

## **2006-1281: CONTENT ENRICHMENT - EXPLOITING THE CYCLE FROM ACADEMIA TO INDUSTRY TO ACADEMIA**

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## **Content enrichment – exploiting the cycle from academia to industry to academia**

### **Abstract**

The quest for balance between theory and practice in education is always a challenge and it is usually resolved according to the personal experience of the course presenter. The purpose of this paper is to report on a way to widen that experience through a series of interactions between a newly emerging academic program on electronic systems and training courses delivered by a consortium of high-tech companies. The concepts covered in both programs are very similar. However, the experience of the participants and the desired outcomes in terms of applicable skills are very different. By sharing content and using the rapid reconfiguration procedures inherent in web-supported delivery, we have been able to exploit the synergy between the academic and industry activities. The experience has clarified educational priorities and improved the learning effectiveness for all participants – including the faculty.

### **Origins – parallel programs**

Many academic courses are reformatted and offered as industry short courses. Less often, courses developed within companies migrate to the academic world. This paper describes experiences where course materials have made several transitions between industry and academia collecting significant enhancements for the recipients on each occasion.

The academic applications are in an electronics systems degree program that is being set up at a new campus of one of the university partners. The industry courses have been developed under the auspices of a State-wide consortium of aerospace and electronics companies in alliance with three state universities. Life-long learning easily becomes a cliché, but for the consortium members it is a way of life for a workforce that has to adapt to rapidly changing technology to succeed in global markets. The implications have been a feature of every recent ASEE Conference as well as CIEC workshops<sup>1</sup>. The main features to address the industry requirements are:

1. Design courses to meet industry needs and schedule for convenient times, locations, and course length.
2. Reduce overall engineering and manufacturing education training costs through pooled resources and best practice experience.
3. Enhance and extend the ongoing relationships with the State's universities.
4. Build a network between high tech industries and state officials to have alignment on policies for education and economic development.
5. Develop a database of contextual industry cases that can be used by the universities to extend the engineering skill set of graduates.

6. Demonstrate the benefits of a continuous learning environment with current courses and quantify their impact on all stakeholders.

The procedure used by the consortium in this case to develop and deliver industry short courses has been to share internal (non-proprietary) courses with other consortium members. For some topics, academic courses have also been adapted to suit the 1 – 2 day short course format. Over 12 years, a successful portfolio has been established and it continues to evolve successfully. Most courses are now grouped into one of 5 clusters that define a certificate after about 100 hours of class time. The content and format of courses within each certificate is overseen by a Learning & Competency Team (LCT) composed of industry and academic experts. They meet every 6 – 8 weeks to review progress and the changes that need to be implemented. It is no coincidence that when ABET required a similar process to be stated for accreditation, the structure used to manage change in academic programs was very similar. With some simplification, the two development processes have been combined in figure 1.

