



The Royal Academy  
of Engineering

**Achieving curriculum coherence:  
constructive alignment of assessment  
criteria within project and problem based  
learning approaches to 14-19 engineering  
education**

Matthew Harrison,  
Dominic Nolan  
The Royal Academy of Engineering, London  
28<sup>th</sup> May 2012



The Royal Academy  
of Engineering

## Email to Awarding bodies, Matthew Harrison (16<sup>th</sup> May 2012)

*You will doubtless be aware of the meeting with John Hayes last week on the subject of next steps with the Principal Learning in Engineering. The Minister was strongly in favour of a suite of smaller qualifications as a next step for the Principal Learning. He asked Baker-Dearing to take a lead in looking at this and I volunteered the RAEng's help.*

*Since then I have been working to re-organise the material from the Principal Learning into a rational set of linked qualifications. This does not signal any weakening of the RAEng's support for the Principal Learning but rather a willingness to work with anyone who wants to offer a quality engineering qualification to 14-16 year olds - in this case John Hayes.*



The Royal Academy  
of Engineering

## Important features of 14-19 engineering education

Discussions with schools, teachers, employers, and the wider engineering community identify the following important features in excellent 14-19 engineering education:

- Employer engagement – for relevance and authenticity (motivating for all involved)
- Alignment with the engineering profession – for progression and respect



The Royal Academy  
of Engineering

## Features of the ideas proposed here

The ideas proposed here are grounded in a determined attempt to apply what is known about effective engineering education. Thought has been given to

- Constructive alignment of learning objectives within a unit / qualification and across units / qualifications – leading to alignment with the RAEng Purpose Statement for 14-16 engineering education.
- Constructive alignment with the professional engineering standards so that proposals are grounded in the profession
- The expressed intent of UTCs to offer *project based learning* – engaging with employers in the process
- The opportunity to do more *problem based learning* – engaging with employers in the process



The Royal Academy  
of Engineering

## Success criteria

The ideas proposed here may well get replaced by something better – or a return to the original Principal Learning. They are offered solely as a contribution to next steps – not as any preferred solution.

Any future qualification will need to pass the DfE criteria of

- Appropriate content (not too specialised)
- Good progression prospects
- Appropriate assessment (including external & synoptic)
- Proven track record / significant learner numbers
- Grading (not pass / fail)



The Royal Academy  
of Engineering

## Guiding principles

Principles extrapolated from UK-SPEC  
(there is no Level 2 professional engineering standard)

### Engineering Principles Level 2 (working title only)

**Engineering knowledge and understanding:** the fundamental technical knowledge relevant to the engineering domain

**Technical knowledge with practical skills:** the general technical knowledge relevant to the engineering domain applied using appropriate practical skills

**Professional knowledge:** knowledge of the nature of engineering enterprise; professionalism; social & environmental responsibility

**Interpersonal skills:** the employability skills – communication, managing projects, managing people, teamwork – required for success in engineering occupations

Professional engineering  
standard UKSPEC from  
the Engineering Council  
***The EngTech standard***  
**(Level 3 +)**

***Engineering Technicians must be competent throughout their working life, by virtue of their education, training and experience, to:***

***A. Use engineering knowledge and understanding to apply technical and practical skills.***

***B. Contribute to the design,***



## Revised taxonomy of the cognitive domain

(Anderson and Krathwohl, 2001)

**Creating**  
(synthesis)

**Evaluating**

**Analysing**

**Applying**

**Understanding**  
(comprehension)

**Remembering**  
(knowledge)

***“Going beyond knowledge is essential to employer engagement, a project-based approach and problem-based learning.”***



The Royal Academy of Engineering

## Guiding principles: mapping cognitive activity

### Checking constructive alignment in the PL

- Knowledge
- Application of knowledge and understanding in context
- Practical skills

### 1. Engineering knowledge and understanding

Learning Outcomes (LO)	Units							
	1	2	3	4	5	6	7	8
LO.1								
LO.2								
LO.3								
LO.4								
LO.5	N/A	N/A	N/A		N/A	N/A	N/A	

### 2. Technical knowledge with practical skills

Learning Outcomes (LO)	Units							
	1	2	3	4	5	6	7	8
LO.1								
LO.2								
LO.3								
LO.4								
LO.5	N/A	N/A	N/A		N/A	N/A	N/A	

### 3. Professional knowledge

Learning Outcomes (LO)	Units							
	1	2	3	4	5	6	7	8
LO.1								
LO.2								
LO.3								
LO.4								
LO.5	N/A	N/A	N/A		N/A	N/A	N/A	

