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Keywords

involvement, industry, perceptions, ict, universities, research, education

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RESEARCH ARTICLE

ICT Industry Involvement with ICT Education and Research in Universities: Industry Perceptions

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Abstract

Stronger linkages between the ICT industry and universities have been called for by both the ICT industry and by universities. The study described in this paper explores the ways in which the ICT industry believes it can and should contribute to ICT education and research in universities. The results confirm how important relationships with universities are seen to be and that industry would like to expand its level of involvement. Industry would like further involvement in curriculum design, both directly and through professional associations. The involvement sought is not just with respect to high-level themes, but many participants felt that they would like input into the content of individual subjects. In addition to providing teaching related input and support, many in industry would also like to benefit from the expertise in universities by attending university run short courses. The paper makes recommendations for how universities and industry can act to strengthen linkages.

Keywords: ICT education, higher education, industry involvement, industry advisory board

Introduction

The information and communications technology (ICT) industry in its various forms provides the destination for ICT graduates. Universities therefore rely on the ICT industry to communicate its needs in terms of student knowledge and skills, and to support student attainment of these by providing opportunities for students to engage with industry whilst still studying. Industry also contributes to ICT faculties in universities by providing applied research opportunities and academic involvement with industry practices. The value of the synergies that exist has been recognised by universities (McGill *et al.* 2014); however academics, graduates and industry in a wide range of countries have indicated that they believe that industry should have more involvement with ICT education (Yen *et al.* 2003, Hagan 2004, Petrova & Medlin 2009, Thompson 2010). The project described in this paper explores the ways in which the ICT industry perceives it can and should contribute to ICT education and research in universities.

Background

The ICT profession includes a very wide range of job titles, designations and descriptions, with a vast array of university programmes existing to supply graduates for the underlying roles. The knowledge and skills developed in ICT degrees are ideally determined in consultation with industry and professional associations, via mechanisms such as industry advisory boards and accreditation processes. In addition to input into the curriculum, the ICT industry may engage more directly with learning and teaching via activities such as supporting forms of work integrated learning (WIL) including internships and industry-related projects, and there is evidence to support the value of these interactions (Patrick *et al.* 2008, Pilgrim & Koppi 2012). Potential synergies also exist in terms of research. Research relationships between universities (both ICT academic staff and postgraduate students) and industry can, on the one hand, enable industry to have access to the stock of knowledge and expertise in universities and, on the other, provide a source of both funding and relevant applied research problems (Lam 2007). Schemes such as the UK Knowledge Transfer Partnerships (see <http://www.ktponline.org.uk/>) and the European Union's Seventh Framework (FP7) programme on Cooperation (see http://cordis.europa.eu/fp7/cooperation/home_en.html) fund projects involving a high level of interaction between universities and private companies, and exemplify approaches designed to achieve these synergies.

While the value of industry involvement with ICT in universities is widely recognised by ICT academics (McGill *et al.* 2014), graduates (Koppi *et al.* 2009) and industry (Koppi *et al.* 2009, Thompson 2010), a number of studies have identified issues that could potentially be improved by stronger linkages, and called for them to be addressed. These issues include shortages of ICT professionals (ACS 2008, Thompson 2010, e-skills UK 2011, Australian Industry Group 2012, Australian Workforce and Productivity Agency 2013), poor perceptions of ICT as a course of study and as a career (Multimedia Victoria 2007, Papastergiou 2008, von Konsky 2008), and gaps in the knowledge and skills of graduates (Kennan *et al.* 2009, Koppi *et al.* 2009, Koppi *et al.* 2010, Thompson 2010, Pilgrim 2013).

The ICT industry has long been characterised by skill shortages (ACS 2008, Thompson 2010, e-skills UK 2011), with the relatively low numbers of students enrolling in ICT degrees seen as a major contributing factor (Computing Research Association 2008, ACS 2012). Poor perceptions of university ICT courses and ICT jobs have contributed to the enrolment issue (Multimedia Victoria 2007, Papastergiou 2008, von Konsky 2008) and it has been argued that better relationships between industry and universities are needed (Hagan 2004, von Konsky 2008, Thompson 2010) to help address this problem.

