THE SKILLS GAP IN THE IRISH SOFTWARE INDUSTRY

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Introduction

In this paper, we present findings from research on the software industry in Ireland. This research is designed to answer two questions. First, from the viewpoint of software executives, does a gap exist between the requirements of Irish software companies and the skills held by graduates of Irish third-level software engineering programmes? Second, at what degree levels does the skill gap exist?

We chose to study the software industry because it is strategically important to the Irish economy, with revenues exceeding €10 billion in 2000 (National Software Directorate, 2003). Since the mid-1980s, the software industry has been one of the fastest growing industries in the economy (O'Gorman, O'Malley, and Mooney, 1997), and has passed out some of Ireland's traditional industrial sectors in size (FÁS, 1998).

As the terms the "knowledge economy" or "information society" suggest, people are the main resource in the software industry. Recent additions to our business lexicon include "software developer", "software designer/architect", "localisation engineer", and "database consultant". These positions are occupied by people in a highly competitive, global market for extremely mobile skills (Irish Software Association, 1999).

Concern over lack of skilled workers has already plagued the industry, and several government-funded and industry-backed groups have been formed to study and offer recommended solutions

to this challenge. The Irish Government has responded in part by investing millions of euros to allow third-level institutions and FÁS to increase their information-technology places. Irish third-level institutions have thus been identified as key partners to help assuage the skills shortage facing the industry.

We organize our paper as follows. In the first section, we present some important facts about the industry and Ireland's key sources of competitive advantage. We also examine the significant challenges and threats that face the industry. In the second section, we present our research question. In the third section, we discuss the methodology we used in the project, including the development of the survey questionnaire, the identification of the population of software companies, and our measurement of the skills gap. In the fourth section, we present a profile of the participating companies, the respondents, and the answers to our research questions. The fifth section contains a discussion of the implications of our findings. Finally, we suggest possible avenues for future research.

The Software Industry in Ireland

Industry Facts

The software industry has become a strategic industry in the Irish economy, with overall industry revenue climbing from €2.2 billion in 1991 to over €10 billion in 2000 and revenue from Irish-owned software firms climbing from €191 million to €1.4 billion in the same period (National Software Directorate, 2003). In 1998, electronics and software accounted for 43% of Irish exports, with Ireland surpassing the United States as the world's leading exporter of software goods (Organisation for Economic Co-operation and Development, 2000: 145). In its report on the information technology industry in 2000, the Organisation for Economic Cooperation and Development (OECD) described the growth of the software industry in Ireland as "spectacular".

In 1998, the Irish software industry comprised 760 companies, of which about one-sixth were foreign-owned (OECD, 2000) while, at the end of 2000, the National Software Directorate estimated the industry to be comprised of over 900 firms (National Software Directorate, 2003). Employment has continually increased in the industry, with growth in some years reaching 20-30% per annum (Centre for Software Engineering, 1990). Recent figures show total employment is over 30,000 (National Software Directorate, 2003), and experts predict

that the industry will become one of the main sources of employment growth in Ireland (FÁS, 1998).

By 1997, seven of the 10 largest US software companies had significant investments in Ireland, choosing Ireland as an operations base for localisation services, product distribution or customer support (National Software Directorate, 2001). In addition to the widely-known US names like Microsoft, Computer Associates, and Oracle Corporation, the industry also contains several hundred indigenous firms, such as Iona Technologies, which is publicly-traded and listed on the NASDAQ.

These indigenous software firms have a success story of their own. In the 1990s, their growth rates for the number of companies, employment and sales have all been exceptionally high (Clancy, O'Malley, O'Connell, and van Egeraat, 1998: 32). Currently, these indigenous software firms are the only group of indigenous firms in Ireland engaged in rapid, innovation-driven export growth (FÁS, 1998).

The software developed in Ireland has a range of applications in telecommunications, electronics, engineering, database management, multimedia, banking, financial services, and insurance (O'Gorman, O'Malley, & Mooney, 1997). The United Kingdom is the largest importer of Irish software goods; together with other European Union countries, the UK imports 46% of Irish software.

Key Sources of Competitive Advantage in the Irish Software Industry

Many other countries and policy makers have looked to Ireland to examine the conditions that have created such success. In this section, we discuss some of the key sources of competitive advantage in the Irish software industry.

