# Development of ICT Curricula through Graduate Career Outcomes and Required Skills

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**Abstract** - *Career outcomes are widely used by Universities to market their programs but there is scant evidence that they are attainable by graduates or if they inform curriculum design. This paper reports on a process for designing a University ICT curriculum that is directly informed by the career outcomes relevant to both local and national ICT industry. Outputs from this process are a set of classified attainable graduate career outcomes and a set of graduate skills that are the basis for the further stages of the curriculum development.*

**Keywords:** ICT career outcomes, ICT skills, ICT curriculum, ICT graduates, ICT degree

## 1 Introduction

ICT curricula are in a constant state of flux in response to continuing changes in emerging technology and resources such as staffing levels, student numbers, and funding models. It is often unclear whether specified career outcomes for particular degrees are part of the curriculum development process or just an advertising mechanism. Curriculum change is predominantly driven by outspoken individuals, budgetary constraints, and student demand rather than academic merit and external curricula [1]. In attempts to respond to external constraints and ever-changing technology it is easy to lose sight of the advertised career outcomes as a focus. Academics and students need to acquire a thorough knowledge of ICT career outcomes and that "*universities must link and publish computing programs, linking each program with specific career tracks, indicating specific career specialisation and knowledge"* [2].

There is little evidence that career outcomes as stated on marketing materials are really attainable by students. Graduate career prospects are one of the major influencing factors when pre-tertiary students (and their parents) are selecting their degree. The main reason for the lack of interest in a career in ICT by pre-tertiary students is that computing is traditionally perceived as asocial, focusing on programming and having limited connections to the outside world [3,4]. To counter this negative and inaccurate perception, and to promote the future growth of the industry, it is essential that the career outcomes for modern ICT degrees reflect the myriad of career opportunities now available and the curriculum is designed such that graduates can attain these careers.

While theoretically, linking curricula design closely with career outcomes might be an ideal situation, in practice, tertiary institutions are currently juggling the different demands of local and international students and there has been increased specialisation of programs and a correspondingly large growth in the number of units (subjects) on offer. This is a common problem as an emphasis on academic objectives tends not to be coherent but results in a large range of topics for students and will typically include the research interests of staff [5]. Alternatively, when emphasis is placed on employment objectives the resulting curricula are more directed and coherent [5].

While an abundance of units might allow for an abundance of career opportunities, this makes isolating core career outcomes very difficult and therefore also difficult for students to know exactly what units to take to achieve a desired career outcome. Graduates find it very difficult to identify ICT career opportunities that relate to the skills they have developed during their study [6,7]. Furthermore, this abundance in units, and course specialisations, makes it difficult for industry to determine solely on the basis of a graduate's degree whether they are qualified for a particular career, instead requiring knowledge of specific unit content.

The Australian Computer Society (ACS) provides a process (*what to do*) to guide the development of new curricula [8], but not the specific activities to undertake (*how to do it).* This is consistent with the more general absence of literature focussing on how to link career outcomes and ICT curricula. As a result, this paper will describe a method for identifying classified potential career outcomes and required skills during an ICT curriculum development effort guided by the ACS process. Specifically, we focus on how to perform the first three of seven steps in the ACS process to develop a new ICT degree, namely:

- *identify potential ICT roles that could be undertaken by graduates of a given program of study;*
- *identify the skills required by professionals in a given ICT career role; and*
- *identify the responsibility level required to be developed for each skill.*

As our implementation of our process will also be important to some readers, our constraints, resources, and outcomes of each phase of the process are included for completeness.

## 2 The process

Figure 1 outlines our four-stage process by which career outcomes and required skills are first identified, then classified before being used as inputs for subsequent curricula design decisions. The process is based on that of the ACS [8] with additional details on *how* to perform each step and feedback from each stage used to develop and refine the list of potential career outcomes.