### 4. Interpersonal skills

Learning Outcomes (LO)	Units							
	1	2	3	4	5	6	7	8
LO.1								
LO.2								
LO.3								
LO.4								
LO.5	N/A	N/A	N/A		N/A	N/A	N/A	
















The Royal Academy  
of Engineering

## Qualifications: mapping cognitive activity







Checking constructive alignment in  
the proposal

	Knowledge
	Application of knowledge and understanding in context
	Practical skills









### 1. Engineering mechanics, materials and manufacturing technologies (120 GLH)

Learning Outcomes (LO)	Units							
	1	2	3	4	5	6	7	8
LO.1								
LO.2								
LO.3								
LO.4								
LO.5	N/A	N/A	N/A		N/A	N/A	N/A	









### 2. Computerised control technologies (120 GLH)

Learning Outcomes (LO)	Units							
	1	2	3	4	5	6	7	8
LO.1								
LO.2								
LO.3								
LO.4								
LO.5	N/A	N/A	N/A		N/A	N/A	N/A	

### 3. Engineering enterprise and the environment (120 GLH)

Learning Outcomes (LO)	Units							
	1	2	3	4	5	6	7	8
LO.1								
LO.2								
LO.3								
LO.4								
LO.5	N/A	N/A	N/A		N/A	N/A	N/A	

### 4. Engineering design and realisation group project (120 GLH)

Learning Outcomes (LO)	Units							
	1	2	3	4	5	6	7	8
LO.1								
LO.2								
LO.3								
LO.4								
LO.5	N/A	N/A	N/A		N/A	N/A	N/A	

### **Unit 1: Exploring the Engineering World**

LO.1. Know about engineering sectors and their products or services

LO.2. Know about job opportunities available within the engineering industry and the role of professional engineering institutions

LO.3. Know about the achievements in engineering that relate to social and economic development

LO.4. Understand the rights and responsibilities of employers and employees in engineering

### **Unit 2: Investigating Engineering Design**

LO.1. Know about the construction and function of an engineered product or system

LO.2. Be able to prepare a product design specification

LO.3. Be able to prepare initial design proposals

LO.4. Be able to prepare and submit a final design solution

### **Unit 3: Engineering Applications of Computers**

LO.1. Know about computer applications in process control and manufacturing

LO.2. Be able to use computer-based systems to solve an engineering problem

LO.3. Understand microprocessor control applications in everyday consumer products

LO.4. Know about computer aided technology in maintenance operations

### **Unit 4: Producing Engineering Solutions**

LO.1. Understand health and safety procedures, standards and risk assessment in engineering & electronic /electrical activities

LO.2. Be able to plan for an engineering product or service

LO.3. Be able to select suitable materials, parts or components for an engineered product or service

LO.4. Be able to use processes, tools and equipment to make an engineered product or carry out a service

LO.5. Be able to apply inspection techniques to the engineered product or service

### **Unit 5: Electrical and Electronic Circuits and Systems**

LO.1. Understand safe working practices in the workshop/ laboratory and understand relevant electrical and electronic principles

LO.2. Be able to recognise and select components used in electrical and electronic circuits

LO.3. Be able to construct an electronic circuit and understand its basic operating principles

LO.4. Be able to test and find faults on electronic circuits.

### **Unit 6: Application of Manufacturing Techniques**

LO.1. Be able to work effectively in a production team and reflect on their performance

LO.2. Know about production information and how this is used to plan and schedule for manufacturing

LO.3. Be able to set up and use tools and CNC equipment safely to process materials

LO.4. Be able to apply appropriate quality control techniques and interpret quality data

### **Unit 7: Application of Maintenance Techniques**

LO.1. Understand different types of maintenance for engineered products, plant or equipment including the use of statistical trends

LO.2. Be able to carry out routine maintenance tasks and devise a maintenance procedure

LO.3. Understand the effects of poor maintenance and the range of spares and replacement parts

LO.4. Be able to carry out a risk assessment in a maintenance environment

### **Unit 8: Exploring Engineering Innovation, Enterprise...**

LO.1. Know about the intellectual property within engineering

LO.2. Understand the role of research, development and raising finance when designing engineering products

LO.3. Know about developments in materials and processes on products

LO.4. Know about the effects of engineering technologies in the home, workplace or built environment

LO.5. Know about the environmental and social impact of engineering and sustainability of resources.