Many international studies have also identified gaps in the perceptions of educators, graduates and employers about the knowledge, skills and competencies required of ICT graduates (Yen *et al.* 2003, Kennan *et al.* 2009, Koppi *et al.* 2009, Petrova & Medlin 2009, Koppi *et al.* 2010, Thompson 2010, Pilgrim 2013). For example, a study of 548 Australian ICT graduates by Koppi *et al.* (2009) found that, while a majority seemed to be satisfied with how their university had prepared them for their work, many felt that they were insufficiently prepared in terms of interpersonal skills and business abilities. This graduate perspective is consistent with claims from employers that graduates lack skills that they regard as important, but surprising given the focus universities place on graduate attributes (Bridgstock 2009), and the prevalence of policies that require industry input into the curriculum (Pilgrim & Koppi 2012). Examples of studies on skill gaps noted in different countries across different ICT sub-disciplines (Yen *et al.* 2003, Hagan 2004, Lee 2004, Zwiig *et al.* 2006, Thompson 2010, Tomlinson 2012) highlight the need for students to have:

- An understanding of business functions and organisational knowledge.
- The ability to teach themselves what they need to know to perform the task successfully.

- Interpersonal skills and personal attributes.
- The adaptability and flexibility required to be ICT practitioners.
- Generic attributes such as lifelong learning.

Thompson (2010) identified further signs of a disconnect between ICT in universities and industry in many countries, noting that few industry people attend academic conferences and vice versa. He cites the role of confidentiality in hampering sharing of practices by industry, and the lack of rewards for academics for involvement with industry, as inhibitors.

A review of the literature (McGill *et al.* 2012) confirmed that a wide range of approaches to strengthening linkages with industry have been tried. Many of these have focussed on directly enriching the student experience by enabling greater exposure to industry practice via such means as work placement or internship programmes (e.g. Carpenter 2003, Wallace 2007), incorporating real-world projects into courses (e.g. Song 1996, Bruhn & Camp 2004, Zilora 2004, James 2005, Pilskalns 2009, Schilling & Klamma 2010), and embedding of industry certifications into university education (e.g. McGill & Dixon 2005, 2013). Many universities have also improved their connections with industry by mechanisms such as using industry advisory boards for curriculum development (e.g. Catanio 2005, Benamati *et al.* 2010), and by offering short courses to industry to provide a good two-way communication channel between academia and industry (e.g. Morasca 2006). It should be noted, however, that the majority of published literature on approaches to improving linkages between universities and industry comes from small groups of ICT academics who have tried something and want to share their experience, rather than from more rigorous evaluations of initiatives (McGill *et al.* 2012). An exception to this is a large research project that involved a series of international workshops to identify and evaluate a range of industry-academic interactions (Thompson 2010).

An attempt to gain a broader perspective on how mutually beneficial stronger relationships could be established with industry was undertaken by McGill *et al.* (2014), who considered the views of Australian ICT academic leaders. These academic leaders recommended that universities should be establishing more connections with industry, and stressed the importance of actively seeking problems and unsatisfied needs from industry in order to help address them. They also noted the potential role of industry associations and professional bodies in assisting to form and sustain connections, which is consistent with Thompson's (2010) call for improved mechanisms to support interactions with government and professional and industry bodies.

What has been lacking in the debate is a deeper understanding of the perspective of the ICT industry. An early study by Hagan (2004) focussed on deficiencies in graduates, but also provided some suggestions from industry to improve the situation. These related primarily to the provision of more work experience, but also emphasised enhancing consultation and communication between universities and employers. Specific suggestions included having industry play a greater role in course and curriculum design, and more use of industry lecturers. Pilgrim (2013) further explored the perceptions of industry regarding involvement into the ICT curriculum. He reported that, while the benefits of direct industry involvement in high-level curriculum design are accepted, industry desires further involvement in curriculum implementation and review. Some doubts were also expressed as to whether universities are acting on the advice that industry provides.

The research described in this paper builds on these earlier studies by considering how those working in the ICT industry view the involvement of industry with universities, and their perceptions of the ways in which this can be strengthened.

Method

In order to examine industry perceptions of involvement in ICT in universities, the opinions of a wide range of participants in the ICT industry were sought via a survey. The data collection was undertaken as part of a broader Australian Learning and Teaching Council (ALTC) funded project on improving ICT education. Only those aspects relating to industry–university linkages are included in this paper.

To ensure that a wide range of industry professionals with a variety of degrees of connection with universities were included in the research, two different sampling frames were used: industry advisory board members for ICT at four different Australian universities; and all members of the Australian Computer Society (ACS), the professional association for Australia's ICT sector. Industry advisory board members were targeted because of the likelihood of them having more direct interactions with students and staff in the universities, and hence more knowledge of the success of linkages. Members of the ACS were targeted to reflect the perceptions of the broader industry.

