

Study on the Industry Oriented Education for Computing of Ireland and Its Application

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Abstract—This paper analyzes the mechanism of Industry Oriented Education of Ireland, especially in DIT and extracts useful experience to the education process of pilot software schools of China. To make an industry-oriented programme development, many key factors should be taken into account, including Quality Assurance System, advanced Ethos and Philosophy of industry-oriented education, modern teaching and learning methods, mechanism of work placement etc. The industry-oriented education model would be a great helper to the development of 35 pilot schools of China.

Keywords—Industry-Oriented; Programme Development; Quality Assurance System; Ethos and philosophy of Education

I. INTRODUCTION

During the past decade, Ireland has gained increasing recognition as Europe’s premier location for software development. Since the 1980s, most leading US software vendors, including Microsoft, Oracle and Symantec, have based their European operations centres in and around Dublin. The country has also become the pre-eminent site for software localisation in Europe.

Comprise of approximate 600 companies, their exports amounted to €1.5 billion in year 2002, an increase of more than 5 percent over the previous year. Ireland successfully developed one of the world’s leading software industry, it has particular strengths in systems software and middleware; insurance and banking applications; telecommunications software; e-learning; and healthcare.

Ireland’s success comes from both its telecommunications infrastructure and its flexible, well educated graduates who could be integrated rapidly into the workforce. Dublin Institute of Technology (DIT) is the largest higher education institution in Ireland, its school of computing has a recognized excellence in producing industry-oriented graduates who have contributes greatly to the recent Irish economic success.

The article studies on the mechanism of Industry Oriented Education of Ireland, especially in DIT and extracts useful experience to the education process of pilot software schools.

II. ETHOS AND PHILOSOPHY OF INDUSTRY-ORIENTED EDUCATION

The main outcome of industry-oriented higher education is the achievement of the smooth and efficient transition from recent graduate to productive employee, and ultimately to entrepreneur or employer.

The process of industry-oriented education must be characterized by the involvement of industry-oriented staff and the development and implementation of an education quality assurance/enhancement system with suitable procedures and a strong industry involvement, and a number of key programme learning outcomes (details in next chapter).

Project EMERSION (EU Asia-Link project) is the application of Industry-oriented Education to China, the project aim is to establish, implement and evaluate an industry-oriented education model in China, focusing on software education to meet the demands of the Chinese software industry. The major achievements of project EMERSION includes:

- Establishment of Industry-Oriented Education Ethos and Model in HIT and beyond in China
- Enhancement of the Industry-Oriented Education Ethos and Model in DIT and UOW
- Establishment of an Industry-Oriented Education Team in HIT
- Evolution of the original Industry-Oriented Education Team in DIT From Educational Practitioners to Active and Innovative Educational Researchers as well
- Development of Industry-Oriented Curriculum
- Development of QA System incorporating European and Chinese culture.

III. INDUSTRY-ORIENTED PROGRAMME DEVELOPMENT

A. What Make A Programme Industry-Oriented

An industry-oriented programme should comprise of

1) A good programme concept
   a) The design team with both academic and industrial experts
   b) Aim at market demand
2) A taught programmes, including
a) Programme documentation
b) Validation process
c) Programme committee
d) Complete quality assurance system
e) Industrial visit/placements/projects
3) Cyclic optimizing mechanism
   a) fit the industrial demands change
   b) Review and feedback on the education process 2 or 3 years

B. Key outcomes of Industry-Oriented Programme learning

The key outcomes of Industry-Oriented Programme learning including
- Acquisition of expertise, theoretical and practical, in the discipline to the normally standard required for the degree award
- Awareness/experience of working in the industry context and the full range of related boundary conditions
- Practical experience of multi-level team working
- Management competence in individual and collective projects
- Possession of discipline, integrity and good interpersonal communications skills
- Acceptable personnel and social behaviour for working in the industry setting
- Commitment to professional and career development and lifelong learning
- Possession of personal portfolio indicating many of these attributes
- Awareness of the global context about the industry

IV. Styling Industry-Oriented Programme Quality Assurance System

An Industry-oriented Programme Quality Assurance System (QAS) should keep focus on a variety of aspects, including

A. Goal of a QA system for industry-oriented education

The goal of a QA system for industry-oriented education should ensure the quality enhancement. The goal should also be the aim of all stakeholders (teachers, students, management staff and industry members) focus on improvement, and also it should be transparent, public and accountable.