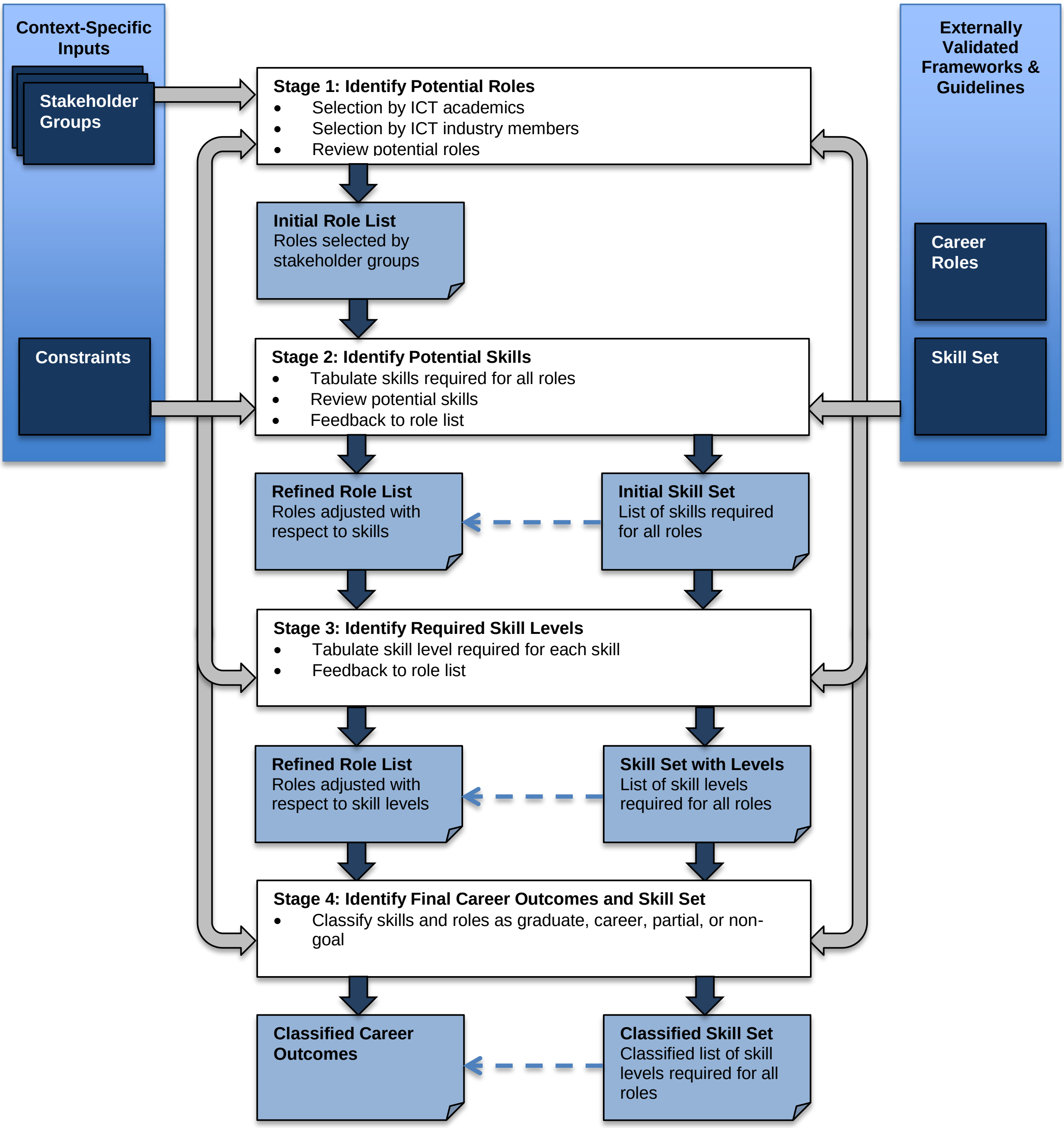


**Figure 1: A Process for Identifying and Classifying Career Outcomes for a Degree**

## 2.1 Constraints

Before commencing the process it is vital that any specific constraints relevant to the curriculum development effort be identified. These constraints will impact on decisions made about career outcomes and skills developed throughout the steps of the process.