ACS members in the workplace were invited to participate in an online questionnaire by a request on the ACS homepage and also in the monthly emailed branch newsletter. Advisory board members were surveyed by paper-based or online questionnaire, depending on the preferences of the university. Both groups were asked the same set of questions, with the online version of the questionnaire created in SurveyMonkey. Completion of the questionnaire was voluntary and all responses were anonymous.

The questions relevant to this paper consisted of a mixture of 5-point Likert scale items and open-ended questions. In the Likert scale items, participants were asked to rate their agreement with a series of general questions about industry and university relationships, and then a series of more focussed questions exploring the nature of the involvement that would be preferred. The categories of questions related to:

- Desired involvement of industry in teaching and learning (see Table 1 for a list of items).
- Perceived value of involvement of industry in non-teaching and learning connections with universities (see Table 2 for a list of items).
- Support of respondents' organisations for interaction with universities (see Table 3 for a list of items).

The open-ended questions focussed on identification of additional forms of interactions with universities beyond those covered in the Likert scale questions and elaborations on ratings of agreement. Recommendations covering what more universities could do to strengthen connections with industry, and what more industry could do to foster connections with universities, were also solicited. The responses to the open-ended questions were content analysed and classified into general themes, with the themes permitted to emerge from the data.

Results and discussion

The contribution of industry to ICT education is acknowledged to be an important one (von Konsky 2008, McGill *et al.* 2012). The survey provided an opportunity to gain further insight into the nature of this contribution, and to explore how the ICT industry believes it can further contribute.

A total of 182 responses to the survey were received: 37.4% from industry advisory board members and 62.6% from ACS members. However, the total number of responses to specific questions differed throughout the survey, with the numbers of responses to specific questions given in the relevant tables. Consistent with the gender proportions in

the ICT industry in Australia (ACS 2012), a majority of respondents were male (79.1%). No significant difference in gender was found between the industry advisory board members and the members of the ACS (chi-square (1) = 1.08; $p = 0.300$).

Table 1 Desired involvement of industry in curriculum development and learning and teaching.

	SD	D	N	A	SA	Total	% Agreement
Universities should have industry representation on committees that review and/or design the curriculum.	3	4	13	78	83	181	89.0%
Universities should seek indirect input to the curriculum through industry bodies or from government agencies/reports.	5	8	17	95	56	181	83.4%
Industry should provide advice relating to high level themes or focus of courses.	1	4	14	83	53	155	87.7%
Industry should provide advice relating to the syllabus of individual subjects/units (including topics and skills).	7	19	28	76	27	157	65.6%
Industry should provide advice relating to the structures of degrees.	6	24	56	52	18	156	44.9%
Industry should provide advice relating to the teaching methods used.	21	52	46	21	18	158	24.7%

Note: Responses range from Strongly Disagree (SD) to Strongly Agree (SA).

Table 2 Perceived value of involvement of industry in non-teaching and learning connections with universities.

	SD	D	N	A	SA	Total	% Agreement
Short courses provided by universities would be very useful to my organisation.	4	11	27	71	18	131	67.9%
Research relationships with universities or university staff are very useful to my organisation.	4	12	52	38	24	130	47.7%
My organisation would like to have more research relationships with university staff.	4	8	65	41	13	131	41.2%
Consultancies by university ICT academics would be very useful to my organisation.	5	13	61	40	12	131	40.0%

Note: Responses range from Strongly Disagree (SD) to Strongly Agree (SA).

Table 3 Support of respondents' organisations for interaction with universities.

My organisation encourages engagement with universities such as:	SD	D	N	A	SA	Total	% Agreement
- hosting internship or work placement students	7	10	30	64	27	138	65.9
- provision of guest speakers	3	12	37	65	21	138	62.3
- participation on university committees	6	14	36	57	27	140	60.0
- hosting site visits	6	22	50	52	9	139	43.9
- provision of case studies or project ideas	6	19	54	50	10	139	43.2
- research linkages	8	18	60	41	12	139	38.1

Note: Responses range from Strongly Disagree (SD) to Strongly Agree (SA).

Industry perceptions of involvement with universities

As discussed above, previous research has shown that ICT academic leaders are very positive about the value of associations with industry (McGill *et al.* 2014). The study described in this paper explored these relationships from the perspective of those working in industry. It found that, in general, those working in industry also perceive connections between universities and industry as valuable: of the 182 responses, 91.8% agreed that these connections are very valuable.

