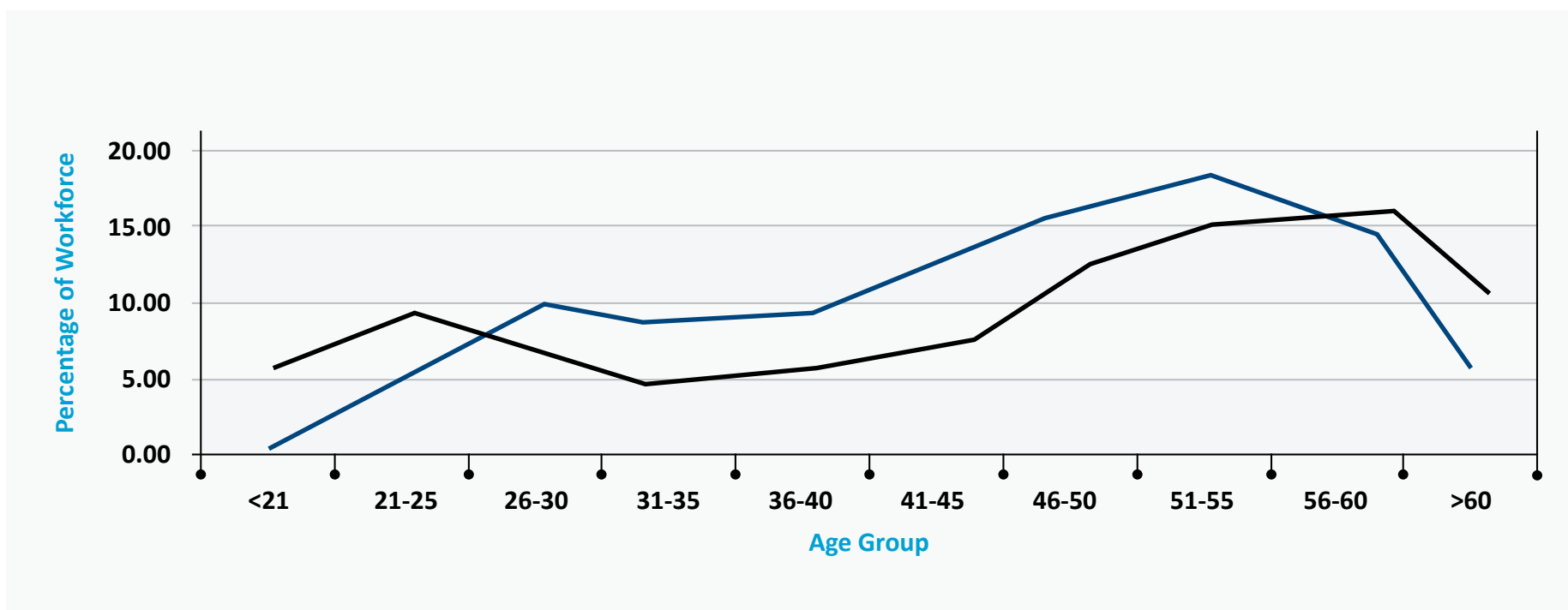

Management & Technical   Production

A number of other industry sectors have undertaken similar age-profile surveys, most notably, the Oil & Gas[6] and Construction industries[7]. Unfortunately the age-groupings are not consistent with those in this survey but the following gives an indication of the comparative age-profiles.