The QA structures or stakeholders for industry-oriented education may comprise of Institute QA committee, faculty board, school (Head of School, Head of Department), programme committees & student representatives, programme teams, programme chairs and class mentors/tutors [1].

B. QAS Process Model (or QA Programme Development)

The process model of QAS can be described as three stages, validation stage, operate stage and review stage [2], as shown in figure 1. The industry-oriented validation stage includes the input and evaluation from industry representatives. The QAS process model emphasizes on continuous improvement.

![QAS process Model](image)

C. QA in the Teaching Process

The QA in the teaching process focus on staff recruitment/background and quality of the staff, staff training, quality awareness of the staff, innovation of teaching and learning approaches, continuously professional development programme and module delivery and assessment.

D. QA in work placement

Industry-oriented program quality assurance system also encompasses work placement stage. The students will take part in a work placement at least 6 months with salary paid. There are four phases to work placement, which are CVs, interviews, work and reporting [3]. All interviews must be arranged by Work Placement Office, and interviews are normally held at employer’s premises.

E. QA in Examination

The key people involved in the QA Examination process are Internal Examiner, Industrial Externals and Academic Externals. The exam paper is prepared and reviewed by them.

Before exam, internal examiners prepare the examination paper, solutions and the marking scheme. After the peer review process, the external examiners will review the examination paper. The exam results sheet contains two parts, internal examiner’s report from exams and internal examiner’s report from continuously assessment [4]. At last, the exam results sheet is presented to the exam board to get the module result.

V. Reflection to Domestic High Education

In a whole, the ethos and philosophy of Domestic High Education, especially in pilot software school is quite similar with that in DIT Ireland. The structure of industry-oriented high education in DIT Ireland is more complete and subtle.

A. Ethos and philosophy of Education Acknowledgment

Ethos and philosophy of Education in DIT Ireland is characterized by industry-oriented, which is characterized by the involvement of industry-oriented staff and the development and implementation of an education quality assurance/enhancement system with suitable procedures and a strong industry involvement.
Ethos and philosophy of Education in domestic pilot software school is characterized by internationalization, practicability and composite [5]. Besides curriculum, more steps should be taken to support the goal of education in domestic pilot software school.

B. Programme Development

1) Issues need to be considered in Programme Development

In an industry oriented environment, when issue or design a new programme, we should consider both the requirements of higher education and the requirements of industry as employers, that is the goal or aim of a programme.

What does industry demands from employees? This question hints what kinds of skills an employee should have. The Employees should have skills to rapidly bring about benefits in industry environment, to remain productive in a rapidly changing commercial environment and meet national and international standards of excellence [6]. The skills or competence may comprise of independent learning teamwork and communication, professional qualifications, experience of key technologies, awareness of the environment in which industry exists etc.

When issue a new programme, the requirements of industry should be translated to the content of a programme curriculum.

2) Programme Curriculum

One important aspect in a programme design is the curriculum design. The curriculum design is a trade off work between industry-oriented and academic-oriented considerations. We should translate the requirement of both parties into computer science curriculum.

Another important issue is the problem what is the difference between degrees, CS, SE, CE etc. From an industry perspective, we may distinguish them by skills, positions in enterprises or enterprise structure. From an academic perspective, we may distinguish them by Computing Curricula 2005 edited by ACM & IEEE [7]. Figure 2 is an example.