## 2.2 Stage 1: potential role identification

Our initial investigation into ICT degrees throughout Australia indicated that degrees aim to produce graduates qualified for a range of ICT careers, and although there are some common career outcomes, most are quite different in their emphasis. ICT is constantly changing and new technology is continuously emerging and as a result career titles and definitions are changing. Our investigation indicated there appears to be no nationally recognised standard set of career titles and definitions that are used or maintained.

If career outcomes are to be achieved, they must be embedded into design. The first essential step must be to identify an externally validated set of ICT career definitions that covers a broad range of ICT careers. External validation limits the "*influence of outspoken individuals*" [1]. At the conclusion of this stage a number of career outcomes is required to create a degree that will meet its objectives as well as give graduates options.

There is a difference between the roles a graduate could be fully qualified for on graduation and those careers that they might aspire to over time. It is useful, not only for accurate marketing to potential students and their parents but also for the latter stages of the process, to be able to distinguish between the different roles available: graduate roles that students can perform when they enter the workforce, career roles they might eventually achieve after a few years of experience, or partially-qualified roles that they might not develop all the skills required during an undergraduate degree and require further study. As a result, to guide the process of identifying relevant career outcomes it is necessary to annotate all identified roles with an identification of the extent of qualification required:

- *Fully*—indicates students should be fully qualified for graduate entry in this role. Some short specific training maybe required, but graduates are expected to be fully capable of performing this role in a business within six months. Unit content should be focussed towards this role.
- *Partially*—indicates students should have some useful skills for this role but not all. There may be content that should not be supplied at university undergraduate level. It could be supplied by another organisation or a postgraduate degree.
- *No*—indicates this is not a role to aim for with the degree (whether it is achieved by skill overlap is irrelevant at this time).
- *Unsure*—indicates the reviewer was undecided.

Unless an institution has unlimited resources or unless a small set of career definitions was chosen to begin with, it is necessary to identify a subset of the roles that are relevant for the new degree. It is recommended that input from all stakeholders is sought but at the very least a two-stage process consulting ICT academics and ICT industry members is recommended.

#### 2.2.1 ICT academics

Academics that will be implementing the new degree should be involved in the identification process. Inviting academics who will be involved in the implementation of the new curriculum to contribute to the design from the outset builds a sense of ownership that will facilitate change [9]. To ensure that the new degree is not heavily influenced by any one individual a range of staff should be invited to identify the roles they deem relevant from the externally validated set of career definitions.

#### 2.2.2 ICT industry members

While academics have a good understanding of the careers relevant to their graduates, it is also important to get relevant industry members to identify the ICT graduate roles "*so as to incorporate the elements that are crucial for employability of graduates as a part of curriculum development, design, training and assessment*" [7].

Each industry member should review each career definition and rate them on the same four-point scale (*Fully*, *Partially*, *No*, *Unsure*) used by the ICT academics. To ensure that the roles are actually available and attainable, each industry member should additionally rate each career as:

- *Employed*—have employed a (Bachelor's level) graduate into this role in the last three years.
- *Would Employ*—would employ a graduate into this role if a vacancy existed.
- *Not Graduate*—would not employ a graduate into this role.
- *Not Relevant*—not relevant to my organisation.

#### 2.2.3 Potential role review

On completion of the initial identification activity, it is necessary to have a reflective discussion with industry members to share and discuss any differences in outcome identification amongst the industry members and with the careers identified by the ICT academics. The discussion should also consider the impact of any constraints.

Even the best externally validated list of career definitions may be missing some key roles that are particular relevant to an institution's particular circumstances; this stage is an opportunity to review the role list and add any missing roles. For example, there may be a significant local industry sector or a significant key research/innovation direction for the university or state. A high-quality and focused degree will also potentially attract students into research.