It can be seen that the Naval sector age-profile is significantly different from these two industries with a marked increase in the older population accompanied by the mid-age "dip". The Oil and Gas report highlighted the numbers of workers entering and leaving the service as a result of retirements. About 24% of the Oil & Gas workforce are below 30 with 15% over 55 whereas for the Naval sector the comparable numbers are almost reversed: 15% and 20%. The Construction industry profile also indicates a significant population of older employees.
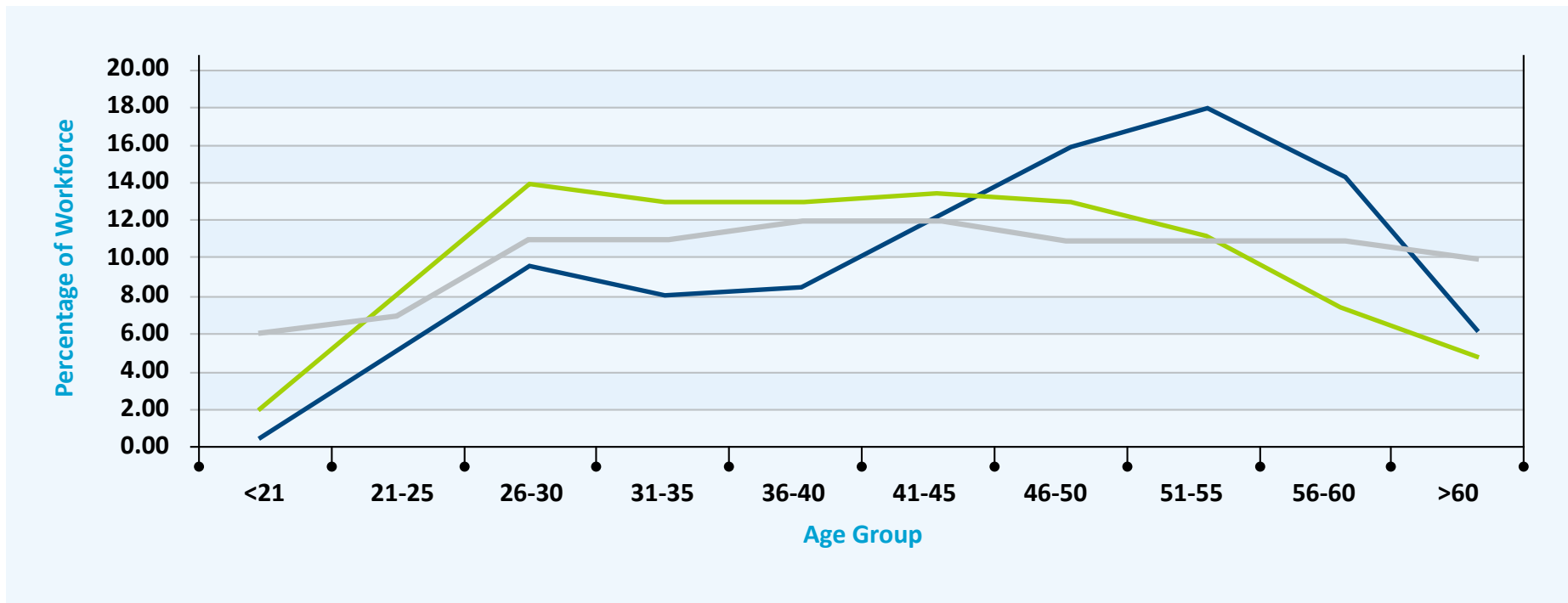
■ Construction　■ Oil & Gas　■ UK NEST

6 Oil & Gas UK 2012 UKCS Workforce Demographic Report.

7 UKCES, Construction, Building Services Engineering & Planning Sector Skills Assessment 2012

The presence of the mid-age gap in the Naval sector is difficult to understand, although there have been indications of similar profiles across wider engineering employment. A review of the HESA data from the mid-1990s does not indicate a drop in the numbers of graduates from the traditional mechanical, electrical and electronic disciplines. Numerous explanations have been suggested for the reduced number of engineers in the 30 – 40 age group that include the attraction of the IT and financial services sectors, coupled with the decline in UK manufacturing during the 1990's. The MoD went through considerable transformation during the outsourcing of many of its responsibilities (such as the Naval Dockyard privatization) that resulted in the cessation and/or scaling-back of a number of schemes such as the MoD apprenticeships and the Royal Corps of Naval Constructors recruitment. Whatever the cause, the current age-profile indicates that there will be a significant short-fall in the middle/senior management resource pool over the next 20 years within the Naval sector unless resources can be attracted from other industries or specialized training can be provided for people with appropriate non-naval engineering backgrounds.

Graduate Recruitment

A notable fact from the age-profile data is the increase in the numbers of <30 year olds who have been recruited since the RAND study. However this has to replace about 20% of the workforce who are over 55 and who could thus potentially leave the sector within the next 5 – 10 years. It must be recognized that there are a significant number of employees within industry who have transferred from MoD through the major out-sourcing such as the privatization of the dockyards and WSMI and who may retire at the age of 60.