Table 1 shows the potential involvement of industry in curriculum development and learning and teaching in a number of areas from the perspective of ICT industry professionals. In terms of input into what is taught in ICT degrees, the participants believed that industry involvement is important: 89.0% agreed that universities should have industry representation on committees that review and/or design the curriculum; and 83.4% believed that universities should seek indirect input to the curriculum through industry bodies (e.g. the Australian Information Industry Association (AIIA)) or from government agencies/reports. The nature of this input was also considered. Respondents were most likely to believe that industry should provide advice relating to high-level themes or focus of courses (87.7% agreement). They also wished for input into the syllabus of individual subjects (65.6% agreement), but less than half (44.9%) believed that industry should provide advice relating to the structure of degrees. Not surprisingly, only 24.7% felt that industry should advise on teaching methods. The lower levels of agreement relating to degree structures and teaching methods highlight industry recognition that these issues are largely beyond its brief, and that its input is likely to be most valuable in influencing the knowledge and skills that students acquire.

In addition to connections related to teaching and learning, respondents were asked about connections relating to research and obtaining expertise from universities. Table 2 provides information about the other kinds of interactions with universities that the respondents believe would be valuable for their own organisation. Short courses provided by universities appear to be the most desired form of interaction, with 67.9% of respondents agreeing that short courses would be useful to their organisation. The value to university ICT staff of offering short courses has also been noted in the literature (Morasca 2006): not only do they allow industry to receive training in emerging areas, but they allow academics to maintain contacts and to gain insights into current practices. The kinds of courses desired are indicated by the following comments:

“Short refresher courses on current methodologies.”

“Courses specifically using industry tools – including both short courses and academic programmes.”

“Organise short courses at a reasonable cost that count towards ongoing professional development.”

Research relationships were also seen as valuable, with 47.7% of industry participants agreeing that research relationships with universities are very useful to their organisation and 41.2% wishing for more research relationships. Consultancies by university ICT academics were similarly perceived as a useful form of interaction with universities by 40.0% of the participants. This is consistent with previous UK-based research that identified the value of ICT academic staff involvement in consultancies to both teaching and research (Grant & Wakelin 2009). In addition to providing direct value to the organisations that employ them, consultancy was felt to enrich teaching and to lead to research linkages. The fact that the level of agreement with the usefulness of consultancy was slightly lower than that of research may be due to the financial implications of employing consultants.

Industry respondents were also asked specifically about whether their organisation currently encouraged engagement with universities. Table 3 summarises the responses. The most encouraged activity was hosting internship or work placement students (65.9%), with some participants calling for even further support of this activity; for example:

“Provide more intern spaces.”

“Providing guaranteed work placements to students.”

This form of engagement has well identified benefits for both students in improving their employability (Pauling & Komisarczuk 2007) and for the organisations involved, as it provides a good source of potential future employees (Pilgrim 2012).

Strong support was also indicated for the provision of guest speakers (62.3% agreement). This sentiment is illustrated by the following comments:

“More industry guest lecturers as part of course. Potential to have one guest industry lecture per subject as compulsory.”

“Have up to two lectures in each unit be given by external industry.”

“Become more involved in taking guest lectures on various subjects (for example on the topics of agile project management and specific development technologies).”

This kind of engagement has the potential not only to directly contribute to student learning, but also to help keep academics informed on recent developments (von Konsky 2008).

Participation on university committees also appeared to be strongly encouraged (60%), and there was substantial support for hosting site visits (43.9%) and providing case studies or project ideas (43.2%). The activity that participants felt was least encouraged by their particular organisation was research linkages (38.1% agreement). Industry–university research collaboration has previously been identified as problematic because of different work norms and reward structures (David *et al.* 1999). In addition, differing goals and intellectual property issues can lead to difficulties (Lam 2007), potentially reducing enthusiasm to embark on research collaborations.

Participants were also asked if there were other forms of engagement encouraged by their organisation. The only additional connection mentioned was direct communication with lecturers in order to provide an industry perspective on assessment items.

Despite the generally positive responses received about the value of, and support for, different kinds of connections with universities, several comments critical of universities and their interactions with industry were provided. These included the following:

“Because universities nowadays interact very little with industry (try getting a university lecturer to give a presentation to an industry SIG – impossible!), industry tends to not want to have anything to do with universities.”

“We have tried many times, the universities are only interested on their arrogant terms.”

“My general feeling is that universities are completely out of touch with industry... I think the blame goes squarely on the shoulders of the academic approach with absolutely no effort in marketing or to attract attendees from industry.”

“Honestly, I think the universities aren’t interested in what industry is doing. There’s an arrogant and ignorant view about what goes on off the campus.”

