



Global Engineer: A Springboard for the Next Decade

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Abstract

Over the last decade, major engineering organizations have been competing to attract the best engineering students. For instance, Shell need top-class Project Managers and Project Engineers to fulfill this ambition; not only to execute their current projects but also to have an eye on future ventures needing to be developed in an equally safe and sustainable manner. Managing in today's environment provides many challenges and project engineers will be confronted with situations which challenge the traditional ways engineering projects have been managed. Terms such as responsive graduate engineer and innovative engineer are increasing in popularity, however, dealing with the mutual inconsistency these two terms provides a challenge to most of today's global engineering organizations. In spite of recent extensive research, there has been little consideration given to how to develop a global project engineering curriculum. This examined how a global project engineering curriculum should be developed to address needs of global engineers. Using two case studies, the results have been summarized under the following headings of: defining the process of developing a global engineering curriculum and the most important factors for successful implementation of a global project engineering curriculum. This provided a comprehensive assessment of factors that will influence curriculum development in project engineering.

Introduction

Demand for staff with key skills and knowledge of engineering project management is increasing. Many heavy engineering projects are now undertaken by multi-disciplinary teams who are responsible for the whole project life-cycle in a multi-project or programme management environment with increasing levels of complexity. As a result graduate students are expected to have a range of engineering project management skills including strategic awareness, contractual knowledge, international financial engineering competency and ethics. For instance, at present, in the UK engineering is poorly understood and beset by stereotypes. As noted by National Grid and the Royal Academy of Engineering¹, there is a lack of clarity about what it encompasses and low appreciation of its huge contribution to the society, making it almost an imperceptible industry. It is worth noting that, there is a huge possibility to raise and enhance profile of engineering, to inspire young people by demonstrating the impact of engineering's successes and to ensure more of them aspire to career as an engineer. According to Harris², warnings have emerge from leading figures in higher education, employment and management across the engineering sector. They affirm that a growing proportion of multinational engineering organizations are struggling to fill vacancies as qualified engineering students are difficult to source-at a time when the need for their operations is intensifying.

As observed from the reviewed literature, the shortage has created a near doubling of recruitment activity in Australia, Asia and South America, placing the demand for professional global engineers under greater pressure². Noticeably, leaving these vacancies open could have an impact on the global economic recovery. While a number of multinational organizations have expressed concern over the issue, not enough are taking

progressive and innovative measures to reverse the trend. For instance, if the UK government is to meet the demands of the new energy age, feed the economic growth engines and replace ageing infrastructure, the private sector must incorporate a more joined-up approach to working with the public-sector departments and educational establishments. With the challenges ahead of us, it is clear educational establishments, governments and industry must make engineering a more attractive proposition for upcoming graduates. It is essential for the long-term health of the profession that we build enthusiasm among young graduates as they make choices about their future careers. There is no easy answer to helping young graduates get more out of their limited exposure to engineering. This paper investigated some of the process of developing a global engineering curriculum and important factors for successful implementation of a global project engineering curriculum. The next section examined QAA Framework for Qualifications. This is followed by a review of two project engineering programmes at Loughborough University and Leeds University.

Application of a quality assurance agency framework

Unavoidable from scrutiny by the academic population is the QAA Framework for Qualifications in the UK. The QAA is the body representing quality standards for higher education in the UK and has prepared a hierarchy of criteria that define the expectations of study through undergraduate to postgraduate qualifications. The five categories can be summarized as:

1. Expression of knowledge and understanding the process;
2. Attaining and appraising information;
3. Formulate arguments and resolve problems;
4. Consultation; and
5. Personal development and progression³.

The above categories provide a suitable alignment with the requirements of project management studies and they can probably be applied to other subjects. There is some resonance with Dreyfus's hierarchy of learning (presented above) as the student develops through the qualification levels from novice (pre-undergraduate) to expert (postgraduate or doctoral). Observation of the Dreyfus and QAA hierarchies recommends that a capable project manager needs to be working at least at the postgraduate level^{3,4}. For study for these higher qualifications, the requirement criteria expect evidence of achievement that result from learning techniques that go beyond normal classroom practice. This suggests that gaining expertise in managing successful global engineering projects demands more than the ability to create a robust plan. We all know that global engineering projects are delivered through people i.e. sponsors, customers, suppliers and the project team. Therefore, skills associated with working effectively with project teams need to be carefully sharpened. This need for effectively organizing both task and people makes the project engineer's job extremely difficult even when delivering relatively small projects. The developing focus on topics related to project teams, such as, multicultural team working, indicates recognition of these people-related skills. It is vital to acknowledge that such skills go outside the initiatives of researchers, such as, Meredith Belbin, Abraham Maslow and Eric Berne. Observers of natural environments within establishments are now drawing upon ideas from the "new science" or complexity theory. Indeed, assessment against the QAA criteria expects abilities in dealing with complex project situations to align with the higher undergraduate and postgraduate