The total number of graduates recruited over the last five years (including non-engineers) is as shown:

Total Number of Graduates
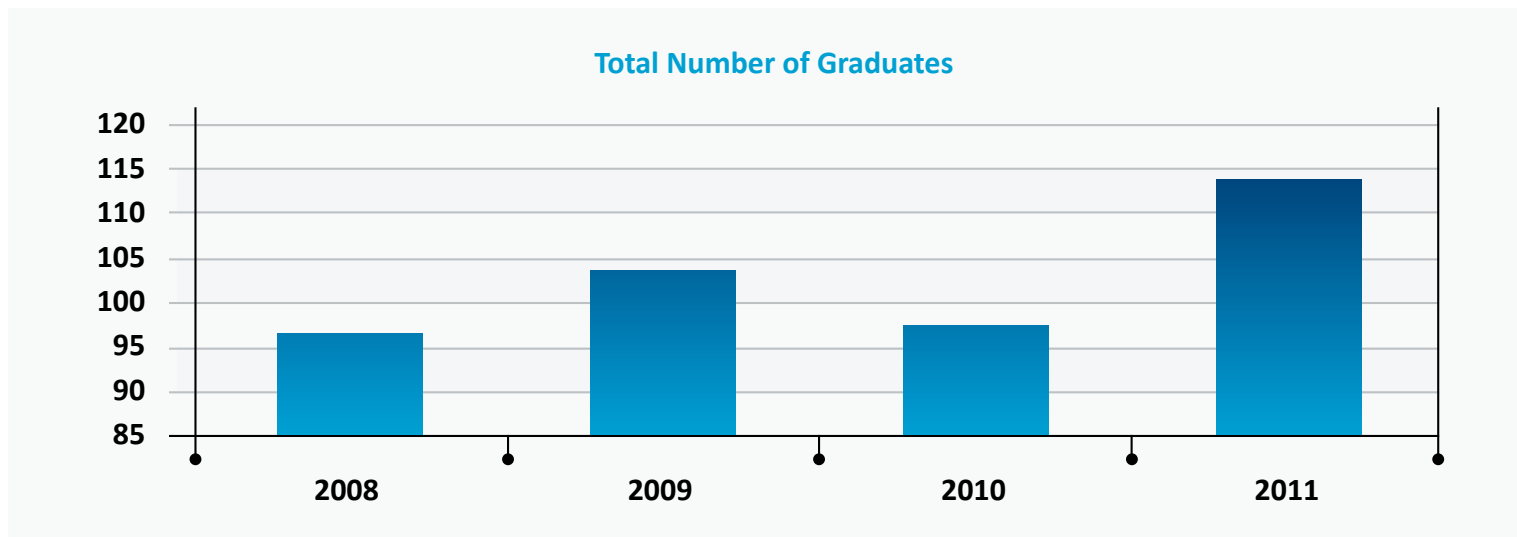
The discipline break-down is as follows:

Chart legend: 2008 | 2009 | 2010 | 2011 | 2012
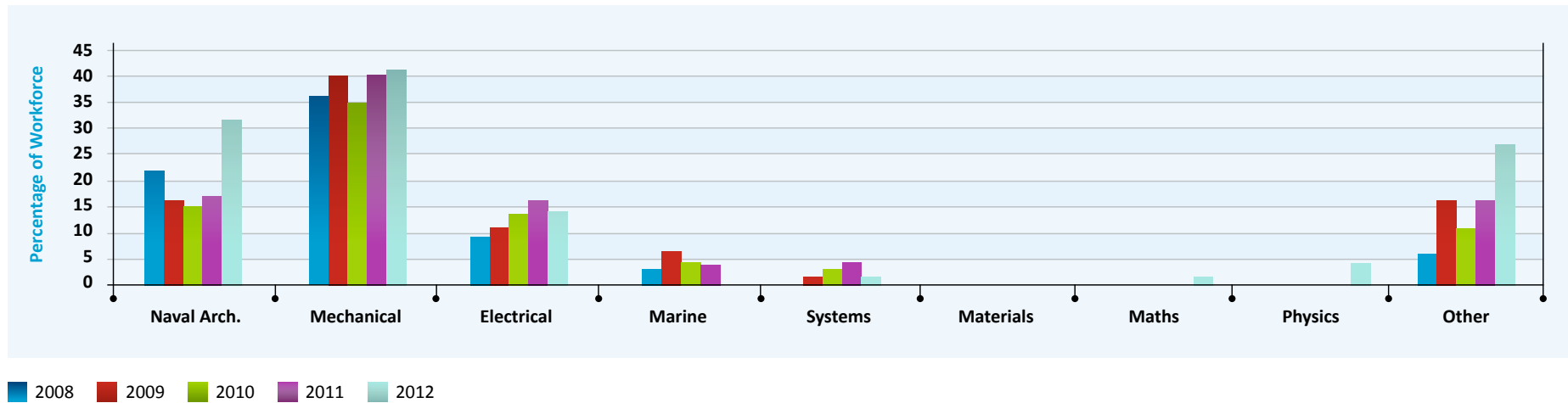
Clearly, the major disciplines are Mechanical and Electrical Engineering and Naval Architecture. There has been a significant increase in "other" degrees over the years that range from Business Studies to Civil and Chemical Engineering associated with the increasing industrial responsibilities for nuclear infrastructure.