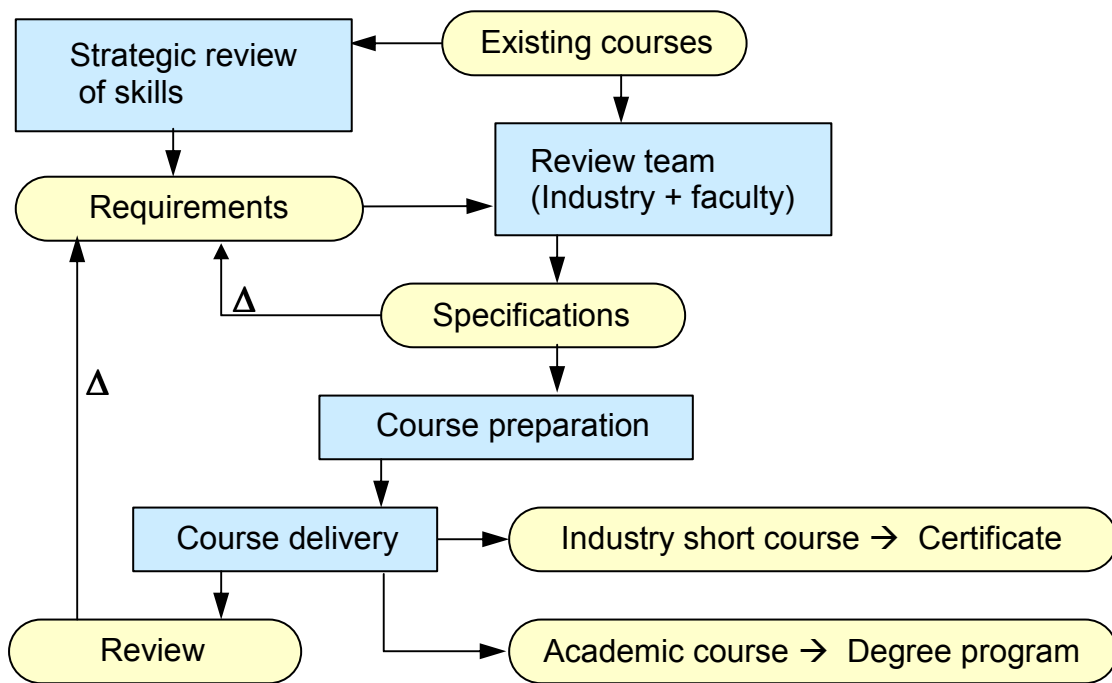


Figure 1. Correspondence of management process for academic and industry courses.

### Academic course requirements

The courses for the Electronics Systems degree program might well have evolved along conventional academic lines where there is a never-ending challenge to squeeze ever-more content into a severely constrained curriculum. The usual

outcome for such a process is that the program starts well but never quite reaches its intended applications demonstrations. However, in this case, two significant changes have altered that scenario:

1. The ABET requirement for a documented change process injected a much stronger planning phase that required industry inputs. The emphasis on outcomes and systems thinking also showed that there are many combinations of content that can be used to achieve the desired effects.
2. The Department worked closely with its Industry Advisory Board to generate a strategy plan based on the Balanced Scorecard process. This process also emphasized outcomes in terms of graduate skills and their application context.

The combined effect of both activities is that the expectations from the academic courses have changed. Traditionally, students were given well-defined problems and were expected to be able to apply pre-defined solution methods. Now, the challenge is to examine requirements, to frame a problem and to apply an appropriate solution. It is much closer to the style of operation in the workplace and it has received warm acknowledgement from the student cohort who are already in jobs.

One of the common outcomes from this approach is that when realistic problems are considered, the formulation process comes to a crashing halt because no-one knows how to find a solution. It may be too complex, ill-defined or simply needs skills that are not yet known. That situation is inevitable if we don't start with a prescribed solution but it is also typical of the workplace. Being able to refer to similar experiences within a company clearly helps to relieve the 'dead end' outcome. In a personally supportive way, it acknowledges that our ignorance on most topics exceeds our knowledge but there are ways to move forward. It also provides a good starting point to look at approximations and ways in which the issues can be clearly stated so an external expert could understand what is being requested.

The following results outline how course development for industry and academic courses proceeded in parallel with many synergistic interactions over a period of about 18 months. This paper is limited to just two cases which deal with data acquisition and business operations.

### **Data acquisition**

Instrumentation (with the associated circuitry and sensors) for data acquisition has been a traditional staple for all electronics courses. However, the job – and therefore the associated skills to do it well – is changing significantly as more functions are integrated on to silicon and computers are used to collect, store and manage the data. The high level of automation that can now be implemented at

modest cost certainly removes the tedium of manual readings but it can also hide problems. The new technology poses challenges for both academic and industry users and some course overhaul is needed as a result. In both cases, the generalized configuration to be managed is shown in figure 2:

