

Contextual Engineering Education – Industry Involvement in Engineering Education

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***Abstract:** The increasing complexity of the engineering workplace continues to present a challenge to engineering educators to be able to provide students with engineering skills and knowledge that are readily transferable to the practical engineering workplace.*

Industry has the ability to participate in the education of future engineers, but it needs to be in an integrated manner, rather than ad hoc guest lectures. In recognition of this the John Holland Group (JHG) and CQUniversity, have implemented the “Engineers for the Future” program. Within this program, practising John Holland professionals deliver industry relevant lectures to all levels of the CQUniversity Engineering student cohort.

This paper outlines the introduction and implementation of the “Engineers for the Future” program, and details the benefits and issues that have arisen. While the program is only one year old, it has provided the basis for a relationship that has positive outcomes for both parties.

Background

The John Holland Group had developed a strong relationship with CQUniversity through their involvement in the university’s engineering co-op program. This program requires engineering students to undertake two paid, 6 – 8 month periods of work placement in their 3rd and 4th years of study. John Holland had been a consistent employer of CQUniversity undergraduates within that program.

In early 2008, Central Queensland based employees of the John Holland Group’s Structures and Mechanical Process Division (now Energy & Resources) formed the Mackay Leadership Group within John Holland. This group recognised that, despite the excellent academic tuition that graduate engineers received, many lacked industry knowledge or understanding of how to apply their engineering theory to the workplace and that there was a difficulty in attracting graduates into the engineering construction industry.

The Mackay Leadership Group identified a number of key areas within their business where they had the expertise to deliver workshops to university students and developed a series of industry topics for consideration by CQUniversity for implementation into its engineering program.

CQUniversity, because of its co-operative education program, is continually aware of the need to produce students who are industry ready, prior to graduation, in order for the co-op employers to have students who are of value to them. The more industry ready the students are, the more that they can gain from the co-op work placements. The employability of the students is a major component of the success of the co-op program. The term employability, according to Franz (2008), “is often referred to in association with ‘skills’ and the ability to get the most out of employment both for the employee as well as the employer”. The co-operative program is a form of work based learning, however as stated by Hunt (2006), “like any other teaching and learning tool, work-based learning is not in itself valuable. The full potential of work-based learning is only realised by the pedagogy that informs its application”. Both Hunt (2006) and Orrell (2004) conclude that the the operational and support infrastructure put in place at the organisational level to support it is critical.

The CQUniversity co-op program is supported by the project based pedagogy that had been introduced and developed to aid in ensuring that students were ready for the workplace by the end of their second year of study. The approach from John Holland was of value, because it identified areas where students could be made more industry ready, and provided the current, relevant expertise that is difficult to maintain in the academic environment.

Development of an Integrated Educational Partnership

While there are many cases of academe - industry partnerships for education (Tenenberg 2009, Toor & Ofori, 2008) At the start of the partnership, the key objectives for the partnership, and the supporting approaches were stated as:

- To increase the industry relevance of CQUniversity engineering degrees and the quality of graduating engineers.
 - John Holland will assist CQUniversity with the development of engineering students by contributing to the teaching process and course development. This will be facilitated through:
 - JHG entering the class room to provide workshops focussed on current industry workplace practices.
 - JHG providing CQUniversity course administrators with regular updates on industry requirements for engineering capabilities during the development of course curricula
 - JHG providing engineering students with practical experience of working on construction sites
- To Provide JHG with an advantage in the early identification, recruitment and selection of promising engineering graduates
 - The work placement component of the Co-op program will provide John Holland with a valuable opportunity to witness the performance of engineers in the workplace prior to their graduation from university. This will assist John Holland in optimising its recruitment and selection processes and ensure that new recruits to the business fit both technically and culturally.
- Assist JHG with project delivery by future proofing the business against potential engineering resource shortages
 - John Holland aims to create an enduring relationship with both CQUniversity and its students. By playing an active role in the development of CQUniversity’s students and assisting the university in the improvement of course content, it is anticipated that the EFP will generate and enthusiasm for people to enter careers in engineering. This will reduce the pressure experienced by many construction companies who currently experience difficulty in sourcing adequate engineering resources to deliver their projects.