qualification levels. There is a developing literature that draws from complexity theory and brings it into the realms of management and organizational interests. Anderson ⁵ (1994) and Miller (1999)⁶ introduce this development. This body of knowledge suggests that an organization exhibits emergent properties that follow the same principles as complex systems.

What does all this mean when applied to a global project engineering curriculum? Fundamentally, it suggests that global engineering project management is not as forthright as initial inspection would imply. The learning environment must provide engagement with managing a complicated activity as well as dealing with the team involved with the project. Gaining and validating proficiency in this type of learning environment is difficult enough but to gain any benefit from learning, the expertise must be transferred to the place of work. Knight and Yorke (2003)⁷ refers to “near and far transfer” that describe the stages of application of such learning. “Near transfer” demotes to, for example, online/classroom based activities or problem-solving case studies, which illustrate application of gained knowledge within a controlled environment. Here, learning facilitators are on hand to assist or to provide guidance. On the other hand, “far transfer” links to the place of work situation where application becomes more difficult due to the nonexistence of instructor support and many real world effects that increase both complications and complexity.

Case: Two UK institutions (Loughborough University and Leeds University) ^{8,9}

The two institutions have Project Management Programmes which have existed for over five years and the experience suggests that the modules do provide sufficient stimulus to enable graduates to acquire global engineering skills. The difficult barriers of a global project engineering need to be encountered for effective learning and development of global project engineering skills at postgraduate level and undergraduate level. Therefore, how can we ascertain a project environment as close to reality as possible? Within any programme of syllabus, there is a palpable project with real outcomes, stakeholders and benefits to be accomplished. This project is the programme itself. Its outcomes are the allied coursework and assignments; the stakeholders are other learners, instructors and teaching colleagues; and the subsidies are possibly the learning itself, the achieved criterion and significantly what you are now able to do as a result of that learning. This project is personal and assuming the learner has selected to attend the course there is dedication. Such personal commitment with the course can be planned and managed like any other project; nonetheless, most learners do not seem to bother!

To commence a consequential level of personal commitment planning, there needs to be enough obtainable data about the course. On the other hand, does there? Real projects do not have readily accessible data, project features have to be sought. How long does it take to compose a coursework? How long does it take to peruse this coursework? The responses differ from person to person, so the time needed must be approximated and then equated with the real time – just like a real project life cycle! Of course, designing a plan is only part of a project life cycle. The plan can be weighed up in remoteness but the actual quality of it is not apparent until it is used to deliver the project life cycle. This is when real learning about planning takes place. What was erroneous with the plan? What happened to deliverables and what did not? How did the plan hold together and how did the team translate what the plan said? How well was the plan sustained as a framework towards project life cycle achievement? These questions help to inform how good the original plan was and provide

learning that facilitates upcoming planning activity. Therefore, weighing up the initial plan will not encapsulate adequate vigour of learning about planning; we also need to appraise how the plan is worked to project life cycle completion. This can be attained through a forthright project audit procedure if documentary data of life cycle progress reviews is sustained and incessant evaluation is determined.

To help institute and widen project engineering skills, we have a personal project task with high stakes i.e. project engineering curriculum. However, to be thriving in today's project engineering surroundings, most skilled global engineering project managers require interpersonal skills, particularly with team involvement and interaction. Within an empirical course of learning, this suggests a team project task. Even so, to provide team engagement with a project that creates dedication, encourages team focus and provides actual delivery appeared not so forthright. As with individual projects, assessment of teamwork can be effectively carried out using chosen project scheduling and monitoring audit techniques. In order to commence these real projects there needs to be good stipulation for teacher support. In case studies and simulations, educators are aware of the fine distinction of the project as the experience becomes repeatable and often stale¹⁰.

