Reshaping higher education: Producing T-shaped Computing professionals

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Abstract:

Input from employer groups consistently shows that people skills are often lacking in new computing graduates. Underdeveloped communication, negotiation and collaboration skills reduce an organization's capacity to apply specialist skills and knowledge to solve problems and exploit opportunities creatively. Graduates must also be independent learners and be able to adapt as technologies and applications continually and quickly change. Underpinning job roles are an increasing number of computing specialties and understanding of how these apply in a range of application domains. Innovation stems from not only an understanding of computing specialties, but its integration with other specialties as Computing + X, or X + Computing. The challenge for higher education is to effectively include these people skills as well as to prepare graduates for expanding numbers of roles that each have their own requirements around breadth and depth of knowledge and skills. In this paper, we call for an approach to computing education which unifies all the computing disciplines. We introduce our definition of a T-Shaped Computing Professional based on SFIA skills and Bloom's taxonomy levels of difficulty and apply this to the ever-changing role of computing education particularly for accreditation and assessment of life-long learning and transferable skills.

Keywords: T-shaped graduates, computing professionals, computing programs, information systems program architectures

I. INTRODUCTION

Technology permeates everything that we do professionally and personally. Designing programs to deliver graduates across all business domains and specialist technology roles has become almost impossible. In Information Systems (IS) and higher education (HE) more generally, we need program architectures and courseware that keep pace with the emergence of new devices and applications of technology within organizations almost continuously.

During COVID-19 the rate of change in organizations and individuals use of technology especially for communications increased. Working from home became the norm across many industries. A general understanding and acceptance that workers require high level digital knowledge and skills has become the norm across the economy. Arguably, computational thinking and an ability to design and implement an algorithm using a programming language have become essential for new business graduates while successful workers across industry demonstrate digital competency to varying degrees of complexity. HE providers are being asked to design computing education to meet employer needs. Reshaping is required in Information and Communication Technologies (ICT) program architectures as it is no longer clear whether digital knowledge encased in essential functionality for other professions belongs in a new Micro-credential or a Graduate Certificate, or a totally new Program.

Based on the Skills for the Information Age (SFIA) Framework and associated description of 102 skills and competencies, recommendations for requisite knowledge and skills for Digital Professional roles have been described. Such foundational and specialist ICT knowledge can be combined with employability skills divided into business enabling and human capabilities. The description of ICT knowledge and skills leans on the SFIA levels and is organized in areas, such as, Information and Cyber Security as a family of Digital Professional skills aligned with more than 20 roles extending from the highly technical Computer Science (CS), Computing Engineering (CE) and Software Engineering (SE) to Information Systems (IS) and Risk Management (RM) type positions. The comprehensive description of ICT knowledge and skills is invaluable to the description of job roles and guides foundational and specialist knowledge and skills in programs of study. Measurement of the level of complexity of the application of professional knowledge and skills in work roles is more difficult within educational programs, other than in a capstone project course.

The Australian Government has generated a digital career pathway and an organizational SFIA 8 -based digital license [1]. Both human and digital capabilities are included in the 150 digital job role descriptions both underpinned by SFIA. Government advice for positions includes details of relevant knowledge and skills, as well as competency SFIA levels aligned with appropriate pay scales. The system is comprehensive and has the capacity to guide curriculum development, especially in the digital professional knowledge and skills space.

The Australian Computer Society (ACS) underpins higher education accreditation requirements with SFIA [2]. The ACS accredits computing programs across Australian universities and requires program to align curriculum with SFIA 8 knowledge and skills associated with graduate roles. A typical program of study increases in levels of complexity as a student, progresses towards completion. The revised Bloom’s taxonomy is used to evidence increasing levels of complexity from the ‘Remember’ level, through ‘Understand’, ‘Apply’, ‘Analyse’, ‘Evaluate’ and ‘Create’ levels [3]. IS professionals apply technical knowledge and skills, in authentic domains to innovatively solve problems [4]. There are usually no entry requirements for work experience so the use the SFIA Levels to evidence depth and complexity of courses is fraught with difficulty in two dimensions. The first dimension is the measurement of complexity of application using SFIA Levels and the second is the sheer volume of job roles.