A significant constraint on the employment of graduates is the requirement for them to be UK Nationals. Over the last decade, whilst the numbers of graduates emerging from the HE institutions has generally increased (although some engineering subjects such as electrical have apparently reduced), there has also been a significant increase in the number of non-UK graduates. In some subjects such as Naval Architecture, the ratio of UK: Non-UK is approaching 50:50. In the traditional engineering

subjects, the ratio is much lower and the Naval sector requirements represent a relatively small proportion of the total graduates. In Mechanical Engineering, there were a total of 5000 graduates in 2012 of which approximately 25% were non-UK. The UK NEST intake represented about 1% of the total UK graduates in that year.

In Naval Architecture there is a very different picture. In 2012 there were 110 graduates of which about 50% were non-UK nationals this implies that around 55 graduates were eligible to work in the Naval sector. UK NEST companies recruited 32 of these students, that represents nearly 60% of UK nationals. Indeed, over the last five years it would appear that UK NEST organisations have been recruiting between 25% and 60% of all of the eligible Naval Architecture students. With the expected pressures from

overseas, offshore renewables and oil & gas, continuing to employ such a large proportion of the UK Naval Architects will be challenging and alternative routes, such as post-graduate "conversion" courses for candidates from the more traditional engineering disciplines will be necessary.

Beyond the scope of the reported survey, it is recognized that there are specific capability shortages in topics such as high-voltage electrical systems that are being addressed through other initiatives.

The principal sources of graduates over the last year have been identified as (in no specific order):
- Newcastle - Marine Science
- Plymouth - Marine, Mechanical & Electrical Engineering
- Southampton - Ship Science & Mechanical Engineering

- Strathclyde - Naval Architecture
- Bath - Mechanical & Electrical Engineering
- UCL - Mechanical Engineering & Post-Graduate Naval Architecture
- Imperial College - Mechanical Engineering
- Loughborough – Systems, Mechanical & Electrical Engineering
- Nottingham - Mechanical & Electrical Engineering
- Cardiff - Mechanical & General Engineering

Discussion

The survey included the majority of the key industrial suppliers in the Naval sector, with the most notable exception being BAE Systems Submarines. However, the organisations that took part in the survey represent about 30% of the total number of employees in the sector[8].

Before any definitive conclusions can be drawn from this "thumb-nail" survey, a review must be made of the forward resources that will be needed to address the design, build and in-service support phases for the RN Fleet based on the current understanding of the re-capitalisation schedule. Further, if the government drive to encourage exports is to be achieved, additional resources will be required across the entire supply chain – from Platforms to the Systems & Equipment.

A number of high-level issues can be identified that are outlined in the following.

A major concern from the age-profile results is that about 20% (i.e. ~5000 people) could retire from the industry over the next decade.   Whilst this would represent a very significant loss of capacity, the more important factor will be the loss of experience. Many of the employers, such as the ex-Naval Dockyards, have enjoyed very high levels of staff retention (~95%) so that many of the retirees will have around 40 years of continuous service. The total loss of experience could be in the order of 200,000 man-years. It is also worthy of note that a very significant proportion of this experience is held within a cadre of people who were initially employed within the MoD and who transferred to industry through outsourcing initiatives. These ex-MoD employees have unique experience resulting from the broad training and development opportunities that were available during their development. The MoD owned and managed establishments that spanned the entire CADMID cycle; from Research & Development (at the Admiralty Laboratories), to Concept Design (at the Forward Design Teams in Foxhill), to overseers at build dockyards, to the support organisations at the Royal Dockyards and Naval Bases. No single industrial entity can now offer this breadth of experience.

8 According to the Marine Industries Alliance Strategy 2012, there are about 25,000 people employed in this sector.

The significant loss of expertise cannot be replaced simply through increasing the supply of graduates. Indeed, the likelihood of recruiting sufficiently to replace the capacity (recognizing the Oil & Gas view that an acceptable ratio is ~2.5:1) would be extremely challenging. This would place a very large burden on the HE institutions, recognizing the constraints imposed on graduate numbers by HEFCE and the introduction of higher tuition fees.

