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Transferring Simulation Skills from other Industries to Nuclear

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ABSTRACT

Engineering analysis and simulation has always played a significant role in the nuclear sector and its use continues to increase across all branches of industry. To remain competitive in an increasingly global environment and to ensure the safety and reliability of designs, the nuclear industry must take advantage of the new engineering simulation technologies. Concerns surrounding the inappropriate use of simulation by staff without the appropriate competency persist, as analyses become more advanced, increasingly embracing more complex physical phenomena, often in an effort to model reality more faithfully. Furthermore, the age profile of the skilled staff in the nuclear sector in the UK is such that the skills shortage is likely to increase in future. These trends emphasize the need for life-long learning and continual staff development along with transfer of skills from other industry sectors to the nuclear sector. The nuclear industry has taken some initiatives to address skill shortages through the National Skills Academy for Nuclear and Nuclear Energy Skills Alliance (NESA) but these are mostly focused on manufacturing and R&D skills. The recently completed EU funded EASIT^2 project is directly aimed at addressing the engineering analysis and simulation skills. This paper gives a brief overview of the EASIT^2 project and its deliverables and points out how it can help the skills issues being faced by the nuclear industry.

INTRODUCTION

The term Suitably Qualified and Experienced Personnel (SQEP) originated within the UK nuclear industry, although similar concepts exist in other industry sectors and other countries. Typically, to be regarded as a SQEP requires suitable qualifications and experience. The SQEP requirements are often broad in nature and also include the requirements for technicians and skilled workers.

There are commercial, legal and regulatory requirements to engage a SQEP and it may be noted that such responsibilities can often be discharged by delegating authority to a SQEP. In the UK, the nuclear industry regulator (ONR) requires that any activities related to nuclear safety is carried out by Suitably Qualified and Experienced Personnel (SQEP). The EASIT^2 project is inherently linked to the concept of SQEP and a primary aim of the project is to produce deliverables that companies can use to demonstrate SQEP, specifically in the analysis and simulation area.

In industry, it is common for the expertise and skill levels necessary to be matched with the requirements of the job. At AMEC five different levels of SQEP used are:

- **Level 1 – Supervised**
- **Level 2 – Unsupervised**
- **Level 3 – Advising and guiding others**
- **Level 4 – As a company "Expert"**

- **Level 5 – As an externally recognised "Expert"**

The design of the EASIT^2 Competence Framework and Analysis has the inherent flexibility to cater for multiple levels of competency. SQEP cannot be built by simply serving time in a job. It is built through a process of developing competencies and these are at the core of the EASIT^2 project.

The big challenge is to have a consistent criteria to assess competencies as professional engineers move from one industry to another. Explicit knowledge in form of formal qualifications can be easily assessed but assessment of implicit knowledge based on experience can be subjective. The EASIT^2 project has aimed to remove this subjectivity and offers a consistent criteria in form of competency statements.

THE EASIT^2 PROJECT

Background

The EASIT2 project[1] can trace its origins back to the EU-funded FENET Thematic Network and more directly to the recently completed CCOPPS Project. In addition, it builds directly on the NAFEMS Registered Analyst Scheme and indirectly on the work of the NAFEMS Education and Training Working Group.

The main aim of the EASIT^2 project is the development of a unique and versatile *Competency Framework*, focused on the use of engineering analysis and simulation tools across all sectors of industry, including Nuclear. The goal is to transfer, modify and extend the innovative output from the CCOPPS project, which was based on the pressure systems industry sector. The CCOPPS Educational Base, consisting of competence statements across 16 analysis and simulation areas, is freely available at http://www.ccopps.eu/. The EASIT^2 project also follows on from participation by the authors in a Skills Forum held at SMiRT 20 in Helsinki [6]. The nuclear industry needs outlined during this event, including concerns raised regarding analyst qualifications, fed directly into the project proposal and are reflected in the project deliverables.