Successive governments in Ireland have implemented policies to encourage foreign direct investment (FDI), including offering financial support schemes, tax concessions, and maintaining a low inflation climate (OECD, 2000: 30). This successful strategy has resulted in a very strong multinational presence in Ireland. By 1997, Ireland had over 1,100 foreign firms, one-tenth of which were in the software industry (OECD, 2000: 30). Ireland now dominates the market for inward investment in software into Europe.

A second competitive advantage is Ireland's location and its membership in the European Union (EU). Ireland offers a convenient location for overseas companies to export to other European countries

and for indigenous companies to position themselves within the world's second-biggest software market, the European Union (FÁS, 1998).

A third advantage is a young, skilled, English-speaking labour force. The Irish secondary school system has produced well-educated graduates. Ireland also has a very high percentage of its population under 25 years of age (four out of 10 people). This is a higher percentage of under-25s than in the United Kingdom, Portugal, Spain, France, the Benelux countries, Germany, Austria, Italy, Denmark, Sweden, or Finland.

A peaceful industrial-relations climate and the social partnership approach to incomes policy, aimed at wage moderation and increases in purchasing power through reductions in tax rates, have provided Ireland with a fourth competitive advantage (Gray, 1998). This advantage may be short-lived as there is now "general consensus among rank and file trade unionists that the rises in basic pay under the Partnership 2000 agreement were too low compared to increases in profits" (Sweeney, 1999: 216).

A fifth competitive advantage is the 12.5% corporate tax rate, the lowest in Europe and one of the lowest, if not *the* lowest, corporate tax rate in the world.

A final advantage is the nationwide software-oriented support infrastructure that has emerged to meet the needs of software companies. This industry-specific infrastructure (e.g., disk and CD ROM manufacturers, DVD mastering and duplication, user manual printing, packaging, and technical support), allows the sharing of knowledge across firms and provides an environment in which future entrepreneurs can develop.

Key Challenges and Threats to the Software Industry

While the Irish software industry has the above-mentioned competitive advantages, it faces serious challenges and threats. Primary among the challenges facing the software industry is Ireland's ability to maintain its cost competitiveness. In the past, Ireland has used exchange-rate devaluations to restore competitiveness when domestic costs got out of line, but with the economic monetary union this option is no longer available (Gray, 1998). Increasingly, other countries are characterised by lower relative costs *and* improving skill bases. Some of the Eastern European countries have large numbers of technically-trained people, available at very low wage rates (Gray, 1998), and Asian and

Middle Eastern countries such as China, India, and Israel are well-positioned to become serious competitors to Ireland.

Another significant threat to the industry's growth is the shortage of qualified labour. "The quantity and quality of the Irish labour force is undoubtedly one of the most important factors in sustaining Ireland's competitive advantage" (Gray, 1998: 134). This challenge is evident across the Irish economy. A Forfás/ESRI Survey in mid-1997 showed that 30% of companies surveyed across the Irish economy see skill deficiencies as a problem and 60% of companies see a need for increasing skill levels, especially in technology and customer service (The First Report of the Expert Group on Future Skills Needs: 13).

This challenge is not unique to Ireland, for it is reflected in global trends as well. In the early 1980s, the OECD published a report (OECD, 1985: 131) that stated "the gap between the present stock and the effective need for skilled human resources in Information Technology is perceived in Member countries as the main policy problem in this field". Their report also referred to studies in the United States, France, the United Kingdom, Finland, and Japan that all revealed serious labour shortfalls. The most serious skill shortage is for software engineers.

This threat is very real for software companies in Ireland. Various studies have estimated that the gap between the estimated demand for engineering and computer science technicians and professionals and the estimated supply is a shortfall of 2,200 to 2,500 *per annum*. Companies are already feeling the tightening of the labour market. The Irish Software Association's *Annual Business Survey Results* finds that over 84% of the companies that participated report a staff shortage, and 78% of respondents state that their most critical staff shortage is of experienced software engineers.

The labour and skills shortages also have a number of serious knock-on effects for companies in the industry (FÁS, 1998: 56). Labour costs appear to be increasing faster than the rate of increase in value added per employee (according to the Irish Software Association figures, annual salary inflation is more than 15% in average cases). Many indigenous companies have indicated that their inability to recruit enough people is constraining the growth of their businesses. The shortage of qualified people can force companies to recruit people with less experience, lower qualifications or with less aptitude for the work. Companies are experiencing high staff turnover rates (an industry figure of almost 20%, according to the Irish Software Association) and many senior managers now spend a substantial

portion of their time working on recruitment, which reduces the time they have for other management duties. A final knock-on effect is that increasing amounts of work are being outsourced to India and other emerging competitors.