### 2.3 Stage 2: Potential skills identification

Stage 1 of our process identified a list of potential roles deemed desirable to use as a guide for the new curriculum development. While this list is a useful starting point, the next stage is to determine the specific skills required for the attainment of these roles by graduates.

As each role relies on the development of a combination of separate graduate skills, it is crucial to identify an externally validated set of skills for each career. Such skillset lists can usually be sourced from relevant industry, educational, or professional organisations. For example while the ACS endorses the use of the SFIA (Skills Foundation in the Information Age) skillset [10], our process does not mandate its use.

#### 2.3.1 Potential skills tabulation

An essential part of the process is identifying the required combination of skills for each role be drawn from an externally validated set of career skills.

To identify a potential list of skills for the entire curriculum, each role identified as a potential role should be considered and the required skill set tabulated. The process will identify some obvious skills to include that are necessary for a number of roles as well as a number of skills that are not needed for any potential role.

#### 2.3.2 Potential skills review

Once the skills required for all potential roles have been tabulated, a review of all the skills from the externally validated set should be undertaken to ensure that no essential skills have been missed. It may be that the set of career role definitions and the skill mappings did not cover the full list of skills. Consideration should also be given to any constraints during this review.

#### 2.3.3 Feedback to role list

Once the list of potential skills is identified, these skills can be used to influence the list of potential roles. For example, there will be some skills that are only needed for a few roles and, if there are constraints, consideration can be given to removing these roles or not developing those specific skills and only partially qualifying a graduate for these roles.

There may be some roles that were not in the list of potential roles but an analysis of the skills required might identify that they are all being covered and the role could be included in the list of potential roles.

### 2.4 Stage 3: Competency level identification

To this point, a list of potential roles and the specific set of skills required for the attainment of each role have been identified. The third stage of the process is to identify the competency level required for each skill to perform each role.

#### 2.4.1 Competency level tabulation

All the identified skills should be reviewed against the competency level required in each to determine the extent to which the skill could be developed in an undergraduate degree. The process will identify skills across a range of levels.

#### 2.4.2 Feedback to role list

There might be a number of roles that required skills at a level beyond that of a typical undergraduate degree. For these skills there are three scenarios:

- *Skills deemed essential*—develop depth in the skill throughout all years of the degree recognising that some of the final development might be achieved in the first six months of employment.
- *Skills unachievable within the constraints*—develop these skills only to a typical undergraduate level.
- *Skills unachievable within the constraints with no lower level of competency*—graduates require 1–2 years of employment to attain required knowledge.

There may be some roles that were selected that have skill levels that are too low or too high for an undergraduate degree. Removing these careers from the list can be considered.

### 2.5 Stage 4: Career outcome and required skill level identification

Using combined insight developed from the previous three stages—identification of potential roles, identification of required skills for each potential role, and identification of the competency level required for each skill—an informed decision can now be made about the final set of career outcomes that would be attainable for the students, and would therefore guide the curriculum development into the future.

Given that not all potential roles and skills identified will be deemed attainable by undergraduate students immediately on completion of their studies, we developed four categories to distinguish the differences in the attainability of these career outcomes:

- *Graduate Roles*—all skills would be fully developed and the role is suitable for graduates (though they may need six months of experience to reach the specific competency level);
- *Career Roles*—all theoretical skills would be covered and the role is suitable for graduates who have acquired one to two years of experience and shown competence;
- *Partially Qualified Roles*—some key skills may be absent from the undergraduate degree which might be available from another discipline of the university or other educational institution or in a postgraduate degree; and
- *Non-goal Roles*—all the skills would be developed however the delivery of the unit content and discussion would not be focused towards these particular roles.

## 3 Our experience

The following section of the paper shows our experience in applying the process as described in our own curriculum redevelopment process.