<table>
<thead>
<tr>
<th>Knowledge Area</th>
<th>CE</th>
<th>CS</th>
<th>IS</th>
<th>IT</th>
<th>SE</th>
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<tr>
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<td>4</td>
<td>5</td>
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<td>Operating Systems Principles &amp; Design</td>
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<tr>
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<td>Net Centric Principles and Design</td>
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<td>Graphics and Visualization</td>
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<td>1</td>
<td>5</td>
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<td>Information Management (DB) Practice</td>
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<tr>
<td>Software Design</td>
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<td>5</td>
<td>1</td>
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<tr>
<td>Software Verification and Validation</td>
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<td>1</td>
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<tr>
<td>Software Evolution (maintenance)</td>
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<td>2</td>
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<tr>
<td>Software Process</td>
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<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
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</tbody>
</table>

Figure 2. Comparative weight of computing topics across the five kinds of degree programs

C. Quality Assurance System

What impressed me most in the QAS system of DIT are QAS Conceptual Model, QA structures for industry oriented education, continuous feedback & improvement. The hierarchy or stakeholders or participants of QAS of DIT comprises of QA committee, faculty board, head of the school, head of the department, programme committees, students representatives, programme teams, class mentors and external Examiners. Compared to our own university, I think we should involve more roles in the QA system, including student representatives and external examiners. Another advantage of QAS in DIT is that they have a complete, manageable QA process control system. The cyclic process of QAS in DIT helps them to build more agile, industry-oriented QA system. As to the QAS in domestic universities, a prominent characteristic is that we help every student at many aspects, including daily life, tuition, study state or other issues through student affair department.
Another advantage of QAS in DIT is the participation of external examiners. The external examiners will take part in the different aspects of QAS, such as programme development, work placement, examination and QA processes [8].

D. Work Placement

Comparing to the work placement in DIT, the difference of work placement between DIT and our university is that the start time and duration is more flexible. In DIT, the start time of DIT is planned at the third year of the programme, and the duration of the work placement can be 3 months, or 6 months or one year. After work placement, the student is required to submit a final report. After finish the work placement will return to the school and take classed and enter the final year project.

E. Teaching and Learning

The ethos and philosophy in teaching and learning is quite similar between DIT and domestic universities, as described in ancient Chinese proverb ‘carry out different teaching or teaching method for different students’. What impress me most in teaching and learning education of DIT is the application of critical and creative thinking methods, which are PMI (Plus Minus Interesting), CAF (Consider All Factors) & OPV(Other People’s Views). All these critical and creative thinking skills can be developed.

On the other hand, we can classify students as four categories, which are abstract & sequential, abstract & random, concrete & random, concrete & sequential, as shown in table 1.

<table>
<thead>
<tr>
<th>Classification</th>
<th>How We Learn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete-Sequential</td>
<td>Learning is linear and sequential.</td>
</tr>
<tr>
<td>Concrete-Random</td>
<td>Learning is concrete and intuitive, and the person thrives on problem-solving.</td>
</tr>
<tr>
<td>Abstract-Sequential</td>
<td>Learning is abstract and analytical, and the person thrives on a mentally challenging but ordered learning environment.</td>
</tr>
<tr>
<td>Abstract-Random</td>
<td>The person is emotional and imaginative, and prefers an active, interesting, and informal learning environment.</td>
</tr>
</tbody>
</table>

Conform to the different type of students, the teacher should adopt different type of teaching method simultaneously in his class to enhance the education quality.

Also the six thinking hats will benefit me in later teaching work, and students should be encouraged to be able to use all of the hats.

F. 3D alignment model

One prominent characteristic in assessment of programme management is the 3D alignment model. Traditionally, the delivery of a module is clearly separated among learning outcomes, assessment methods, learning and teaching method [9]. In other word, each module is largely or relatively independent of each other and stands alone. The 3D alignment model emphasizes fasten relationship among learning outcomes, assessment methods, learning and teaching methods across the modules at the same stage (horizontally), at different stages (vertically) and internally within the module (constructively).