The Engineers for the Future Program

The goals and approaches stated above became the basis for what was to be named the “Engineers for the Future Program”. The Mackay Leadership Group of John Holland identified initial areas for development into workshops, and provided details of the purpose, method and practical elements they felt would be advantageous in the Engineers for the Future Program. These areas were:

1. Safety Procedures and Systems in Industry
 - 1.1. Safety Leadership
 - 1.2. Planned Inspections and Auditing
 - 1.3. Incident Investigation
 - 1.4. Emergency Preparedness
 - 1.5. Risk Management
2. Quality Assurance
 - 2.1. General QA Overview
 - 2.2. Project Lot Methodology
 - 2.3. Inspection and Test Plans and Check Sheets
 - 2.4. Quality Control, A Function of Quality Assurance
3. Environmental Requirements
 - 3.1. Construction Methodology in Environment
 - 3.2. Environmental Legislation
 - 3.3. Environmental Management Plans
 - 3.4. Environmental Management
 - 3.5. Temporary and Emergency Works
 - 3.6. Working with Endangered Species
4. Marine works / False works
 - 4.1. Construction Methodology
 - 4.2. Construction Loads
 - 4.3. Temporary Works
 - 4.4. Marine Works
5. Planning and project controls
 - 5.1. Introduction to Planning
6. Estimating
 - 6.1. Introduction to Estimating
7. Contract Administrations / Risk Management
 - 7.1. Contract Administration
 - 7.2. Risk Management
8. Commercial Management
9. 4P’s – The John Holland Way
 - 9.1. People, Performance, Partnership, Profit – The John Holland Way

Staff at CQUniversity assessed how the proposed workshops could be integrated into the engineering program. To ensure seamless integration, it was essential that the workshops were relevant to the course the students were studying. As the delivery philosophy at CQUniversity is a project based approach, the workshops needed to provide a beneficial addition to the project knowledge and be integrated into the delivery. It was also considered essential that the program be spread across each year of the degree to create a consistent approach. Both the JHG team and the CQUniversity team wanted the students to see a partnership between the two organisations, and to expect JHG to be part of their learning environment. The final proposed program was as follows in Table 1 below.

A trial offering was made in the second term of 2009, with the full program being implemented in 2010. The trial offering allowed John Holland to progressively develop the workshop materials and for the John Holland staff to gain feedback from a small number of offerings. The trial allowed

CQUniversity program staff to gauge the impact of the workshops, and to redesign their courses to ensure that the next offerings were integrated into the curriculum, rather than seen as guest lectures.

Table 1 John Holland / CQUniversity Engineers for the Future 2010 Program

Year of Degree	Term 1	Term 2
1	CQUni Course - Engineering Skills 1 Wk 1 - Introduction to EFP Wk 4 - 1.3 - Incident Investigation	CQUni Course - Engineering Skills 2 Wk 6 - 3.2 - Environmental Legislation Wk 7 - 3.7 - Working with Endangered Species
2	CQUni Course – Design Planning Wk 2 - 5.1 - Introduction to Planning Wk 5 - 7.1 - Contract Administration Wk 6 - 2.1 - General QA Overview	CQUni Course - Professional Practice Preparation 1 Wk 8 - 9.1 - The John Holland Way CQUni Course – Design Implementation Wk 6 - 6.1 - Estimating Wk 9 - 4.1 - Construction Methodology and 4.2 - Construction Loads Combined
3	Co-op Placement 1	CQUni Course - Professional Practice Review 1 Wk 3 - 1.5 - Risk Management
4	CQUni Course - Professional Practice Preparation 2 Wk 3 - 8.1 - Commercial Management - General	Co-op Placement 2
5	CQUni Course - Professional Practice Review 2 Wk 3 - 3.3 - Environmental Management Plans) and 3.4 - Environmental Management Combined	

Benefits and Issues

Industry experience

John Holland is a strong supporter of the CQU engineering co-op program. Through being a consistent employer of CQUniversity undergraduates over a number of years John Holland is now seeing the fruit of this involvement offering employment in the 2 year John Holland National Graduate Program for 2011 to 4 CQU graduates. Students with industry experience coupled with academic excellence make sought after candidates. In the most recent interview round, 5 out of the 6 nationally short-listed candidates were from CQUniversity.