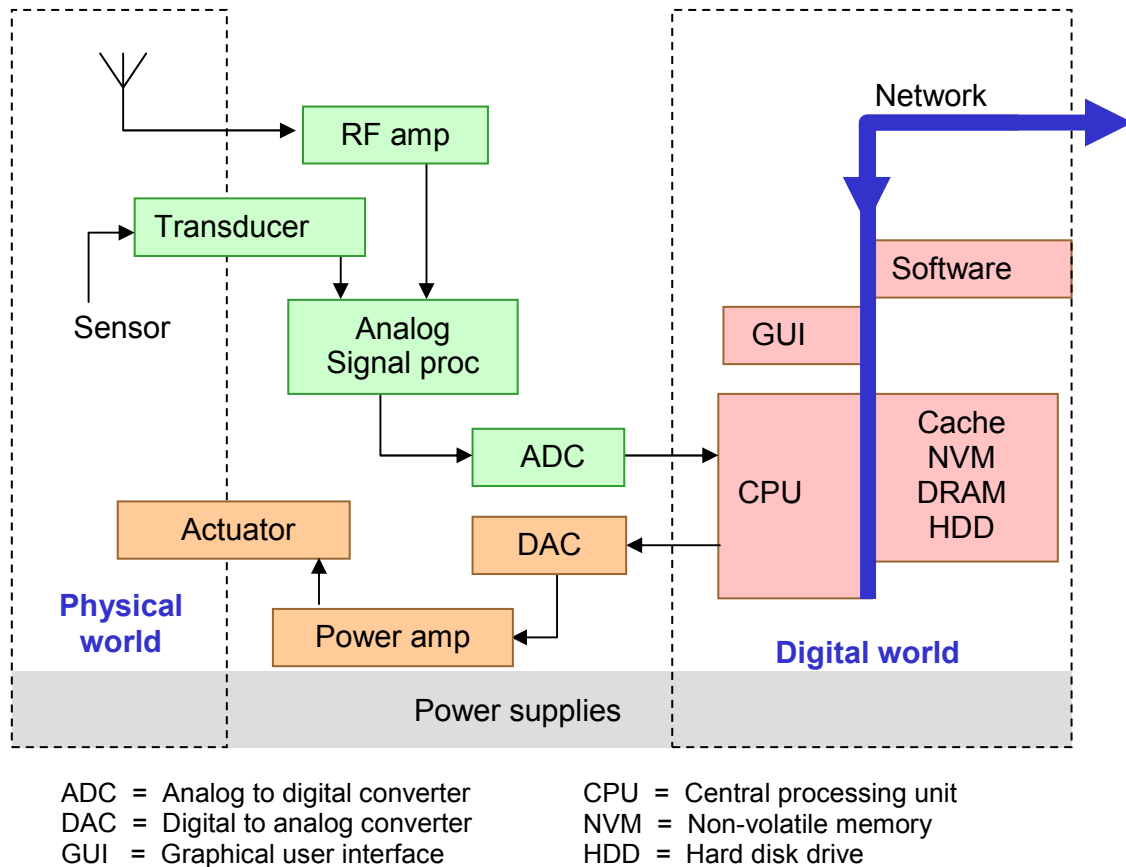


Figure 2. Generalized data acquisition system

Within the industry consortium, the applications are constrained by business interests and therefore familiar to all the participants. The immediate objective of the short courses is to emphasize best practice and ensure that the process really does work as intended. However, there is also a more fundamental issue. Computer-based instrumentation has changed many job specifications. Once, there were many technicians connecting up sensors and taking readings. They reported to test engineers who managed the tactical process of setting up tests and structuring the results. The outcomes were then distributed to product designers, systems engineers and eventually to customers. With fully networked test systems, there is much more transparency, so data organization has to be done *before* any measurements are made rather than after. From a knowledge and understanding viewpoint, the result is that everyone in the data chain needs to have greater understanding of the way the systems works – what is safely reliable and where limitations and problems can arise.

The academic case has similar scope. A new curriculum on Electronics Systems is being implemented. The starting point was a general introduction to the range of applications in first year followed by more detailed courses on components, building blocks and network design later. The applications of the industry consortium provided a ready-made freshman starting point. They ranged from car track testing through gas turbine performance to clean room facilities and tool operation. Together, they provided realistic cases and brought a sharp focus on operation in a hostile or demanding environment. The academic program was therefore able to kick-off with good documentation and practical demonstrations in visits to local companies. The benefit to the industry activities from this parallel academic program was to have the whole taxonomy of theory, design and new technology available in a structured format. The LCT was able to select and assemble the topics most useful for the evolving short course series.

With the introduction of integrated sensors and direct computer links, instrumentation system design is usually a lesser problem than its effective application. The user needs a mixture of good trouble-shooting capabilities, practical skills of a very high order and a sound understanding of the limits of the design. The vast practical experience of the industry consortium provided many good case studies for the academic courses. They also had data on the most typical problems and effective processes to be followed for diagnosis and correction. For example, data transmission in noisy environments is more analog than digital and undesired wireless transmission is everywhere.