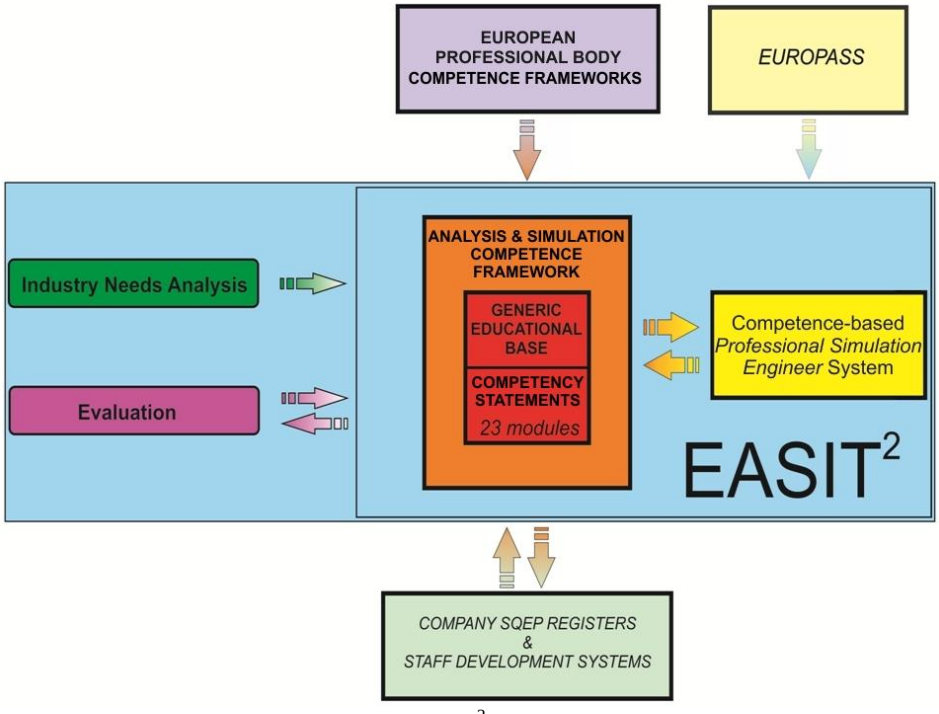

Fig.1: The EASIT^2 Project Outline

The project outlined in Figure 1, is managed by a partnership headed up by the University of Strathclyde (also leader of the earlier CCOPPS project). Other key partners represented petrochemical, process engineering, nuclear power, Aerospace, Civil engineering, Construction), Marine, Offshore), Consumer Goods, Land Transport), Defence and General Industrial Goods sectors.

The Educational Base

This is a set of statements explaining what competencies a simulation engineer should have. These are split into a number of different modules, covering various areas of technology, as detailed in Table 1. The list was drawn up as a result of an extensive study of industry needs[2][3]. Those with a blue background are non-industry-specific versions of the CCOPPS modules and those in green are new.

Table 1: EASIT^2 Educational Base Modules (Technical Areas)

Finite Element Analysis for Structures	Optimisation
Mechanics, Elasticity and Strength of Materials	Computational Fluid Dynamics
Materials Modelling, Characterization and Selection	Simulation Management
Fatigue	Multi-Physics Analysis
Flaw Assessment and Fracture Mechanics	Fundamentals of Flow, Heat and Mass Transfer
Nonlinear Geometric Effects and Contact	Multi-Scale Analysis
Beams, Membranes, Plates and Shells	Probabilistic Methods
Dynamics and Vibration	Noise and Acoustics
Plasticity	Electromagnetics
Thermo-Mechanical Behaviour	Multi-body Dynamics
Buckling and Instability	
Composite Materials and Structures	
Creep and Time-Dependency	

The project focuses on the production of generic (non-industry-specific competencies), although it is recognised that SQEP will require additional industry-specific, company-specific and software-specific competencies, as shown in Figure 2. The EASIT^2 Competency Framework will allow for these specific competencies to be added by sector bodies or individual organizations, either by adding to the above modules or by creating new modules.