The loss of experience is a factor that requires urgent attention that must include the application of knowledge transfer processes. To date, whilst there have been attempts to embed such methods into working practices, the imperative to succeed has not been as apparent as it is now. Whether the Naval sector, with its traditional and conservative approaches to HR issues is "up" for this challenge is debatable. However, unless effective methods can be implemented, key submarine and warship programmes are at risk of having insufficiently suitably qualified and experienced people both to deliver them and then provide the In-Service Support.

The MoD recognized the imperative to sustain the warship design and build competences through the Terms of Business Agreement that was negotiated with BAE Systems in 2009 that enumerated the size of the Key Industrial Capability required to deliver both the warship build and in-service support workforce. This survey has highlighted that the issue of sustaining the workforce extends beyond a single employing organization and is a characteristic across the entire sector.

On the graduate recruitment front, the core Naval Architecture capability is absorbing an extremely high proportion of the total number of UK national graduates. This also requires rapid action both because of the growing need for similar skills from emerging industries and the long "lead-time" required to increase the volume of graduates emerging from the academic pipeline that stretches back into schools feeding suitable qualified STEM subject students. Alternative training methods will be required that should include the cross-training of graduates from other disciplines (such as mechanical and

marine engineering) through suitable Masters courses (such as that at UCL).

The US has undertaken a similar assessment[9] of their Naval workforce and their conclusions chime well with the findings in this survey. As with the UK, a serious shortage of STEM qualified students available for undergraduate course was noted but this was exacerbated by a relatively small number of universities that specialize in Naval Engineering topics. It was concluded that, in addition to a major drive to increase the numbers of STEM students, there have to be specialist development programmes to "convert" general engineering graduates to the naval disciplines. In addition, universities that currently support Naval Engineering have to be further encouraged to expand their student numbers. Finally, it was recognized that there is no single body responsible for raising the issue for the entire Naval Engineering Enterprise.

9 Examining the Science & Technology Enterprise in Naval Engineering Workforce & Education", Special Report 306, Naval Engineering in the 21st Century. The Science & Technology Foundation for Future Naval Effects. Ronald & Kiss, Webb Institute 2011

Conclusions

The survey has demonstrated that the Naval sector has some unique issues. These relate to a relatively high forward workload associated with a number of key re-capitalisation programmes (Successor and Type 26 in particular). Further, the entry into service of the largest warships (QEC) ever to be operated by the RN will place heavy demands on all industrial support service providers. This problem will be exacerbated by the extreme level of "lean-manning" associated with these ships, far above any current platforms.

The workforce to deliver the future design, build, in-service support and export programmes must to be quantified and a long-term Naval sector HR plan developed.

The key issues emerging from the survey include:

- The workforce is aging and there will be a very significant loss of capacity and experience over the next decade.
- The middle-management age group, 30-40, appears to be losing numbers and may be insufficient to provide the senior management required to deliver future programmes. The reasons behind the loss of people in this age group must be identified and a strategy developed to either retain or attract replacement personnel from adjacent sectors.
- Whilst improving, the number of graduates entering the sector appears insufficient to meet the medium to long-term requirements of the sector.
- Naval Architects provide key skills to the sector but the current recruitment of ~50% of UK National graduates will be difficult to sustain and, future retention of these people may be difficult when adjacent sectors begin aggressive recruitment to meet offshore and renewable energy demands.
- There is little evidence to indicate that Government recognize the potential impact that the decline in the capacity and expertise of the Naval sector workforce will have on our "sovereign" capability to design, build and support submarines, warships and their associated systems and equipment.

Noting the concerns expressing in the US survey, UK NEST could provide the single focal point through which to represent these major issues at Governmental level using channels such as the MILC initiatives.

UK NEST

The United Kingdom Naval Engineering Science & Technology (UKNEST) Forum seeks to sustain and develop the Naval sector's world-class intellectual base. It is the Forum for the UK's professional community to address issues of common concern, fostering specific development needs and giving a focal point for interaction with, and influencing, the wider Government and Industrial Maritime community.

Current Members of UK NEST include: BAE Systems, Babcock Marine & Technology, Thales, QinetiQ, Rolls-Royce, BMT, SEA, Ministry of Defence - Defence Equipment & Support, Royal Navy, Lloyds Register, Atlas Elektronik, GE Powerconversion, IMarEST and RINA

Further details can be obtained on the website (www.uknest.org) or by contacting the UK NEST Executive Coordinator (and author of the paper) Dr Ben Dobson (07747697905, drbendobson@aol.com)

UK NEST
c/o IMarEST
33 Aldgate High Street
London
EC3N 1EN.