The result is represented in figure 3. It briefly shows the back and forth flow of experience and documentation that was able to substantially assist both efforts even though the objectives and conditions were radically different.

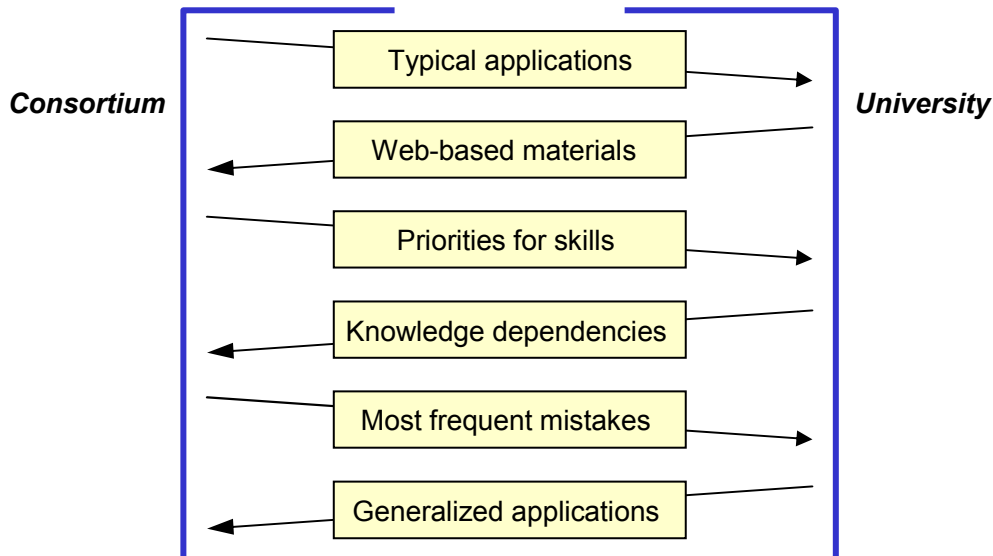
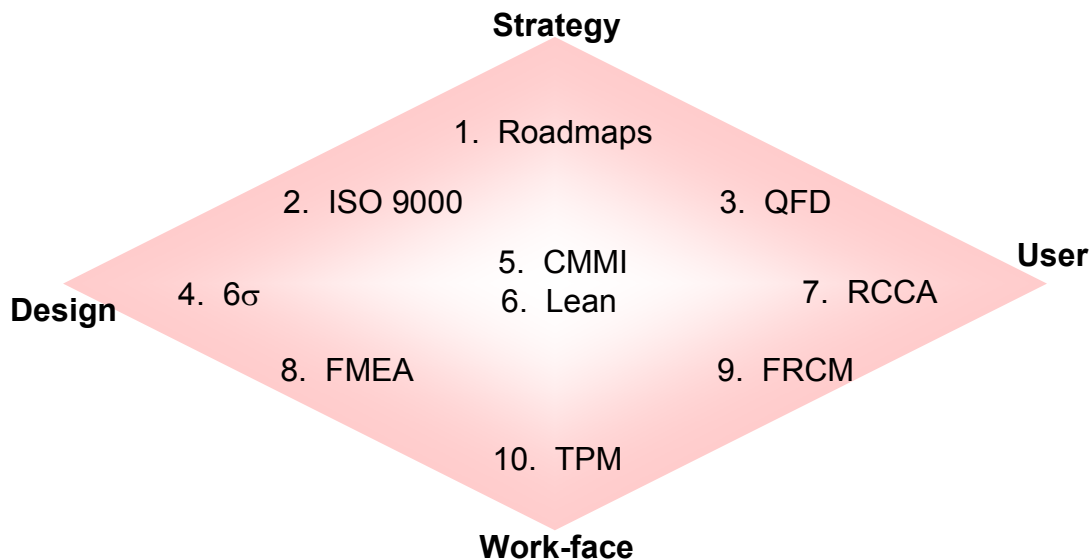