The IS2020 competency model for IS programs lists IT consultant, data analyst, computer systems analyst, IT auditor, software application developer, and cybersecurity analyst as the most common jobs for IS graduates but recognizes the breadth of impact of IS and overlap across specialist CS, SE, IT, cybersecurity (CyberSec), Data Science (DS) and Computer Engineering (CE) sub-disciplines of the ICT/Digital Professional [5]. The description of IS graduate roles is fluid at best but always difficult to translate into program architectures that are sustainable for universities.

The new IS2020 curriculum model includes competency areas and has shifted IS2010 elective courses to core and included new areas, such as Ethics. Specialist areas include Data, Technology, Development and Organizational Realm. The system recognizes the differing aspects of jobs across sub-disciplines. Descriptions of curriculum and choices allow for a focus on a myriad of job roles by recognizing the interplay between ICT sub-disciplinary knowledge through a need for core, specialist and Work Integrated Learning (WIL). Assurance of employability uses the revised Bloom's taxonomy to describe complexity as well as establish foundational, core, depth in a specialist area of ICT, a capstone and human capabilities.

The research investigation in this paper examines the literature discussing the IS and ICT discipline in terms of graduate roles, University undergraduate program architecture and accreditation of quality assured curriculum. IS graduates obtain jobs in all industries and sometimes lose roles to non-Digital Professionals with another qualification as many particularly large organizations conduct specific functional on-the-job technical training. The critical program and course design challenge for academics and universities is to re-imagine the mix of knowledge and skills so that all possible industry contexts are included, and technology graduates are employable.

As a part of this research investigation a review of professional body and government accreditation requirements as they pertain to curriculum requirements and program architectures was undertaken. This was to enable an understanding of the current IS identity in terms of graduate roles, with a long-term view to simplifying accreditation and quality assurance.

The research questions are:

RQ1: What would an ICT Program Architecture that can support the great variety of roles look like?

RQ2: How could a process be developed to build communication/trust between government, professional accreditation bodies and universities, so that program change processes can be expedited?

II. METHODOLOGY

The review of accreditation requirements undertaken as the basis for this research was managed as a case study that enabled a description of the synergies between industry expert comments, ACS ICT job profiles, the Australian Quality Framework (AQF) Level 7, IS 2020 and SFIA8 undergraduate IS program curriculum requirements for Information and Cyber Security Specialists. A Design Science research approach was used to assure the inclusion of data drawn from stakeholders' external and internal university data [6].

The research focusses on creating business processes that streamline collection and consolidation of data to align industry graduate needs and program architectures, at the design point, to ease implementation and upgrade processes. It is anticipated that the merging of conversations between professional bodies, governments and University quality systems would build stronger relationships. Trust would enable simplification of business processes as reliance on compliance checks would be reduced. In the post COVID dynamic digitalized work environments, extension of the SFIA 8 T-shaped model built on agreement across professional and government accreditation bodies and Universities is necessary to speed up program change.

The study commenced with focus groups including Business and IS management industry representatives asked what they required of an IS graduate to be successful in the workplace (see Table 1 for the composition of the focus groups). Participants were asked to comment on current and future business processes that they feel are essential to support students and graduates entering the workplace.

Use of a qualitative case study approach to the research was critical as boundaries between phenomena and contexts are blurred and an in-depth understanding of IS graduate roles and program architectures was needed. IS graduates work across all domains in industry and therefore shaping of professional identities across IS are dynamic. A range of data sources were triangulated to evidence the description of an IS professional identity and alignment of the Information and Cyber Security Specialist and Business Analyst graduate roles across industry contexts.