However, with a real project, the task is new and the level of improbability becomes demanding. Teachers need to be able to help with this type of commitment to facilitate efficiently the emergent learning. The above examples of individual and team project tasks form a secure basis for "far transfer" of learning. There needs to be a concluding phase to ascertain that learning has actually been conveyed into a project engineering environment and that involves evaluating the post-transfer phase. At this point, "far transfer" gains from personal inspiration derived from thriving "near transfer" as the result of effectual individual and group assignment. There is a clear viewpoint about what is a flourishing project that leads to accomplishment of a vital outlook about the "far transfer" procedure. Learners can be persuaded to cross-examine decisively how their planned growth occurred and to monitor any deliverables from their altered practice. This crucially reflective type of review is usual in Higher Education, providing an arguable conclusion to the learning project activity. The following section provides engineering educators with a palate of tools for how to structure a project engineering curriculum.

Process of developing a global curriculum

Programme aim

- Produce global engineering professionals who are able to provide a more holistic perspective of global project processes; and
- Provide students with an innovative and forward-looking view of managing global engineering projects.

Learning outcomes

- A higher level of generic and transferable management skills;
- A better understanding of the principles of global project management within a global engineering environment;

- Familiarization with global engineering problems encountered and the techniques used in the appraisal and implementation of projects;
- A positive attitude to the setting and achieving of realistic performance targets; and
- A better understanding of working in global structures, with a variety of procurement routes and an emphasis on collaborative working throughout the project life cycle.

Implementation: Course content

The following modules should be undertaken:

| Modules | Contents | Course |
|---|---|---|
| Advanced Engineering Project Management | <ul style="list-style-type: none"> • This module should examine aspects of engineering project management to advanced level, fully integrating complexity and uncertainty. • On completion of this module students should be able to critically evaluate complexity and uncertainty. | MSc Engineering Project Management/MSc Engineering Management |
| International Project Finance | <ul style="list-style-type: none"> • Should address the current methods of financing major national and international projects and provide a review of funding practice and policy. • On completion of this module should be able to apply current international finance methods on global engineering projects. | MSc Engineering Project Management/MSc Engineering Management |
| Principles of Project Management | <ul style="list-style-type: none"> • The aim of this module should be to provide students with an understanding of project management principles. • On completion of this module students should be able to identify stakeholders in global projects, analyze stakeholder perspectives, define projects success and develop appropriate enhance control mechanisms. | MSc Engineering Project Management/MSc Engineering Management |
| Leadership and Multicultural teams | <ul style="list-style-type: none"> • To introduce students to the range of techniques and strategies for managing multicultural teams within the context of a global engineering project. • On completion of this module students should be able formulate innovative human resource solutions and strategies which are aligned with the business processes of a modern global engineering organization. | MSc Engineering Project Management/MSc Engineering Management |
| Risk Management | <ul style="list-style-type: none"> • To introduce students to global risk management processes and techniques. • On completion of this module students should be able to apply various risk management techniques | MSc Engineering Project Management/MSc Engineering Management |
| Global Strategic Management | <ul style="list-style-type: none"> • This module should address planning process, international business strategy, alliance and joint ventures, international marketing and knowledge management. • On completion of this module students should be able to apply strategic management tools and appraise strategic positions of global multinational engineering organizations. | MSc Engineering Project Management/MSc Engineering Management |
| Global Procurement and Contract Procedure | <ul style="list-style-type: none"> • The aim of this module should be to develop students understanding of procurement methods, different forms of contract and contract practice. • On completion of this module students should be able to analyze and evaluate how the global general law affects all types of global engineering projects. | MSc Engineering Project Management/MSc Engineering Management |
| Ethics in project management | <ul style="list-style-type: none"> • To introduce students to ethical standards in global project engineering. • On completion of this module students should know how to act when faced with an ethical dilemma. | MSc Engineering Project Management/MSc Engineering Management |
| Research Dissertation: Engineering | <ul style="list-style-type: none"> • This module should provide students with the experience of the process and methodology of research by defining and studying a complex global engineering problem in a specialized area. • On completion of this module students should be able to analyze data using appropriate methods that deal with complex global issues, and draw conclusions from the collated data; and present research findings using both written and verbal presentation techniques. | MSc Engineering Project Management/MSc Engineering Management |