Whilst only apparent in a small number of responses, this perception of universities as uninterested and inaccessible is consistent with Pilgrim's (2013) comment that, whilst universities appear to welcome industry input, industry perceives that this advice is often not acted upon. This perception signals a potential barrier to realising the synergies associated with industry involvement with ICT in universities. This issue is not exclusive to ICT though; Cavanaugh (2010) reported on the egocentrism of universities in general as a long standing problem, claiming that "academia is unresponsive, disconnected from current realities, and arrogant" (p233) and called for change. This potential for arrogance is something for universities to be aware of when they attempt to strengthen industry linkages.

Do the views of industry advisory board members reflect those of the wider ICT industry?

Given that the two groups of participants in the study potentially had very different levels of involvement with ICT in universities, a comparison was undertaken. Mean levels of agreement with the survey questions were compared between the industry advisory board members and the broader ACS membership using t-tests. It was notable that those participants who were members of an ICT industry advisory board were significantly more likely to believe that connections between universities and industry are very valuable (4.60 vs 4.38; $t(178.9) = 2.06$, $p = 0.041$). This suggests that, despite the perceptions reported by Pilgrim (2013) that advice offered by industry is often not acted upon, those who have closer links with universities not only maintain confidence in the value of these interactions, but are more positive than those with less formal connections.

There were, however, few differences in terms of perceptions of the types of input and advice that industry should provide with respect to curriculum development or in the way in which it should be provided (see Table 4). Both groups had consistent high levels of agreement that both direct input via university committees ($t(179) = 1.50$, $p = 0.134$) and indirect input through industry and government bodies ($t(179) = 1.35$, $p = 0.179$) were important. There were also no significant differences in agreement about the need for industry to provide advice relating to the high-level themes of courses ($t(153) = 1.85$, $p = 0.067$), the structures of degrees ($t(154) = -1.47$, $p = 0.143$) or the syllabus of individual subjects ($t(155) = -.95$, $p = 0.342$). The only significant difference related to whether industry should provide advice about teaching methods, with significantly less industry advisory board members believing that it should ($t(156) = -2.32$, $p = 0.022$). The consistency in opinions is reassuring in that it indicates that the advice universities receive from industry advisory boards is in-line with what the broader ICT industry believes. The difference with respect to providing advice about teaching methods is possibly because the closer connections industry advisory board members have with universities have either reassured them about the teaching approaches taken, or indicated to them the difficulty of being involved in decisions about teaching.

There were also no significant differences in how useful the other main forms of linkages between industry and universities were seen to be (see Table 5). Members of industry advisory boards were no more likely to believe that research relationships were very useful to their organisation ($t(128) = 0.70$, $p = 0.482$) or that the organisation wanted more ($t(129) = 0.90$, $p = 0.368$). They also had similar perceptions of the usefulness of consultancies by university ICT academics ($t(129) = -1.68$, $p = 0.095$) and of short courses provided by universities ($t(129) = -1.20$, $p = 0.233$). Industry advisory board members therefore appear to reflect the perspectives of the broader ICT industry with respect to the usefulness of these forms of linkage.

There were more differences between the industry advisory board members and the broader industry members with respect to the extent to which their organisation

encourages engagement with universities (see Table 6). The organisations to which the industry advisory board members belonged were significantly more likely to be perceived as encouraging engagement in the following ways: participation on university committees ($t(138)=5.01$, $p < 0.001$); provision of case studies or project ideas ($t(137)= 3.04$, $p=0.003$); provision of guest speakers ($t(134.9)=3.53$, $p=0.001$); and hosting internship or work placement students ($t(133.9)=2.12$, $p=0.036$). It is unclear whether this encouragement results from benefits already received by the industry advisory board member's participation, or that organisations with positive perceptions of the value of engagement with universities are more likely to contribute industry advisory board members. No significant differences were found for hosting of site visits ($t(137)=1.20$, $p=0.232$), nor in levels of encouragement to establish research linkages ($t(137)=1.52$, $p=0.130$), which, as previously discussed, were relatively low for both groups.

Table 4 Comparison of industry advisory board opinions with broader industry opinions of desired involvement in curriculum development.