The use of Design Science Research as a method enabled the creation of an artefact or Utility theory to improve the practice of program design so that external environmental industry needs and technology changes are incrementally and quickly reflected in programs [21]. Four components of the Design Science Research Framework were used to underpin the conceptual model for our work: a) Problem Diagnosis – descriptive and interpretive analysis to identify and explain the problem, as detailed in [7] based on the data from the industry focus groups presented in Table 1; b) Review of the SFIA 8 and SFIA T-shaped models, curricula from the Association for Computing Machinery (ACM) and the Association for Information Systems (AIS), [8]; c) Technology Evaluation – a case study in the Higher Education context from the ACS accreditations of AQF Level 7 undergraduate Information and Cyber Security Specialist and Business Analyst graduate roles; and d) Technology Invention or Design – to derive the system solution and perform normative analysis of the contribution to the SFIA 8 T-shaped model for graduate role descriptions. Following this methodology, recommendations for work to augment accreditation-university-government conversations to align industry roles and specialist IS undergraduate curriculum were devised and are presented in the conclusion to this paper.

Data Collection

Stakeholder analysis theory from [9] and Constructive Alignment from [10] underpin the research design, data collection and analysis. The instrumentalist use of stakeholder theory takes information drawn from processes that connect external program accreditation and internal university quality systems to foster continuous improvement. Quality of curriculum is assured through the use of constructional alignment. A functional outcome derived from the collection of information of all stakeholders will facilitate a functional outcome [11]. The aim is to deliver a simplified cyclical University quality assurance process that feeds and draws information from both accreditations and University quality systems to support program change. This approach assures that the opinions of all stakeholders are collected, which in turn will assure alignment of industry and government driven descriptions of IS graduate role requirements and specialist ICT programs at a meta level. Constructional alignment drives the quality of delivered courses/subjects within universities.

Participants

An instrumentalist stakeholder analysis was undertaken to assure perspectives on industry requirements for IS graduates and the how the information was translated into programs and courses was well understood [22]. In this project both general business and IS industry representatives, with experience recruiting graduates, were gathered in focus groups and asked what they considered necessary to be a successful IS employee today. A summary of the commentary served as a reminder of the importance of technical foundations and specialist knowledge combined with the human capabilities needed to understand problems and create innovative implementable solutions. The distribution of industry representatives participating is described in Table 1 below.

Focus Groups	Business	Information Systems
1 – 4 September 2020	1 x Business Recruiter	1 x Information Systems
2 – 4 September 2020	1 x Business Management 1 x Supply Chain	2 x Information Systems

3 – 30 October 2020	2 x Business Recruiters 1 x Supply Chain	

Table 1: Industry Focus Groups 2020

The place of IS graduates in industry is the first subject addressed in the literature review. Synergy across the descriptions of IS roles, predictions for important future change to graduate roles and common methods for designing and evaluating program/course architectures are discussed. An imperative to create appropriate program architecture quality and change processes is assumed.

During the technology evaluation and problem diagnosis phases of the research an inductive approach was used to seek a better understanding of mechanisms to align industry descriptions of IS graduate roles and university program architectures. This report first outlines findings from a review of descriptions of undergraduate curriculum requirements to deliver Information and Cyber Security Specialist graduates. The SFIA 8 T shaped graduate role sits at the heart of our investigation of program architectures.

In the focus groups questions asked of the participants centred around the following two:

1. What does industry regard as the most important characteristics of a successful IS graduate?
2. How can industry and universities collaboratively define an appropriate graduate IS skill set?

In Australia, ACS accredited IS undergraduate programs contain a five-course core, which is common irrespective of desired specialist graduate roles. Typically, the IT core includes:

- Applications Development – programming
- Infrastructure
- Systems Analysis and Design
- Database Management; and
- Project Management (Horizontal Bar of the T)

The core courses are followed by a long tail of options. In the Australian study of IS ACS accredited programs IT Project Management, capstones and WIL to develop professional skills were core [7]. A point of difference for Australian ACS accredited degrees compared to [4] has been the importance of Professional Practice Project Management, a mandatory part of IS programs alongside Interpersonal Communication and Ethics/Social Implications since 2001.