### 3.1 Constraints

The University of Tasmania (UTAS) is the only university within Tasmania, and the School of Computing and Information Systems, as the only ICT School at UTAS, must meet the ICT higher education needs of the ICT industry in Tasmania.

An external school review conducted in 2011 recommended the consolidation of the two existing undergraduate degrees (a Bachelor of Computing and a Bachelor of Information Systems) into a single Bachelor of ICT. Additionally, due to a shrinking staff profile coupled with pressure for increased research output across lead to a recommendation to reduce the number of undergraduate unit offerings from 50 to just 30.

### 3.2 Stage 1: potential role identification

Our externally validated list of career roles was sourced from the Queensland (QLD) ICT Public Sector Development Office [11] ICT career streams diagram. It is maintained to keep it current, and was last updated in 2012. This diagram identifies four different career streams and 55 key ICT roles. The online version of the diagram is interactive and selecting a role will take the user to further information that clearly defines the role and also has information essential to the later stages of our process as it identifies the SFIA skill set required to perform the role along with the competency level (referred to as "level of responsibility" in SFIA) for each skill [10].

Given our constraint of only 30 units (as recommended from our external review) it was necessary to identify a much-reduced subset of the 55 roles that would be career outcomes for our new degree. At the conclusion of this stage a broad range of career outcomes was required in order to create a non-specialised ICT degree that would have wide appeal.

To identify a practical subset consultation was sought from both academics within the school and local ICT industry members.

#### 3.2.1 ICT academics

A working party was formed consisting of eight academics, heavily interested in teaching and learning with a variety of different characteristics and backgrounds: drawn from geographically separate campuses; three primarily from the Information Systems discipline, five primarily Computer Science; and three being female and five male.

Only a small number of roles, 8 (out of 55), received 5 (out of 8) or more *Fully* votes. There were 16 roles that received at least 75% (6 out of 8) of the votes when combining the *Fully* and *Partial* votes. The results are shown in Table 1. The careers that are different to the ICT industry member responses (as discussed further in the next section) are shown with a shaded background.

### 3.2.2 ICT industry members

Three industry forums were held and eighteen representatives of the local and national ICT industry and Government participated in an exercise to identify career outcomes with a broad range of organisational focusses including: recruitment, consulting, security, education, research, development, and government.

Our attendees represented organisations with varying number of ICT employees from one to thousands. Nearly all had employed graduates into various positions throughout their career; most less than ten, some as high as fifty or more.

Only a small number of roles, 5 (out of 55), received 10 (out of 18) or more *Fully* votes from the industry representatives. There were 12 roles that received over 75% (14 out of 18) of the votes when combining the *Fully* and *Partial* votes. The results are shown in Table 1. The careers that are different from the ICT academic responses are shown with a shaded background.

Additionally, the industry members were asked if they would have employed in the past or would employ in the future a graduate into the role. The total number of respondents (out of 18) is shown in Table 1.

### 3.2.3 Potential role review

The most interesting and relevant points from a discussion between all parties who had participated in the career outcomes exercise were:

- Employers commonly place graduates in a Help Desk Operator role initially to test competence, and if they show ability, they are quickly advanced to a Systems Administrator or Software Developer role.
- Industry members believed the role of Graphics Designer was attainable and of high demand, however it was questioned whether this role was likely to be attained by graduates solely undertaking an ICT degree, as specific skills would be required from Fine Arts related units.
- Only two industry members identified the Game Developer role as one that should be *Fully* achieved, but all recognised that this role was a strong draw card for students and they welcomed the potential increase in graduate numbers it provides.
- Industry members believed it was essential that graduates were exposed to concepts in project management and business analysis during their degree but that a graduate could not enter into a Project Manager or Business Analyst role without job experience. Once shown competent, they would be rapidly promoted to these roles.