Engineers for the Future Program – Graduate Workshop

Through the process of developing the “Engineers for the Future Program” to be delivered to CQU students, it was discovered that the same knowledge gaps (that the program was targeting) exist within the current cohort of John Holland graduates. On this basis it was decided to run the program in an intensive format over 2 days for all Northern Region John Holland Graduates.

The key objective with the internal program was to eliminate knowledge gaps within John Holland’s Graduate Engineers by exposing them to the ‘Engineers to the Future Program’.

The Engineers for the Future Program - Graduate Workshop focused on the elements involved in completing a project successfully within time, quality and budget constraints in a system that delivers safety to the people, environment and community.

John Holland content specialists delivered presentations to John Holland Graduates on the following topics:

- The John Holland Way
- Introduction to Planning
- Commercial Management
- Environmental Management
- Environmental Legislation
- & Working with Endangered Species
- Incident Investigations
- Contract Administration
- QA Overview
- Risk Management
- Estimating
- Construction Methodology & Construction Loads

Due to the overwhelming success of the internal program The ‘Engineers for the Future Program’ will form part of the John Holland National Graduate Program for future years.

The John Holland Graduates believed that through the presentations, they received a better insight in to areas of the business that they had not previously been exposed to, and that this would assist them with the development of their careers. They also commented that the program gave them not only critical information about the business but enabled them to make personal connections with key personnel.

Evidence of Success

CQU Student feedback – survey comments

The first offering of the Engineers for the Future Program is nearing completion. A survey to evaluate the workshops was conducted at the end of each workshop, with the results going directly from the students to John Holland. The students were very appreciative of the effort made by John Holland.

Some of the student comments from the surveys are:

- I found the project planning and discussion of how projects go wrong very interesting.
- I now understand the role of the engineer in commercial management, because it was explained well.
- The examples used throughout the presentation allowed me to understand the topics much better.
- I now know how much responsibility the engineer does have in regard to the commercial outcome of a project.
- The program was good for people interested in the construction industry.
- I thought the presentation I attended will be beneficial to me now and into the future.
- Interesting to see how other companies conduct their QA.
- I appreciated seeing real life applications and examples, showing the integrations of the end product, the standards and how everything comes together.
- It would be beneficial if a demonstration of how the programmes work that John Holland uses.
- More case studies. Very interesting how the project was completed.
- It was great to see what tools actual industry is using and showing examples in context.
- Case studies were good seeing how John Holland incorporates the theory with their practice.
- Practical insight into contract management.
- I now understand the importance of timeliness and a tight contract

Reflections / Recommendations

Considerable time and resources continue to be committed to the development of this unique industry and education initiative by both CQUniversity and John Holland. It is vital that the program continues

to be fully integrated with the Engineering curriculum and not just a series of industry visits to the students.

John Holland supports the program through financial commitment which includes travel and accommodation for content specialists and support staff to deliver on site in Rockhampton. Further financial commitment includes the development of promotional materials including flyers, programs and posters and attendance at other associated occasions and initiatives such as employing CQU Co-op students and continued Gold Sponsorship for the GECon (Graduating Engineers Conference).

John Holland's belief in the positive outcomes of the program for both industry and the education of developing engineers is shared by the John Holland content specialists who continue to support the program choosing to be involved over and above the scope of their roles. The construction industry is a demanding, fast paced industry however John Holland staff are committed to the delivery of industry relevant information to students at CQU.

The Engineering program is committed to the Engineers for the Future program, and supports that commitment with the co-ordination of all the workshops and a team of educators that work with the John Holland representatives to ensure that the workshops are relevant and timely within the engineering program.

Moving forward John Holland would like to introduce a recognition and reward component to the 'Engineers for the Future Program' which will recognise students whose involvement in the program goes beyond regular attendance at the sessions. The design, objectives and desired outcomes for this development are still to be considered by both John Holland and CQUniversity.

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