As the ACS places importance on capstones and WIL experiences, IT Project Management was included in the majority of programs as a core [7]. In older ACS accreditation guidelines both Ethics and IT Project Management were mandatory curriculum requirements. This was not deemed as requiring significant coverage in the IS guidelines of [4] but is now included in the IS 2020 curriculum [5]. The voices of industry representatives in the focus groups conducted affirmed that WIL was still important and is integrated in capstone and industry projects as indicated by the following comments from various participants:

- Real world experience via WIL, industry involvement, internships and capstone are critical. WIL more important than ACS accreditation of the program completed, as:
    - *Real world problems help students fit in as grads when they finish*
    - *Industry gets a good conversion for students staying in the organization.*
    - *Hire an IS graduate but do not really care too much about accreditation as more concerned about capabilities in terms of application of IT skills to solve problems (Participant 1,3,4,5, 8, 9, 10).*
    - *Expect the graduates to work together in multidisciplinary teams – Learn and develop whilst in the diverse group which should help them gain the skills which*

> *they would need so they can meet the needs of a community. Soft skills are grown. Expand industry project opportunities and get graduates to mentor students (Participant 5, 10).*

Here the similarities between the ACS [4] and SFIA 8 became apparent. It is a requirement of the AQF and ACS to evidence increasing depth through the combination of discipline knowledge and professional/generic skills, in authentic business domains. In SFIA 8 new added detail have been provided by an additional sub-categories and skills. Information and Cyber Security Specialist are described in detail for the first time (SFIA, 2021).

III. RESHAPING EDUCATION OF COMPUTING PROFESSIONALS

The development of people skills is an ongoing task and past work has been described as 'Same Wine New Bottle' by one of the participants. The T-shape [1] and its exploration in the context of SFIA job roles [2] offers the opportunity for a new approach, a lens through which knowledge and competencies can be viewed from a depth perspective as well as from the level of integration with other specialties, application domains and enabling people skills. A shift in emphasis enables the identification of higher education computing programs that are unique and/or successful in the modern world of work. The important question is: can the SFIA T-Shaped model be used to link industry and higher education by augmenting strategic conversations, describing emerging graduate families of roles and designing innovative programs suited to constant change?

SFIA has recognized the importance of skills other than technical skills needed by computing professionals through its exploration of the T-shape in job descriptions [1]. A T-shaped professional has depth (the vertical bar) of technical skills, as well as breadth (the horizontal bar) in the form of skills that enable creative cross-disciplinary working across application domains.

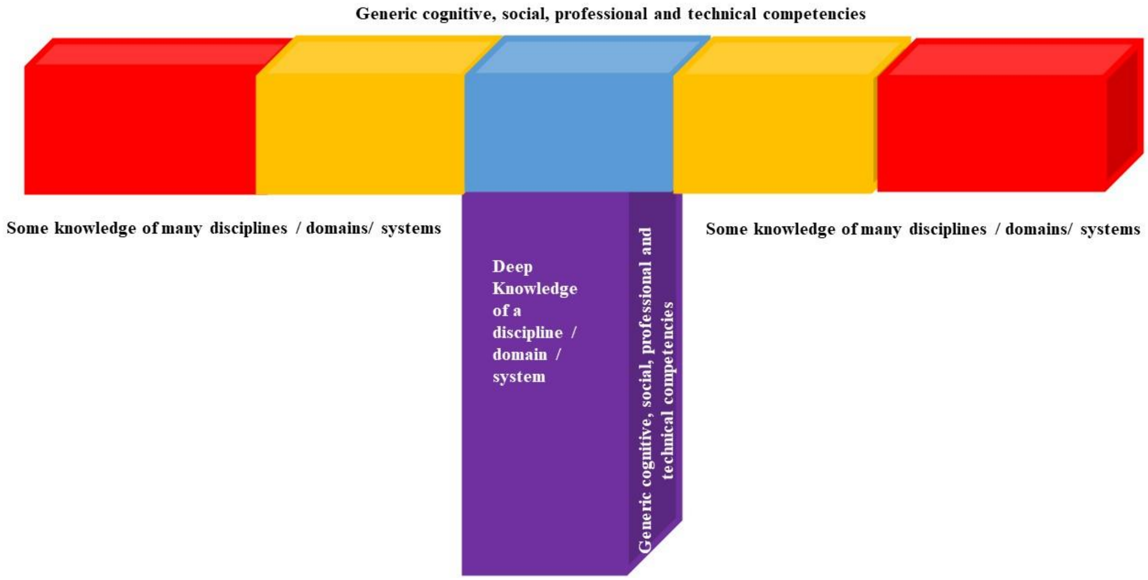
While T-shape professionals are continually developed in the workplace [3], higher education has an important role to play in laying the foundations and doing what they can to bridge the "real world" experience gap. Though some higher education providers [4] [5] and curriculum designers [6] [7] [8] [9] have embraced the concept of the T-shape graduate, it is not widely used as a tool to design programs and certificates that incorporate computing professional specialist and human capabilities required to apply learnt knowledge and skills to design solutions to real problems. Adoption of the T-shape in frameworks such as SFIA [2] and their use by national accreditation bodies will increase interest and motivation, but wider adoption faces challenges.