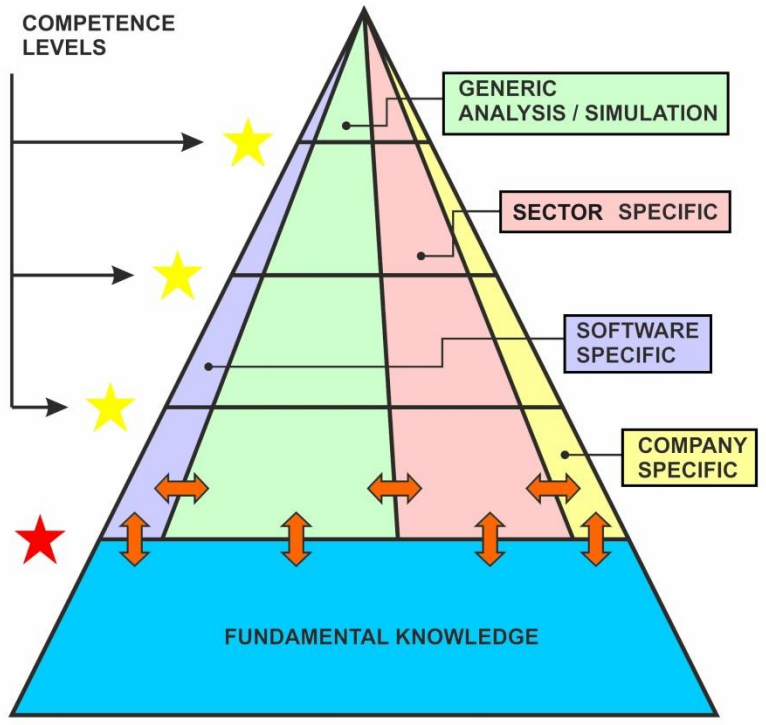

Fig. 2: Competency Types and Levels

Each competency statement will have a reference link to appropriate sections in text books and eventually training courses, that will assist staff in the development of the appropriate competency. This concept is illustrated in Figure 3, which shows a selection of competency statements from the CCOPPS project in the Fatigue area.

The Educational Base, containing over 1000 statements of competency over 22 modules, will have the following uses:

- Providing useful information to self-learners;
- Providing focus for the developers of short courses, text books and other learning material;
- Providing a basis for the production of self-test quizzes and examinations to aid in self-assessment or formal assessment of competence;
- Providing the basis for SQEP registers.
- Providing the basis for the Competency Framework and Professional Simulation Engineer System

Category & Code Number	COMPETENCE STATEMENT	Standard or Advanced and EQF Level	Resource Reference Code
Knowledge			
FATkn8	Sketch typical butt and fillet welds, highlighting features detrimental to fatigue performance.	S, 7	FATref8
Comprehension			
DBAco20	Explain why the assessment of Shakedown and Fatigue is often carried out using elastic analysis.	A, 7	DBAref15
FATco7	Discuss the observed relationship between endurance limit and static tensile strength for steels and explain why this relationship does not hold for welded steels.	S, 7	FATref19
FATco17	Discuss the significance of the choice of equivalent st assessment of welded joints.		
FATco27	Describe the approximations inherent in a plate/shell and how these could influence fatigue assessment.		
Application			
FATap7	Use hot spot stress techniques (extrapolation and/or structural stresses for fatigue assessment.		
DBAap7	Carry out a Fatigue design check.	S, 7	DBAref14
Analysis			
FATan1	Assess the results from fatigue analyses and determine whether they satisfy the requirements of a Code of Practice.	S, 7	FATref55
Synthesis			
FATsy5	Specify appropriate idealisation(s) for welds, which are consistent with the objectives of fatigue analyses and available computing resources.	A, 7	FATref60
Evaluation			
FEAev4	Manage physical and human resources within an organisation; in an effective manner.	A, 7	FEAref84

FATref19

Maddox S J; 'Fatigue design rules for welded structures', Prog. Struct. Engng Mater. Vol.2, 2000, p6-15.
Maddox S J: 'Fatigue Strength of Welded Structures', Woodhead Publishing Ltd., Cambridge, ISBN 1 85573 013 8, 1991. p31.
Fuchs H O and Stephens R I: 'Metal Fatigue in Engineering', John Wiley and Sons Inc., New York,
ISBN 0-471-05264-7, 1980. p70 & 84.

Fig. 3: Typical Module Competency Statements

The Competency Framework

The main objective of the Analysis & Simulation Competency Framework is to enable large, medium and small companies, as well as individual analysts and engineers, to record and monitor competence levels in the engineering analysis and simulation area. Basic search and reporting tools will allow organizations to undertake competency planning. At the heart of the Competency Framework will lie the Educational Base described above.

This will be an open and versatile web-based relational database system that will allow the skills that are developed by individuals to be tracked and logged. This can then be used by individuals to plan and monitor their personal development, or by companies to do the same for their staff and to keep a register of the combined simulation skills of their workforce. The structure of the Educational Base and the Competency Framework will allow modules to be added, deleted or modified. Individual competency statements will also be able to be translated and it will also be possible to add preferred links to other resource material.

As shown in Figure 1, the Competence Framework will allow data to be transferred to/from wider company staff development systems and SQEP registers. The aim is to ensure that the EASIT^2 developments support the SQEP process.

The database record for the Competence Framework is illustrated in Figure 4. Inclusion of a module in a person's list of competent areas will require a particular subset of competences from the Educational Base to be assessed and achieved. Competences may be achieved by internal attestation, external attestation, internal examination or external examination. Up to 6 levels of practice may either be directly linked to appropriate competences from the Educational Base or be assigned by an organization as a result of job function. The inclusion of an analysis system in the record will normally be related to the achievement of generic competences in the Educational Base by association, rather than analysis system specific competences.