These challenges to the continued growth and competitiveness of the Irish software industry have not gone unheeded. The Expert Group on Future Skills Needs was formed to study the skills required by Irish industry, with information technology skill needs as a priority, and to offer recommended solutions to the problems.

Seven of the 13 proposals submitted by the Expert Group on Future Skills Needs directly impact the third-level educational system in Ireland. One proposal is to increase the number of third-level places to educate professionals and technicians. Another proposal is to improve course completion rates, especially in the technician area. A third proposal is to attract more students into multi-skilling and conversion programmes. Increasing the number of research full-time and post-graduate students is also proposed. The Group proposed that there should be more flexibility in modular delivery and accreditation of prior learning. A final proposal is to encourage the direct involvement of many more technology companies in the design of courses and the identification and setting of priorities for skill needs.

We have seen that the knowledge-intensive nature of the industry and the attendant human resource issues from both a supply and demand perspective are of paramount importance to the continued success of the software industry in Ireland. We have also seen that third-level institutions are viewed as critical partners in the country's ability to produce the graduates needed with the skills required by the industry. Consequently, in this research study we focus on the skills of graduates.

Our research is different from prior studies in that we ask company executives to evaluate the skill gap not by reporting shortages in numbers of workers of particular types, but in reporting the skills that they are looking for and expect different types of graduates to have. Thus, we speak directly to the broader issue of the identification of the different types of skills graduates need to acquire, some through third-level education or training programmes, to be employable in the software industry.

Research Design and Methodology

We designed our research to answer the following questions. First, from the viewpoint of software executives, does a gap exist between the requirements of Irish software companies and the skills held by graduates of Irish third-level software engineering programmes? Second, at what degree levels does the skill gap exist?

Our first step was to interview several industry experts and review industry publications to identify a set of critical skills that would be necessary for employment in the industry. We supplemented that list with additional skills that we thought would be important such as an ability to work independently as well as to work in teams. A complete list of the 25 skills is shown in **Table 1**.

TABLE 1: SKILLS INCLUDED IN SURVEY

Excellent analytic skills
Excellent ability to write code
Excellent ability to work in teams
Excellent knowledge of legacy languages
Excellent problem-solving skills
Excellent ability to work independently
Excellent knowledge of multimedia
Excellent knowledge of Java
Excellent knowledge of UNIX
Excellent knowledge of C++
Excellent understanding of business issues
Excellent knowledge of web technologies
Excellent knowledge of e-commerce
Excellent knowledge of object-oriented methods
Excellent knowledge of platform architecture/design
Excellent knowledge of project management
Excellent knowledge of software localisation issues
Excellent interpersonal communication skills
Excellent understanding of the software industry
Excellent leadership skills
Excellent knowledge of networks
Excellent ability to resolve conflicts within teams
Excellent knowledge of ActiveX
Excellent knowledge of MS Visual Basic
Excellent knowledge of operating systems
Excellent knowledge of operating systems

We developed a survey designed to collect data on company and respondent characteristics, hiring practices, important skills for software engineers, skills of graduates produced by third-level institutions, outsourcing practices, and perceptions of skill and labour shortages over the coming 12 months.

Three organizations that play an important role in supporting the software industry in Ireland and Northern Ireland (National Software Directorate, Irish Software Association, and Momentum: The Northern Ireland ICT Federation) collaborated in this study by providing us with their membership lists. Executives from these three organisations believe that the population of software companies from the 32 countries is contained in these three mailing lists. We distributed the survey by post to all the organisations on these membership lists.[1]

We classified software engineers by their qualifications into five types of graduates: (1) certificate/diploma programme, (2) undergraduate programme,[2] (3) post-graduate conversion programme,[3] (4) post-graduate follow-on programme,[4] and (5) experienced software engineers from other companies.

For each of the five types of graduates, respondents were asked to answer three questions. First, they were asked to report how many of each type of graduate the firm had hired over the preceding 12 months. Second, using a five-point scale (strongly agree, agree, neither agree nor disagree, disagree, strongly disagree), respondents were asked to judge the importance of each of the skills

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[1]   As completed surveys were returned to us, we discovered that the mailing lists also contain organisations that are not software firms but instead have an interest in developments in the industry, such as university-based research centres. We discarded responses from these organisations since they are not companies that hire software engineers.

[2]   By undergraduate programme, we mean graduates of primary university programmes, i.e., recipients of four-year Bachelors degrees.