Firstly, further description of the combined computing specialist, human and business capabilities are typically included in a T-Shaped employee. Second academic program designers need practical tools to develop programs that align with T-shaped graduate roles as described by SFIA. The level of detail in which alignment is measured is worth investigation, as well as the character of programs and appropriate flexibility to address families of SFIA roles rather than a single graduate outcome. The vertical includes computing specialist knowledge and skills that make graduates able to apply learning to authentic problems. The application complexity can be measured using Bloom's [3] as a third dimension. The notion of looking at specialist knowledge and skills in increasing depth and application in ever increasing complexity as a third dimension has the potential to reduce linear increasing levels of detail. The T-Shaped model can be the connection between industry descriptions of roles and flexible HE degrees. Finally, an understanding of the costs and benefits to Higher Education, Industry and Professional Associations is needed as validation of the need for change.

IV. DEFINING THE T-SHAPED GRADUATE

While the general ideas that underpin the T-shape are clear enough, definition of the T-shape vary greatly at a detailed level [1,8]. The model in Figure 1 provides a widely used model that captures the essential elements. A simple two-dimensional model cannot capture the complexity of academic programs but does lay the foundations for a way of thinking about curriculum.

Figure 1: The T-Shaped Graduate



Deep knowledge

The vertical bar ("|") represents the primary area of expertise of the graduate. It represents depth of knowledge and skills in a discipline, domain, or system, essentially the ability to analyse and solve problems from the perspective of an area of expertise, expertise not available from other professionals. This depth is not only in technical skills but a holistic combination of technical and non-technical skills (sometimes, perhaps erroneously referred to as "hard" and "soft" skills). For example, there should also be a deep understanding of written and oral communication, and ethical frameworks in programs for graduates who aspire to be business analysts who can effectively work with a range of business systems stakeholders to professionally elicit, document and communicate solution requirements and options.

From an educational perspective the vertical bar defines what graduates "can do" and can do well. Increasingly, professional education programs are expected to represent outcomes in terms of competencies [11] [12] [13]. Achieving this depth requires demonstration of higher levels of achievement in industry frameworks, such as level 3 in the European Software Skills for the Information Age (SFIA) [2], and level 4 or 5 in educational taxonomies such as Bloom's [10]. Essentially, there is an expectation that professionals can apply analytical and synthetical skills to develop solutions or identify opportunities that requires deep knowledge of their discipline, domain, or system of expertise.

Disciplines are typically sub-fields of knowledge within broader knowledge areas [14]. The joint ACM/ IEEE-CS report [11] defines the computing disciplines as artificial intelligence, computer engineering, computer science, cyber security, data science, information systems, information technology, and software engineering. Discipline knowledge is the focus of higher education, and these are commonly presented as majors in computing degrees at both undergraduate [15] and graduate level [16].

More important for organisations is the application of disciplines in their domain and to their systems. Application domains or systems are areas with their own ways of working, regulatory frameworks and culture that deliver services and/or products, for example, specific areas in banking or financial services, health, transport, logistics and supply chain, and the justice system. Some disciplines are closely linked to a single area, but disciplines like computing can be termed domain-agnostic [17]. This domain-agnosticism should not preclude exposure to application domains and exploration of classes of systems such as distributed systems, real-time systems, web-based applications, e-commerce, scientific applications and so on.