	Industry advisory board		ACS		p
	Mean	Std. dev.	Mean	Std. dev.	
Universities should have industry representation on committees that review and/or design the curriculum.	4.41	0.60	4.22	0.93	0.134
Universities should seek indirect input to the curriculum through industry bodies (e.g. AllA) or from government agencies/reports.	4.16	.78	3.97	0.98	0.179
Industry should provide advice relating to high level themes or focus of courses.	4.31	0.59	4.09	0.84	0.067
Industry should provide advice relating to the structures of degrees.	3.20	0.85	3.43	1.09	0.143
Industry should provide advice relating to the syllabus of individual subjects/units (including topics and skills).	3.52	0.94	3.68	1.12	0.342
Industry should provide advice relating to the teaching methods used.	2.51	1.00	2.95	1.27	0.022

Table 5 Comparison of industry advisory board opinions with broader industry opinions with respect to the perceived value of involvement in non-teaching and learning connections with universities.

	Industry advisory board		ACS		p
	Mean	Std. dev.	Mean	Std. dev.	
Research relationships with universities or university staff are very useful to my organisation.	3.57	1.00	3.45	1.00	0.482
My organization would like to have more research relationships with university staff.	3.46	0.80	3.32	0.94	0.368
Consultancies by university ICT academics would be very useful to my organisation.	3.17	0.85	3.44	0.95	0.095
Short courses provided by universities would be very useful to my organisation.	3.57	0.91	3.76	0.93	0.233

Table 6 Comparison of industry advisory board opinions with broader industry opinions with respect to different types of engagement.

My organisation encourages engagement with universities such as:	Industry advisory board		ACS		p
	Mean	Std. dev.	Mean	Std. dev.	
- participation on university committees	4.05	0.88	3.34	1.03	<0.001
- provision of case studies or project ideas	3.54	0.82	3.07	0.98	0.003
- hosting site visits	3.37	0.90	3.17	0.98	0.232
- provision of guest speakers	3.94	0.83	3.41	0.93	0.001
- hosting internship or work placement students	3.88	0.86	3.51	1.14	0.036
- research linkages	3.36	1.00	3.11	0.95	0.130

What more can be done to strengthen industry–university connections?

All participants were asked what more they believed universities could do to strengthen connections with industry and what more they believed their organisation or industry could do. The responses to these open-ended questions were content analysed and the themes that emerged are listed in Table 7.

Table 7 Themes in participants' suggestions for strengthening connections with industry (with number of comments in brackets).

What more universities could do	What more industry could do
Create more opportunities for industry interaction with academics. (13)	Become more involved in teaching and research supervision. (12)
Market more to industry. (7)	Create more opportunities for interaction. (8)
Facilitate more student contact. (6)	Communicate needs to universities. (2)
Actively seek problems and unsatisfied needs from industry and help address them. (7)	Provide research funding. (2)
	Work with professional bodies. (2)
Be less 'academic' and more 'real world'. (3)	Provide technology to universities. (1)
Work more with industry associations and professional bodies. (5)	
Have liaison roles. (3)	
View industry as a partner not a just a source of funds. (3)	
Focus on a key set of organisations and align with them. (1)	
Offer industry certifications. (1)	

The most frequently provided suggestions for what universities could do to strengthen connections with industry related to increasing opportunities for contact and interaction with both academic staff (13 suggestions) and students (six suggestions). There appeared to be some desire from industry to be provided with situations that would allow them to develop ongoing relationships. This is illustrated by the following comments:

"Offer to host industry user groups on university facilities and encourage staff to become involved in these user groups. This would increase networking potential with industry, could give the staff an opportunity to learn from

presentations given by industry at these events, and staff could present at these events as well."

"Maintain communications with past students."

"Have industry events held at universities for the Industry plus students."

A few respondents believed that creating liaison roles was an important way to achieve these kinds of improved interactions (three comments). Opinion was divided as to whether this role should be a specialist one or whether existing students and/or staff could undertake it, as indicated by the following comments:

"Employ specialised people to act as Industry Liaison people who have good experience and can act as a bridge between industry and the Uni. Not academics who have not been in industry for years and lost touch with reality."

"Perhaps assign student (or staff) liaisons to potential industry partners to engage the industry partner in further activities with the university and develop the relationship."

Respondents also recognised that creating these opportunities was not solely the role of universities, with eight respondents suggesting that industry should also create more opportunities for interaction:

"Encourage staff to maintain contact with the organisations they studied with."

"Promote more post-graduate learning among staff."

"Bring researchers to workplace for discussion."

Some respondents considered that universities should market more to industry (seven suggestions); perhaps believing that their organisations were not fully aware of the benefits that could be realised, as the following comments suggest:

"Market more to industry. Possibly use success stories from previous engagements as proof statements of the value and benefit to industry."

"I think that Universities need to be more proactive in advertising what they can do for organizations. This would include road shows that highlight what the universities do, industry nights and other contact events."