The inclusion of multiple industry sector entries is to allow the competence framework to reflect employment history or to reflect the variety of work carried out by consultants. Inclusion of a particular industry will require satisfaction of industry-specific competency statements in the Educational Base where available. The specification of industry, company and software specific competence statements is beyond the scope of the EASIT^2 project. In summary, the Competence Framework will:

- have an analysis and simulation scope only;
- be flexible, open and capable of being tailored for individuals, SMEs and large organisations;
- be web and intranet enabled;
- have relational data-base functionality;
- use open systems for development and will not require implementation of a proprietary software development system for operation;
- will provide integration with the Educational Base;
- will provide integration with the Professional Simulation Engineer system;
- will provide an open system capable of interfacing to existing SQEP and staff development systems.

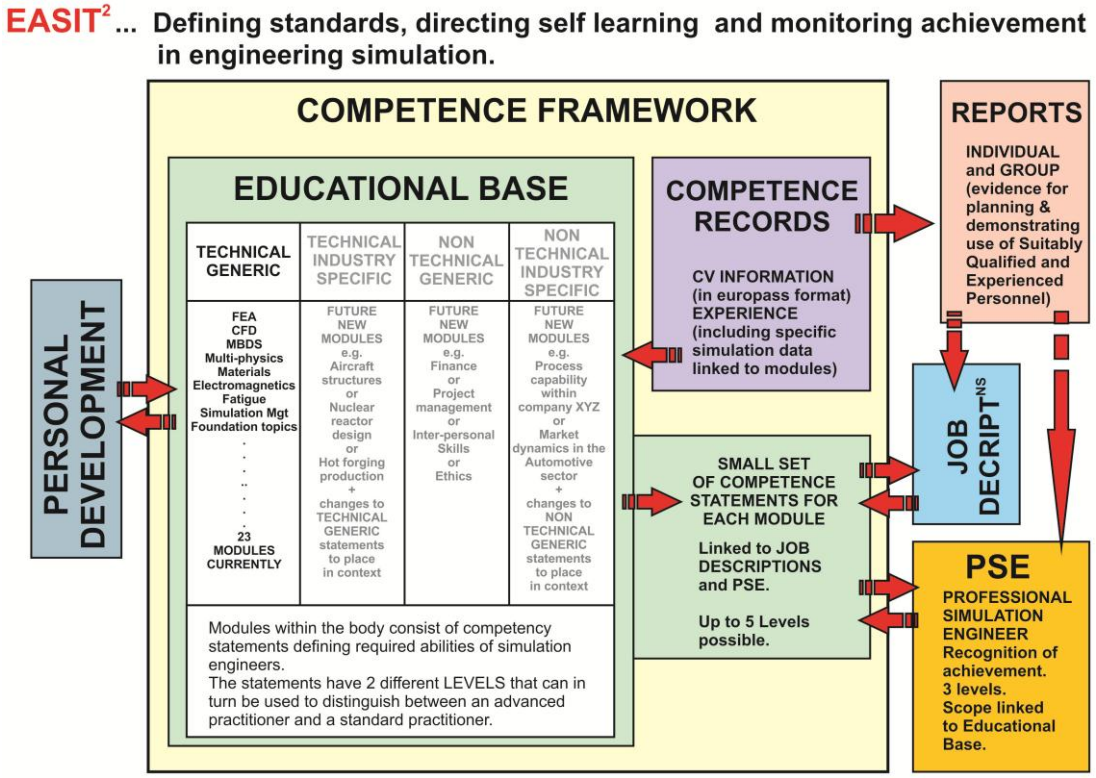

Fig. 4: The EASIT^2 Competence Framework

The Professional Simulation Engineer Standard and Qualification

The project proposal includes the development of a *Competence-based Registered Analyst Scheme*, leading to a Professional Simulation Engineer (PSE) qualification to be offered by NAFEMS. The new system will be structured around the competency statements that have been established as part of the above Educational Base and will recognize that effective analysis and simulation requires:

- a satisfactory underpinning in engineering or a related discipline;
- the development of competence in the application of analysis and simulation through experience in the workplace;
- product and industry sector knowledge;
- training in the software tools being used;
- training in the theoretical underpinnings relevant to the analysis types to be included within the approved scope statement.