The ICT careers stream diagram was very focused on business careers and does not include titles that might fall under ICT Scientist or ICT Researcher. These careers are not necessarily of high interest to industry, but given that one of our constraint is an increase in research output it is clear that they are of significant interest to the University and the School and other research institutes within Tasmania especially with the introduction of the NBN, Sensing Tasmania, CSIRO ICT Centre, and the HITLab. As a consequence ICT Researcher was added to the list of potential roles as shown in Table 1.

Table 1: Roles identified by working party and industry

| Agreement on Role's Importance | Industry Would Employ |
|---|---|
| **> 50% Fully Votes** | |
| Data Modeller | 14 |
| Software Designer | 12 |
| Software Developer | 16 |
| Web Developer | 12 |
| Database Administrator | 11 |
| Systems Administrator | |
| Project Manager | |
| Games Developer | |
| **> 75% Fully + Partial** | |
| Systems Analyst | 12 |
| Help Desk Operator | 11 |
| Network Analyst | 7 |
| Security Specialist | 10 |
| Business Process Modeller | 11 |
| Project Support Officer | 10 |
| Multimedia Designer | 5 |
| Multimedia Developer | 7 |
| Technical Architect | 8 |
| Security Architect | |
| Testing Manager | |
| Network Manager | |
| Information Management Specialist | |
| Solutions Architect | |
| Technical Development Manager | |
| ICT Manager | |
| *Graphics Designer* | 9 |
| *Business Analyst* | 11 |
| *Project Manager* | 10 |
| **Added to Meet Constraints** | |
| ICT Researcher | |

| Key |
|---|
| Agreement between academics and industry |
| Roles identified by academics only |
| *Roles identified by industry only* |

### 3.3 Stage 2: potential skill identification

In our process we relied on the SFIA skillset as it is the world's most popular definition of information technology skills. SFIA provides a common reference model for the identification of the skills needed to develop effective information systems making use of ICT. It provides a standardised view of a wide range of professional skills needed by people working in information technology. Specifically, it lists 86 professional ICT skills, with each skill being mapped across seven levels of “responsibility” (i.e. competency).

Table 2: Roles identified after skill identification

| Roles | |
|---|---|
| **Fully Qualified Roles** | |
| Data Modeller | Security Specialist |
| Software Designer | Business Process Modeller |
| Software Developer | Project Support Officer |
| Web Developer | Technical Architect |
| Database Administrator | Security Architect |
| Systems Administrator | Testing Manager |
| Project Manager | Technical Development Manager |
| Games Developer | ICT Manager |
| Systems Analyst | Business Analyst |
| Help Desk Operator | Project Manager |
| Network Analyst | ICT Researcher |
| Benefits Analyst | Customer Services Manager |
| Animator | Incident Manager |
| Hardware Engineer | Change Manager |
| **Partially Qualified Roles** | |
| *Multimedia Designer* | *Information Management Specialist* |
| *Multimedia Developer* | *Solutions Architect* |
| *Network Manager* | *Graphics Designer* |

| Key |
|---|
| Fully qualified roles selected by stakeholders |
| Incidentally qualified roles |
| *Partially qualified roles* |

### 3.3.1 Tabulation of skills for potential roles

We identified 38 skills needed for our potential careers out of the 86 defined by SFIA including a number of skills that were necessary for a range of careers.

### 3.3.2 Reviewing potential SFIA skills

When reviewing all the SFIA skills that were not included, we discovered two that we decided to include: HFIN (Human factors integration) and UNAN (Non-functional needs analysis). Both these skills relate to the recommendation in the ACM IT curriculum [12] that user-centeredness become a pervasive theme.

### 3.3.3 Feedback to role list

We identified a number of roles that require a specialist skill that we were unable to include due to our constraints on unit numbers and roles that were not identified as potential roles for which all the skills are covered incidentally (see Table 2).