[3]   By post-graduate conversion programmes, we mean academic programmes that admit students whose first degree is not in software engineering or computer science, and then "convert" them into software engineers through a period of intensive study.

[4]   By post-graduate follow-on programmes, we mean academic programmes that only admit students whose first degree is in software engineering or computer science. These graduates have received both their primary and their post-graduate university degrees in software engineering or computer science.

listed in **Table 1** with the statement, "As my company has recruited software engineers over the last 12 months, we consider it very important that software engineers have …" by type of graduate. We then constructed a variable named "Required Skills" for each of the five types of graduates by summing the scores across the 25 skills listed in **Table 1**. Third, using the same five-point scale, respondents were asked to evaluate the quality of the software engineers they actually hired in the last year against the set of 25 skills: "The software engineers my company has hired in the last 12 months have …" by type of graduate. We then constructed a variable named "Acquired Skills" for each of the five types of graduates by summing the scores across the 25 skills listed in **Table 1**.

For each type of graduate, we constructed a variable named "Skills Gap" for each of the five types of graduates by subtracting the "Acquired Skills" score from the "Required Skills" score (i.e., Skills Gap = Required Skills – Acquired Skills).

Results

We posted 952 surveys and 83 were returned, giving us a response rate of 8.7 percent.[5] A profile of the survey respondents is shown in **Table 2**. Respondents tended to be Managing Directors or other Directors (53 percent of all respondents). Respondents possessed an average of 13 years of experience in the software industry. Roughly nine out of 10 hold Bachelors-level degrees and about four out of 10 hold Masters-level degrees or higher.

A summary profile of the companies is shown in **Table 3**. Forty-four percent of the companies are Irish-owned. Company-size, as measured by the number of employees, varied from one to 300. The average company size is 35.7 employees.

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[5] This response rate is low, but typical of survey research in the software industry.

TABLE 2: RESPONDENT PROFILES

	Mean	S.D.
Years in current job title	4.13	4.45
Years working for current employer	6.06	5.33
Years working in the software industry	13.26	8.99
Post-secondary school diplomas, degrees, or educational qualifications held		
Bachelors Degree	89%	
Post-Graduate Diploma	36%	
Masters Degree (non-MBA)	27%	
MBA Degree	8%	
Doctoral Degree	6%	

TABLE 3: COMPANY PROFILES

	Company ownership	
Irish	44.6%	
Northern Irish	25.3%	
British	6.0%	
Continental Europe	4.8%	
United States	10.8%	
Other Country	8.4%	
Number of workers in responding companies 1 (min) – 300 (max)	35.7 (mean)	
Hires in Preceding 12 Months:	**% of hires from this source**	**total hires from this source**
Certificate / Diploma programmes	36%	12
Undergraduate programmes	46%	115
Post-graduate conversion programmes	39%	20
Post-graduate follow-on programmes	18%	15
Experienced applicants from other firms	55%	20

In the preceding 12 months, 36% percent of companies had hired graduates from certificate/diploma programmes; 46% from undergraduate programmes; 39% had hired from post-graduate conversion programmes; and 18% had hired graduates of post-graduate follow-on programmes (meaning these workers had earned both undergraduate and masters degrees in software engineering). Fifty-five percent had hired experienced applicants from other software firms. Over three-fifths of all software engineers hired by the responding firms (115 out of 182 hires) came from undergraduate degree programmes.

Next, we turn to the answer to our research question. Does a gap exist between the requirements of Irish software companies and the skills held by graduates of Irish third-level programmes? To answer this question, we first asked respondents to note their agreement to several statements that sought to assess their views on the current and future status of the labour market for software engineers. Twenty-nine percent of respondents agreed with the statement, "There is a shortage of software engineers: my company has a difficult time recruiting enough software engineers". Twenty-nine percent agreed with the statement, "There is no shortage of software engineers, but my company has a difficult time recruiting software engineers with world-class skills". And 41% agreed with the statement, "There is both a shortage of software engineers *and* a shortage of world-class skills." One percent believed there is neither a shortage of software engineers nor a shortage of software engineers with world-class skills.

TABLE 4: DOES A SKILLS GAP EXIST FROM THE VIEWPOINT OF SOFTWARE COMPANY EXECUTIVES?