The goal of the EASIT^2 project is to establish a criteria based on clear statements of competencies. Project thinking however has recently moved towards the development of a ***Professional Simulation Engineer*** standard and qualification, with person details based on the Europass[4] template. This is a system, within Europe, supported by a network of National Europass Centres and is aimed at facilitating workforce mobility by providing a transparent record of skills and qualifications. The various Europass documents are shown in Figure 5 and it is the aim of the EASIT^2 project to import this information into both the Competence Framework and the Professional Simulation Engineer system, where available.

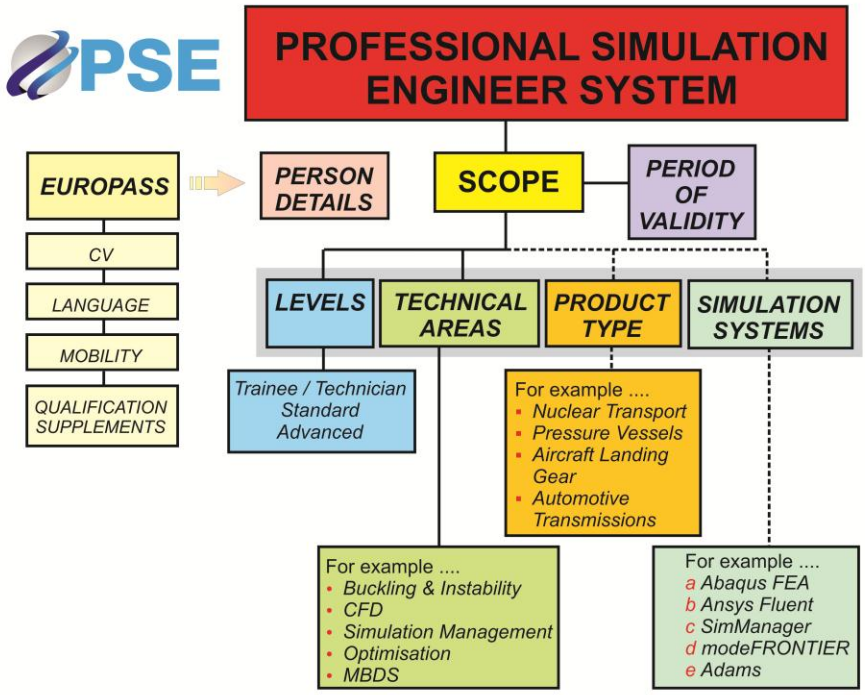

Fig. 5: Proposed Professional Simulation Engineer System

In the UK there is a **Nuclear Skills Passport** currently being rolled out under the auspices of the National Skills Academy[5]. The Nuclear Skills Passport provides participating nuclear organisations with secure web access to information on their nuclear skills base, including training completed. This information can also be made available for other participating organizations granting permission. A fundamental aim of the system is to aid the mobility of staff from one nuclear site to another, or from contract to contract, through the implementation of industry-agreed and cross-site recognized training standards. The Nuclear Skills Passport concept comprises four key elements :

- A learner database that provides a registry of training records for individual passport holders and the facility to generate a skills passport card;
- Datasets that describe job roles, industry training standards and the Skills Academy assured provider network;
- Benchmarking and signposting tools to support up-skilling , involving skills gap analysis against Job Context role profiles, with signposting to training provision to meet the gaps identified.
- A reporting suite that generates statistics at industry, regional and corporate levels.

As we can see, there are fundamental similarities between the goals and structure of the Nuclear Skills Passport and the EASIT2 project deliverables. The EASIT^2 Educational Base will however define a comprehensive list of competencies across 20 technical areas, which will in turn assist with personal development and the production of training resource materials designed to deliver the stated competences.

CONCLUSION

The EASIT^2 project has produced deliverables that will allow individuals and organisations of all sizes to assess and develop competencies in the analysis and simulation area.

NAFEMS will take responsibility for the development and maintenance of the Educational Base, Competency Framework and Professional Simulation Engineer system. The success of any qualification system will be largely dependent upon industry seeing its implementation as a business imperative and this will remain one of the biggest challenges for the new Professional Simulation Engineer system. The Nuclear Skills Passport does not specifically address analysis and simulation and there is clearly potential for the two systems to be interfaced. The EASIT^2 Competency Framework is being developed with the goal of openess and flexibility, to allow this to happen across all industry sectors, including nuclear. The EASIT^2 project deliverables were prepared in consultation with nuclear employers at every stage.

The EASIT^2 Educational Base, Competence Framework and Professional Simulation Engineer system represents a significant step in competency development, evidencing staff and organizational competence, promoting staff mobility and eventually helping to transfer simulation skills from other industry sectors to the nuclear sector.

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