Approaches to learning and assessment

There is the need to identify the current and future subject base. This is addressed by several initiatives, such as, the British Standard 6079 for Project Management, the UK Body of Knowledge developed by the Association for Project Management and journals, such as, the International Journal for Project Management. Regular project management practitioner

conferences are held and these make a valuable contribution to the overall subject area. They provide a reality check on their war stories and valuable data from case studies. Project management is a phenomenon; it is no more than what those involved with the discipline and profession says it is. The fact that there is no agreed single definition for global project management could be in part because the subject base needs to adapt to constant changes, a feature that could prove to be its enduring strength. Secondly, and arguably just as important, there is the need to provide the most appropriate learning and assessment environments to enable students to achieve their potential. This area has to date received less attention than the drive to define ‘how to?’ and ‘what is?’ global project management. The market place is full of courses that offer training in project management under various headings, styles and outcomes. The cost to industry of this training is immense and my observation of its effectiveness is that it offers minimal change in practice. Experience tells us that it is difficult to assist our students to learn the skills needed to manage global engineering projects effectively.

Entwistle (2000)¹¹ suggested that there are three approaches to learning: surface, deep and strategic. A surface approach to learning entails avoidance of engagement with meaning. This is a short range view that relies on memorizing facts. Perceptibly, global project engineering does not lend itself to this approach as the simple memorizing of techniques or approaches from theory are insufficient to develop the skills suggested by the literature. A deep approach suggests real engagement with the subject where meaning is established through a critical perspective. In a time bound programme of study, this presents difficulty to the extent of the learning necessary within a given period. In a more pragmatic approach to learning, developing a strategy to identify the important demands of the subject and focusing upon these, allows the student to manage study time effectively. After all, is this not the way we approach our project work? In order to align learning activities with the desired intentions it is vital to ensure that the assessment measures are also allied to the learning intentions. What get measured gets done. If we are to develop global project engineering programmes using a strategic approach, as programme designers we must be very clear about what we expect to be learnt and then institute strategies to certify its achievement. However, as educationalist, we know there is a hierarchy of learning development that suggests progression from the acquisition of knowledge through skill development into application in practice.

From the reviewed literature, curriculum development and revision theories have provided concepts for higher education, recently the British “Teaching and Learning Support Network (LTSN) based on Biggs (1996)¹². “*The key is that the components in the teaching system, especially the teaching methods used and the assessment tasks, are aligned to the learning activities assumed in the intended outcomes (Biggs 1996)*”. According to Heitmann (2005)¹³, the alignment process can encompass more dimensions than learning outcomes, teaching activities and assessment. Internationalization has become a main challenge and driving force not only for restructuring Higher Education System and competing on a global educational market but also for revising curricular and providing teaching/learning facilities which promoted an engineering education with an explicit international profile (Heitmann (2005).

Challenges and opportunities

As illustrated above, globally, project management teaching is facing several challenges. The incorporation of real case studies through the provision of suitable learning environments, and the need for learners to reflect on their own skills and attitudes to projects, has been identified as an essential approach to promote more sensible and sufficient responses to

current complexities we face in managing projects¹⁴. In an attempt to learn from projects, the two UK institutions have incorporated corporate learning in their programme portfolios. Corporate learning extends the margins of project management to include:

- consistent delivery of projects with excellence
- alignment with client expectations; through
- understanding and definition of the project life cycle;
- service delivery to produce a quality product¹⁴.

The above objectives are attainable through delivery that is dispersed, captured and facilitated. The new global economy is now complex and uncertain. For instance, the Eurozone crisis took us all by surprise and still has colossal unexpected effects. The interest in understanding how a global project engineer can deal with complexity has transcended into the higher education curriculum. At present, a number of undergraduate and postgraduate courses integrate insights on project typologies, groups and management skills in order to encourage learners to think how they could better utilize their project management skills¹⁵. Any project management curriculum developed by higher education institutions needs to take into account the universal nature of the new global economy. Cordoba and Piki¹⁶ suggested that a possibility for improving project management engineering can be achieved by offering generic project management in educational institutions whilst practical project management can be delivered in practice-related settings. However, this should be carried out without disengaging the two.

Conclusion

Some insight into the devise of a project engineering curriculum has been explored. In developing a project engineering curriculum consideration of programme objectives, learning outcomes, assessments as well as performance indicators should be taken on board from the beginning. Every stated learning outcome must be assessed and evaluated. It is no longer processed or teacher centered, but is should be centered on the needs of organizations and student. Programme outcomes should address knowledge, skills and attitudes to be attained by students. There is no easy answer to helping students get more out of their limited exposure to project engineering. Institutions must ensure that the curriculum is coherent. Governments, academic institutions, professional bodies and industry must work closely to ensure greater exposure to project engineering, research and development.

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