	Now	12 Months From Now
There is a shortage of software engineers: my company has a difficult time recruiting enough software engineers.	29%	26%
There is no shortage of software engineers, but my company has a difficult time recruiting software engineers with world-class skills.	29%	26%
There is both a shortage of software engineers *and* a shortage of world-class skills.	41%	46%
There is neither a shortage of software engineers nor a shortage of software engineers with world-class skills.	1%	2%

Next the respondents were asked to look 12 months into the future and predict the state of the Irish software industry. Twenty-six percent of respondents agreed with the statement, "There will be a shortage of software engineers: my company will have a difficult time recruiting software engineers". Twenty-six percent agreed with the statement, "There will be no shortage of software engineers, but my company will have a difficult time recruiting software engineers with world-class skills". Forty-six percent agreed with the statement, "There will be *both* a shortage of software engineers <u>and</u> a shortage of world-class skills". Two percent of respondents believed there will be neither a shortage of software engineers nor a shortage of software engineers with world-class skills.

Based on these results, there is strong evidence that software industry executives perceive two types of gaps in the Irish labour market for software engineers: (a) a gap between the number of graduates being produced and the requirements of the industry, and (b) a gap between the skills required by the industry and the skills to be found in graduates of Irish third-level software engineering programmes.

The goal of this research was to examine more closely the perceived skills gap. It is interesting to note that among the 25 skills assessed in this research, the skills *most* demanded by employers are general skills such as problem-solving skills, the ability to work in teams, analytic skills, ability to write code, and communication skills.

(All these items are statistically different from 3, the neutral point on the five-point scale, at the .05 level of significance.)

The skills *least* demanded by employers are a knowledge of legacy languages, multimedia, Unix, C++, and software localisation.

As reported in **Table 5**, all five types of graduates show a skill gap, and all skill gaps are statistically significant from zero at the .05 level. Respondents reported the biggest skill gaps among post-graduate follow-on graduates, certificate/diploma graduates, and undergraduates. Although statistically significant from zero, the perceived skill gap among post-graduate conversion graduates and experienced hires were approximately half as large as the other three types of graduates.

TABLE 5: WHERE IS THE SKILLS GAP?

	Skills Gap*	t-statistic	Significance
Certificate / Diploma Programmes	10.13	2.987	.004
Undergraduate Programmes	9.12	3.554	.001
Post-graduate conversion programmes	5.79	1.857	.037
Post-graduate follow-on programmes	12.69	3.630	.002
Experienced Hires	5.14	1.737	.045

* Skills Gap = Required Skills – Acquired Skills.

Discussion

Our data show that executives of software companies in Ireland share a strong generalised concern about the number and quality of software engineers being produced by third-level institutions. Ninety-nine percent of respondents reported that there is a current shortage of either software engineers or software engineers with adequate skills, or both. Looking forward 12 months, 98% of respondents shared the same concerns.

With respect to the skills gap, respondents reported large and statistically significant gaps between their skill requirements and the skills actually possessed by software engineers hired by their firms in the preceding 12 months. Skill gaps were found for each of the five

types of hires (certificate/diploma, undergraduate, post-graduate conversion, post-graduate follow-on, and experienced hires).

These results raise serious questions about how well the software industry will be able to meet its need for highly-educated and skilled graduates. If the software industry in Ireland is to retain its competitive position *vis-à-vis* competitors in the United States and emerging nations such as India, Israel, and China, graduates of Ireland's software engineering programmes must have world-class skills.

In a 1997 speech (Pollak, 1997), Dr. Christopher J. Horn, Executive Chairman of the Board and co-founder of the successful Irish software company Iona Technologies Plc., proposed that universities should move away from vocational training and foster within students the ability to think strategically and creatively. He envisioned multi-talented technologists with excellent communication and interpersonal skills to complement world-class technical skills. The results from this study suggest that this view has become widespread within Ireland's software industry. The challenge is for third-level institutions in Ireland and Northern Ireland to produce these multi-talented software engineers.

Irish universities' success in producing graduates with world-class skills has become even more important with the recent global slump in the information technology sector. In times of strong industry growth and high product demand, many software companies possess resources that may be spent on staff training and development to produce the "multi-talented technologists" envisioned by Dr. Horn. With the global slump in IT spending, there are fewer slack resources available for such training. Therefore, we believe that it is even more critical than in the past for Irish universities to resolve the skills gap facing the Irish software industry.

Suggestions for Future Research

In the future, we plan to analyse institution-specific data to identify which third-level institutions are best meeting the requirements of Ireland's software industry. Additionally, we suggest an analysis of the Irish software engineering programmes against an acknowledged world-class benchmark and against educational institutions in emerging-market countries that are rapidly becoming key competitors to Ireland.

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