Several themes related to the perceptions universities may have about industry and the need for universities to better understand where industry is coming from. Three respondents urged universities to be less 'academic' and more 'real world'; for example:

"Educate all University staff (particularly senior research staff) to understand industry's 'reason for being' and in particular the drivers that link technology opportunities to commercial outcomes."

"Actually do industry research rather than call their pet project 'industry related'."

This sentiment was also associated with advice to view industry as a partner and not just a source of funds (three responses), and to actively seek problems and unsatisfied needs from industry and help address them (seven responses). Some respondents also recognised that industry should communicate its needs to universities (two comments)

and be prepared to provide research funding (two comments). The following comments illustrate some of these sentiments:

“Stop looking at commercial organisations primarily as an opportunity to get funds.”

“Put some effort into it. See industry as a customer not a source of funding. Most if not all approaches from universities are because they want something: money (e.g. research funding, student scholarships etc), ideas (project or research topics), or provide assistance to students (advice on projects, placements etc). I’ve not seen any examples of universities working closely with a company to understand their ‘issues’ and then suggesting projects, work etc that would assist both.”

“Actively seek from organizations their problems and unsatisfied needs (e.g. difficulty in credibly estimating software intensive projects) and support organizations to address the issues (research/consultancy/centers of expertise when significant enough (e.g. The UniSouthCal CSSE in USA)).”

The value of industry associations and professional bodies in helping to form and sustain connections was acknowledged by several comments recommending that universities become more involved with these groups (five comments) and that industry also do so (two comments). This is consistent with Swan & Newell’s (1995) identification of ICT professional associations as enabling boundary spanning individuals who facilitate communication between industry and academia and with von Konsky’s (2008) recommendation that all ICT academics, students and professionals should be encouraged to obtain professional association membership.

Suggestions that were offered by single respondents included focussing on a key set of organisations and aligning with them rather than trying to liaise more broadly; and offering industry certifications. The need to limit the number of organisations has also been recognised by Lam (2007), while forming partnerships with industry to offer certifications has been reported as being successful (McGill & Dixon 2005).

Respondents were also asked to consider what more industry could do to increase interactions with universities. In addition to the suggestions spanning both university and industry action that have been discussed above, the most common theme of these responses related to becoming involved in teaching and research supervision (12 responses). Many respondents recognised the benefits of this kind of interaction and were keen for their organisation to be more involved, as the following quotes indicate:

“Provide supervisors or assistant supervisors for theses topics.”

“Be involved with defining/mentoring final year projects.”

“Have interns from 3rd/4th years come and do work on a project.”

“Nominating employees to give talks at various classes, teaching in their area of expertise.”

“Providing guaranteed work placements to students.”

One respondent also noted that industry could support universities by providing infrastructure such as technology. This is consistent with the recommendation that universities offer industry certifications, as these programmes are often facilitated by support from organisations such as Microsoft and Cisco Systems.

How do the views of industry compare with those of universities?

Given anecdotal reports of lack of agreement between industry and academia, the results of this study were compared with the views of ICT academic leaders reported by McGill *et al.* (2014) to determine the degree of consistency around the benefits for ICT of strong connections between universities and industry, and the ways to achieve these benefits. Table 8 summarises the key results from the two studies and highlights the consensus that is apparent. Both ICT academic leaders and those working in industry recognise and value the existing connections between universities and industry. They recognise that industry can contribute to teaching, learning and research, and that both academic staff and students can contribute to industry. Both ICT academic leaders and those working in industry desire stronger connections, and both groups have made recommendations to help achieve this.

Table 8 Comparison of industry views of benefits and ways to achieve them with published findings relating to ICT academics.

Industry respondents (this study)	University leaders (McGill <i>et al.</i> 2014)
Believe connections between universities and industry are valuable.	Believe connections between universities and industry are valuable.
Want more research relationships with universities.	Believe university research would be stronger if there were more connections with industry.
Industry wants to be more involved in teaching and learning including:	Believe student learning would be improved if there were more connections with industry.
1. Curriculum design – both degree and subject design.	
2. Provision of WIL placements.	
3. Provision of guest lecturers.	
4. Provision of case studies and project ideas.	
Industry wants to increase involved in postgraduate research by providing supervisors for theses.	Believe student learning would be improved if students have more involvement with research.
More connections with universities are desired. Key recommendations include:	More connections with industry are desired. Recommendations for taking advantage of synergies between teaching, research, industry and learning all include increasing connections with industry. Increased support from universities for this is the common thread.
1. More opportunities for interaction should be created.	
2. Universities should actively seek problems and unsatisfied needs from industry and address them.	
3. Industry staff should become more involved in teaching and research supervision.	
4. Universities should market more to industry.	