## 3.4 Stage 3: level of responsibility identification

SFIA recognises seven levels of responsibility (competency level) ranging from 1 at basic entry to 7 at a very senior level, normally in a large organisation [10]. This step is guided by the ACS recommendation that undergraduate degrees should produce graduates with skills around SFIA level 4 of responsibility [8].

### 3.4.1 Tabulation of level of responsibility

Given the constraint of 30 units, we reduced three skills to level 4 as we will be unable to develop these to level 5. We develop three skills with lowest level 5 but these skills require experience to fully achieve based on feedback from industry members.

Table 3: Final Career Outcomes

| Roles | |
|---|---|
| **Fully Qualified Roles** | |
| Data Modeller | Systems Analyst |
| Software Designer | Business Process Modeller |
| Software Developer | Project Support Officer |
| Web Developer | ICT Researcher |
| Games Developer | |
| **Career Roles (After 1 or 2 Years Experience)** | |
| Database Administrator | Security Specialist |
| Systems Administrator | Technical Architect |
| Project Manager | Security Architect |
| Network Analyst | Business Analyst |
| **Non-goal Roles** | |
| Benefits Analyst | Customer Services Manager |
| Animator | Incident Manager |
| Hardware Engineer | |
| **Partially Qualified Roles** | **Missing Skill** |
| Testing Manager | TEST Level 5 |
| Help Desk Operator | USUP, SLMO |
| Technical Development Manager | Level 6 |
| ICT Manager | Level 6 |
| Change Manager | CHMG Level 5 |
| Multimedia Designer | INCA |
| Multimedia Developer | INCA |
| Network Manager | NTDS, ITMG |
| Information Management Specialist | IRMG |
| Solutions Architect | ARCH |
| Graphics Designer | INCA |

### 3.4.2 Feedback to role list

Whilst we develop all the skills required for the Help Desk Operator role this career is not considered as a worthy outcome of a university degree but more as a side-effect outcome of the degree, as many students take on these roles before graduation.

We added the Project Support Officer and Data Modeller required as these were seen as good graduate roles that students could use to enter the workforce.

Both the Technical Development Manager and ICT Manager require skills at level 6. As both careers also require other skills that we will develop, it was decided these would be partially qualified roles for the new degree.

## 3.5 Stage 4: final career outcome identification

In total we have identified 33 career outcomes for our degree as shown in Table 3. The categorisation resulted in the identification of 9 graduate roles that would be immediately attainable by our graduating students and would thus be our primary focus in developing an ICT curriculum. In addition to these core ICT graduate roles, we also identified 8 career roles, 11 partially qualified roles; and 5 non-goal roles.

Our curriculum will develop 31 skills (12 to level 4, sixteen to level 5, and three to almost level 5 but experience is needed to achieve that level of responsibility). The skills will be embedded throughout the units, and each unit will work towards developing a number of skills.

#### 3.5.1 Next steps

Having identified the career outcomes, skills and level of responsibility we went onto complete the final steps of the ACS process [8] as documented in Herbert *et al* [12] and are currently creating the units based on the ACM international curricula [13]. Having completed the first draft of the framework we have identified the equivalent of 29 units to cover these skills at the required level to be developed throughout 2013 for delivery in 2014.

## 4 Summary

Curriculum design is a complex process that must be informed by stakeholders and developed from multiple perspectives. In creating a new ICT curriculum we determined a need to identify those careers that would be attainable by our graduate students and guide our future curriculum design process. While career outcomes seem a logical place to commence curriculum design, there exists little direction available to guide the process of identification and evaluation of potential career outcomes and the required skills for each.

This paper reports on the development of an ICT curriculum that was guided by the ACS recommended process for developing curricula and provides practical suggestions for undertaking the first three steps:

- have a range of academics and industry members select the roles within the constraints using an externally validated set of roles with clear definitions;
- using the roles selected, identify the skills relevant to each career, and use these to modify the list of potential roles (to both remove some options and introduce others) within the constraints; and
- identify the competency level for each skill within any constraints and use this level for each skill to refine the list of roles and to classify these roles to aid in accurate marketing of the degree.