G. Examination Process Management

An interesting characteristic of examination process management is the compensation mechanism after the module exam result is presented to the exam board. The exam board is comprised of internal examiners of staff, external examiner from academic, year tutor, programme chairperson, head of department, head of school, exam board, chairperson, exams office representative, external examiner from industry.

The examination board permits a candidate’s overall assessment performance to compensate for partial failure. Compensation may be applied only to enable a candidate to pass the assessment as a whole, it may not be applied to grant exemptions or additional exemptions.

VI. NEXT WORK TO DO AT SOFTWARE SCHOOL IN HUST

A. Background

Huazhong University of Science and Technology (HUST) located in Wuhan, the capital city of Hubei Province, in the middle reaches of the Yangtze River. The campus of HUST is beautiful nestled at the foot of Yujia hill and beside the East Lake with green grass scattered all round in 500 hectares of land. It is a key comprehensive university under the direct leadership of the Ministry of Education of P. R. China. The former Minister of Education Prof Zhou Ji, who graduated from this University, is also the former president of the University. The software school of HUST is one of the 35 first approval pilot software schools in China, which make the teaching contents closely related to software industry development demands and effectively ensure the quality of education and personnel training.

This paper proposed a novel practice capability maturity model for software talent cultivation (STP-CMM). It consists of four levels: Awareness Level, Curriculum Level, Project Level and Enterprise Level, which represent a path of continuous improvement for those universities who want to gradually improve the practice capability of their students. The specific details will be mentioned in another article.

The industry-oriented education system in the school of computing of DIT is so comprehensive that it will take a long time for me to totally understand all aspects of QAS. In
one hand, the structure of the programme and QAS are quite similar between software school of HUST and DIT. In the other hand, I have perceived some defects in our daily operation, so I will talk about some work I’ll do after going back.

B. Programme & Curriculum Adjustment

The process model of QAS in DIT contains the review stage. The duration of review work may happen at any time when the adjustment is needed, and also the duration of a total review may happen in every 2 or 3 or 5 years. Compared to the programme of SE (software engineering) in the software school in HUST, it’s time for us to implement the review process. One important work in review stage is to rebuild or modify the Programme Curriculum.

The work in curriculum adjustment contains course module building, course combination and new course setting up. The idea of module building is to group several courses into different modules. The skills contain in each module may fit different industry requirements.

There are great changes in IT every year, such as SOA, design pattern, multi-core computing. So we should adjust curriculum to involve new changes in skills and competency.

With the development of the state of art, we also need to combine some courses to give capacity to new changes in our curriculum. There are some possible combinations, such as OO (Object-Oriented) + UML (Unified modelling language), SA (System architecture) + SOA (Service-oriented architecture), C++PSP (Personal software process).

C. Informationization of Department management

The Informationization in the teaching and management in computing school of DIT is another advantage over our software school in my experience. We should build up more strong resource sharing mechanism in the management process between teachers, managing staff and students. The students should easily get the resources from the teachers, and teachers should easily get the feedback from students, and the channel between teachers and management staffs should be facilitated. Configuration and version management should be adopted to manage the document in daily management operation.

D. About Industry-Oriented

The domestic universities have adopted the ethos of industry-oriented education. We can list a variety of ways to do that, including work placement, guest lectures, validation and review by industry involvement or external examiners, programme committee. The difference between DIT and domestic universities lie in the industry environment, including accessibility to industry, industry scalability, categories of industry, especially in software related industry. In order to get more compact relationship with software industry, we should open up more channels according to our programme objectives.

VII. CONCLUSION

Ireland has successfully developed one of the world’s leading software industry on a variety of reasons, including talent preparation, software industry orientation (vertical market where the competition is not Microsoft or Oracle), a significant percentage of Irish companies have quality certification, well-positioned time zone wise (geography reason), historical and culture reason etc. The Ethos and Philosophy of industry-oriented education in DIT Ireland have showed its influence on talent cultivation, the industry-oriented education model would be a great helper to the development of 35 pilot schools of China.

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REFERENCES


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