Figure 3. Information flow between academic and industry courses

## Business processes

Over the last 30 years, most large technology-based companies have systematically concentrated on what they perceive to be their core competency either as specialist suppliers or as system integrators. A side-effect has been that many functions that were once done in-house are now outsourced – not necessarily to US-based suppliers. A feature of systems management at this level is the staggeringly wide range of issues that have to be addressed by the technical leaders in each company. To meet the challenge, the industry consortium has developed a Chief Engineer Certificate<sup>2,3</sup>. It uses internal company courses and others adapted from the university graduate-level systems management program. The outcome from several delivery cycles of the certificate program is that we now have a unique insight into the work profile and skills attributes of the engineering leaders in the participating companies.

The industry experience has provided a very convenient framework that can be used to address a much-debated deficiency in academic programs - the development of personal skills to comprehend and fully participate in the many processes used to enhance quality and business efficiency. The range of topics is represented in figure 4:



**Key:**

- 1 Roadmaps for product and the industry
- 2 ISO 9000 process and its derivatives
- 3 Quality function deployment (QFD)
- 4 Six sigma methodology
- 5 CMMI measures for software
- 6 Lean operations
- 7 Root cause & corrective action (RCCA)
- 8 Failure Modes & Effects Analysis (FMEA)
- 9 Field results correlation matrix (FRCM)
- 10 Total productive manufacturing (TPM)

Figure 4. Framework for business processes

The application started in 2003 as a small part of a junior-level course. It is now a full (3 SCH) course for both BS and MS students. The impact of the course can be determined very readily by the number of times that working students declare that it is the one course they wish had been available earlier in their academic career. Many full-time students, even in a Technology department, have no idea these processes exist or the need to have everyone in the organization fully committed to them. One of the outcomes has been to identify the competencies that can be expected from beginners. In turn, that list is now the starting point for other industry short courses aimed at the early stages of professional development that will eventually lead into the chief engineer program.

The back and forth movement of information in this case is shown in figure 5.

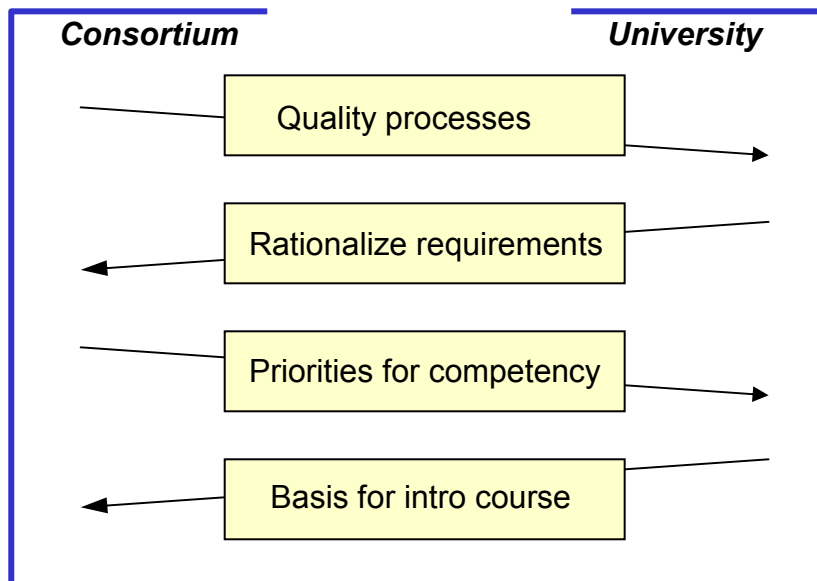


Figure 5. Information flow between industry consortium and academic program

## Conclusions

As we try to re-engineer the essential features of the degree program and show the scope and diversity of careers in technology, current high-level examples from industry are essential. The outcomes from the education process are there for all to see in the interaction between technical skills, cost and global markets. However, access to the information and experience does not come readily. It requires commitment, persistence and a coherent vision shared by all academic and industry participants. The results described in this paper are capable of further enhancement as the adaptation of similar content to meet the needs of each



learning group brings many synergies that continue to enrich both academic and industry programs.

### **Acknowledgements**

The authors gratefully acknowledge the contributions and support received from their colleagues in both organizations and the participating companies.

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