Broad Knowledge

The horizontal bar (“---") indicates some knowledge of other disciplines, or domains and systems. For graduates, this may be an exposure to different disciplines and ways of thinking obtained through program minors. The challenge is in deciding which other disciplines, how many and how much. In organisations, this is a more contained problem, achieved by rotation across divisions [18]. This can be termed as “what we need to know” to look at solutions from a broader perspective. The outcomes for these need not be as high as for the deep knowledge, typically SFIA level 1 or 2, or Blooms level 2 only is required. From an educational perspective, this may be achieved more briefly and by lower levels of achievement, such as awareness, understanding of concepts and language of the discipline or domain.

The second part of the horizontal bar, located above all else, represents the people skills, the generic individual skills and competencies that support creativity and the free flow of ideas, discussion, and collaboration across disciplines and domains (see [19] for a good analysis of these skills under the banner of 21st-century skills). These are not only the focus of educators but are increasingly visible in job roles and advertisements [20] [21]. While there is broad agreement about the need for these skills and competencies, there is less agreement about which skills and how they are demonstrated.

V. PRODUCING T-SHAPED COMPUTING GRADUATES

The challenge for higher education professional education is to lay the foundations for personal career and life-long development within a constrained curriculum space in a relatively short period of time. The nub of the problem is that higher education has traditionally taken place separate from the workplace. The focus on employability has strengthened with the massification of higher education in the 60’s and 70’s and the emergence of the knowledge society. Difficulty in specifying and agreeing quickly changing requirements, long planning cycles in higher education, concerns that an employability focus detracts from the role of universities in developing graduates for life and a broad range of roles, and debates about balancing general and specific content are some of the perennial issues (see for example, p8 of [22]) in meeting the requirements of employers.

In this context the T-shape can provide a clarity around curriculum, an openness about what competencies are being addressed as part of the never ending task of improving graduate outcomes, and in the conversations with the world of work. Graduates are prepared for broad roles, often commencing in junior positions where learning and development in a particular domain or systems is the focus. The foundations are important, however, and good people skills will help the transition to senior roles and ultimately leadership roles where T-shaped behaviour is expected [23].

Many universities and their offerings can be outwardly supporting “new skills”, but internally failing to do enough to create more job-ready students and lay platforms for long careers including roles in management [24]. If the ‘Same Wine New Bottle’ observation is to be avoided with respect to the T-shape, then practical tools need to be developed. As the philosopher Edgar Morin said (quoted in [14] “*It is not enough to value the links between experience, disciplines, creativity and ideas. One has to develop methods, strategies and practices that will transform these links into real connections.*”)

Embedding the T-Shape in Higher Education

The T-shape does not, nor should it, prescribe “how” curriculum is implemented. The most significant guidance is that the horizontal and vertical components ought to be of equal size and importance. Different implementations will depend on different contexts and local needs.

There are however common questions that can be raised in the use of the T-Shape as a framework in the design of specific curriculum for computing programs.

- Program Level Considerations:
    - What are relevant disciplines, domain, systems, generic personal and technical skills in the context of computing professionals?
    - How should these be integrated into the program design?
    - What methods support learning within the curriculum?
- Institutional or Departmental Level Considerations
    - What are the implications for the scholarship of learning and teaching, particularly in the computing disciplines?
    - What are the implications for university organisational structures?
- National considerations
    - How can curriculum that better produces T-shaped graduates be encouraged and assessed on a national level?

Job readiness requires links between content and job requirements, but also appropriate levels of education [22]. Higher Education institutions, government and professional bodies assess the quality of academic programs and measure the complexity of the application of specialist skills and knowledge in authentic settings, often using Blooms taxonomy [10]. A two-dimensional T-shape does not capture the complexity of the multiple learning outcomes (competencies), their interactions and their increasing sophistication. Some have addressed this through multi-dimensional T-shapes [25] [26]. Certainly, it seems that at least the addition of outcome levels, such as SFIA or Blooms would be a constructive addition. There is a trade-off here between an accepted model that captures the T-shape at a lower level of abstraction, while remaining useful in communicating structure and outcomes. Also, useful maybe the development of curriculum mapping processes [27] that translate the detail at the learning unit level to the overall T-shape outcomes in a concise and informative way. Like constructive alignment it will provide a tool that has a clear and simple process, but with enough flexibility to fit a range wide range of needs.