The study of ICT academic leaders by McGill *et al.* (2014) explored relationships between research and teaching in addition to relationships with industry. It is interesting to note that the request for recommendations to help improve both these relationships led almost exclusively to recommendations for strengthening industry connections. This was perceived as more important than strengthening ties between research and teaching and learning, and is clearly a priority for universities. Although the ICT education literature

reports many successful attempts to integrate various kinds of research experiences into the curriculum, the connections with industry are less well entrenched in universities. Whilst there have been some published examples of successful strengthening of these links (e.g. Bruhn & Camp 2004, Pilskalns 2009, Schilling & Klamma 2010), ICT academic leaders clearly believe that more is required, and this study shows that the ICT industry agrees with them, and has valuable ideas on how to do so.

Conclusion and recommendations

The research described in this paper has explored the ways in which the ICT industry believes it can, and should, contribute to ICT education and research in universities. The results have established how important relationships with universities are seen to be and that, in general, industry would like to expand its level of involvement. Industry would like further involvement in curriculum design, both directly and through professional associations. The involvement sought is not just with respect to high-level themes, but a majority of participants believed that industry should have input into the content of individual subjects. Many organisations currently support provision of guest lecturers and hosting of internship or work placement students. In addition to providing teaching related input and support, many in industry would also like to benefit from the expertise in universities by attending university run short courses and, to a lesser degree, by establishing research linkages, and using ICT academics as consultants.

In the past, attempts to strengthen linkages with industry have generally been piecemeal, and undertaken by universities without a solid understanding of the perspectives of those in industry. It seems likely that the potential benefits associated with strengthening industry linkages are more likely to be achieved when industry's views are taken into account. This study provided an opportunity to obtain input from ICT professionals across a broad spectrum of organisations and therefore its results provide a basis for more comprehensive attempts to improve engagement with industry. The strong commonalities in perceptions of both industry participants in this study and the views of ICT academics (McGill *et al.* 2014) also provide a strong starting point from which to build firmer relationships.

The recommendations for both universities and industry that emerged from this study are:

- More opportunities for interaction between industry and students and academic staff should be created. Both formal and informal occasions are of value in providing situations that allow the initiation and development of ongoing relationships. Liaison roles may help with this. Even simple measures from industry, such as encouraging staff to maintain contact with the universities they studied at via alumni groups, and encouraging post-graduate study of staff, can help.
- Universities should market more to industry as many organisations are not fully aware of the benefits that could be realised through new associations. Focussing on a key set of organisations and aligning with them may be an effective approach.
- Industry associations and professional bodies can play a valuable role in helping to form and sustain connections. Participation should be encouraged and opportunities to work together through these organisations should be embraced. Accreditation of courses provides an opportunity for industry associations and professional bodies to provide valuable input into curriculum and can lead to other opportunities to strengthen linkages.
- Industry advisory boards should play a strong role in supporting attempts to strengthen the linkages. Their value includes curriculum and content advice, provision of guest lectures, and support in obtaining student projects and sites for internships. They can also facilitate the initial connections needed for other linkages.

- Universities should actively invite industry to be more involved in teaching and research supervision; there appears to be an unmet desire from industry to participate in teaching and learning.
- Universities should actively seek problems and unsatisfied needs from industry and help address them. To do this, a better understanding of the demands and constraints industry faces is required. Equally, industry must be prepared to communicate its needs to universities. Knowledge transfer partnership programmes can support this process (e.g. <http://www.ktponline.org.uk/>).

Three problems facing the ICT industry in a range of countries were highlighted at the start of this paper. These include shortages of ICT professionals (ACS 2008, Thompson 2010, e-skills UK 2011, Australian Industry Group 2012, Australian Workforce and Productivity Agency 2013), poor perceptions of ICT as a course of study and as a career (Multimedia Victoria 2007, Papastergiou 2008, von Konsky 2008), and gaps in the knowledge and skills of graduates (Yen *et al.* 2003, Kennan *et al.* 2009, Koppi *et al.* 2009, Koppi *et al.* 2010, Thompson 2010, Pilgrim 2013). The stronger relationships with industry that should result from following the recommendations of this study will directly help to address knowledge and skills gaps. These stronger relationships should also help improve perceptions of ICT as a career, ensuring that students have more accurate perceptions of the careers for which they are being prepared and ultimately helping to reduce skill shortages by improving the student experience and therefore reducing attrition.

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