In following the stages of this process, career outcomes can be identified that are informed by a balanced view of academic insight and employer needs, both being further supported by externally validated and industry-standard skill definitions. Furthermore, potential students can be assured that advertised career outcomes as are really attainable, and that the degree was developed with these career outcomes in mind.

Following the process documented in this paper has succeeded in producing an ICT degree curriculum and given the participants confidence that by following this process a curriculum development team can:

- determine exactly what career outcomes from the degree will be covered completely, which will be covered partially, and which will not be covered at all;
- be guided by career outcomes when developing and making decisions about what skill set to include in specific curricula;
- avoid the problems of outspoken individuals having undue influence on curricula; and
- reduce the number of units to operate within budgetary constraints, allowing time for staff to do research, and still offer a broad range of career outcomes to meet student and industry demand.

## 5 References


[1] Gruba, P., Moffat, A., Søndergaard, H., & Zobel, J. (2004): What Drives Curriculum Change? in *Proceedings of the Sixth Australasian Computing Education Conference*, ACS, pp 109–117.

[2] Calitz, A.P., Greyling, J.H., Cullen, M.D.M., 2011, ICT Career Track Awareness amongst ICT Graduates, *ACM SAISSIT'11*, October 3-5, 2011, Cape Town, South Africa, pp 59–66.

[3] Babin, R., Grant, K. and Sawal, L., 2010. Identifying Influencers in High School Student ICT Career Choice. *Information Systems Educational Journal*, 8(26).

[4] Biggers, M., Brauer, A. and Yilmaz, T., 2008. Student Perceptions of Computer Science: A Retention Study Comparing Graduating Seniors vs. CS Leavers. *ACM SIGCSE'08*, 12-15 March 2008, Portland Oregon, USA, pp 402–406.

[5] Henkel, M. and Kogan, M. (1999), Changes in curriculum and institutional structures, in C. Gellert. ed., '*Innovation and Adaption in Higher Education'*, Jessica Kingsley Publ., 116 Pentonville Road, London, N19JB, England, Chapter 2.

[6] Alexander, P.M., Holmner, M., Lotriet, H. H., Matthee, M. C., Pieterse, H.V., Naidoo, S., Twinomurinzi, H. and Jordaan, D., 2010, Factors Affecting Career Choice: Comparison between Students from computer and other disciplines, *Journal of Science Education and Technology*. Springer, 16 October 2010.

[7] Nagarajan, S. & Edwards, J. (2008): "Towards Understanding the Non-technical Work Experiences of Recent Australian Information Technology Graduates" in *Proceedings of the Tenth Australasian Computing Education Conference*, pp 103–112, ACS.

[8] Australian Computer Society (2011): Accreditation Manual, ACS.

[9] Elizondo-Montemayor, L., Hernandez-Escobar, C., Ayala-Aguirre, F., & Aguilar, G. M. (2008). Building a sense of ownership to facilitate change: The new curriculum. *International Journal of Leadership in Education, 11(1),* 83-102.

[10] SFIA Foundation, Skills Framework for the Information Age. http://www.sfia.org.uk, Accessed 8 Aug 2012.

[11] QLD Government, Chief Information Office, Department of Science, Information Technology, Innovation and the Arts, http://www.qgcio.qld.gov.au/qgcio/projectsandservices/ictworkforcecapability/Pages/ICTcareerstreams.aspx, Accessed 8 Aug 2012.

[12] Herbert, N., Dermoudy, J., Ellis, L., Cameron-Jones, M., Chinthammit, W., Lewis, I., de Salas, K., Springer, M., (2013) Industry-Led Curriculum Redesign, Submitted to *Proceedings of the Fifteenth Australasian Computing Education Conference*, ACS.

[13] ACM, Association for Computing Machinery. http://www.acm.org/. Accessed 8 Aug 2012.