Benefits of Producing T-Shaped Graduates

There is obvious complexity in deriving benefit from employees in any circumstance, and the same is true for T-shaped professionals. Current thinking is that a critical mass of T-shaped professionals is seen as a necessary condition for organizations to adapt and survive in the digital economy [25]. Productive innovation is an on-going pursuit for many organizations. Delivering innovation through improved products, services, or simply ways of doing things better require professionals with deep understanding of technical solutions and their domain of application as well as the ability to work across a range of areas of expertise. Real-world problems and opportunities are rarely siloed [3]. Successful change, innovation and an understanding of impact require collaboration. The notion that collaboration within an organisation facilitates creativity and innovation is not only commonly promoted in the popular industry press, but also supported by research [28]. Further, studies suggest in more dynamic environments generalist teams, or teams with breadth of knowledge, will produce better outcomes [3].

Most recent studies, suggest that innovation results from the interaction of individuals in the context of structural (or organisational) influences [29]. Organisational systems and practices provide motivation and support to exercise expertise and creativity in individuals and teams [30]. The combination of domain expertise and creativity skills is important for innovation [31]. Individual training and development programs are beneficial indicating that creativity can be developed [32].

Developing T-shaped graduates can come at a cost [3]. It would require a considerable re-tooling effort in curriculum development. Broader expertise needs to be available and learning resources and situations more complex and expensive. The debates about what is best for graduates will be eternal, but there needs to be a belief and understanding that designing curriculum for the T-shape has arguable benefit for both the individual and the community, if it is to be embraced by higher education.

VI. CONCLUSIONS AND FUTURE RESEARCH OPPORTUNITIES

University IS program architecture and course curriculum design procedures need to be reviewed alongside professional and government accreditation requirements to reflect the importance of the business and its contextual domain on the data drawn from applications and technologies. Programs require technical depth and contextual breadth in a specific industry domain. Business acumen underpinned by graduate personal attributes enables the T-shaped role required to perform in the work-place. T-shaped program architectures support working students in multidisciplinary teams to innovatively solve real world problems. To act effectively in the roles irrespective of industry, graduates need to:

1. Contextualize or apply specialist knowledge in a specific domain that requires some knowledge at a foundational level of the industry in question e.g. health – Breadth = top of the T;
2. Have acquired specialist technical skills and knowledge – Depth = vertical to the ascending into the horizontal T;
3. Assure students can apply the appropriate skills and knowledge - using Blooms and TEQSA requires a third dimension.

IS professionals in addition to Information Systems (IS)/Information Technology (IT) skills and knowledge require contextual understanding of the business domain. Graduates obtain jobs in all industries and compete with professionals in the contextual discipline with sometimes just on-the-job training to win roles despite completion of programs. The critical program and course design challenge for academics and universities is to re-imagine the mix of knowledge and skills to serve all industries. Answering questions around - what is the value added? If indeed the recognition of the importance of the mix of discipline and business contextual skills is critical, how does that play out in universities? What does the appropriate skill set look like within courses and programs? Can assuring quality and enabling incremental change contribute to moving forward whilst allowing choice and flexibility for students to aspire to a range of IS graduate roles?

The T-shaped computing professional enables a review IS/CS SFIA Version 8 T-Shaped model graduate role descriptions with a view to assuring alignment of the ACS, SFIA and AIS. It provides a tool to align SFIA graduate roles in the workplace and enable quality assurance of curriculum evidenced by the revised Bloom's taxonomy. Simplification of compliance tools will enable a shift in focus towards upgrade in the digitally dynamic post-COVID world. The mapping against SFIA and Bloom's during accreditation processes creates unnecessary work. Simplification of the tools to describe curriculum knowledge and skills at evidenced levels is critical to the building of trust between the parties.

The T-Shaped Model could be improved by the addition of a third dimensional to enable a simple evaluation of graduate role level of complexity. The third dimension would shift the levels of complexity in response to applications of IS/IT in a range of professional contexts. An extension that would also allow groups of specialist subjects/units on the vertical "need to know" would assist in rapid response to student needs. Building on the common core base across ICT would provide an opportunity to move to an incremental change situation rather than building expensive programs.

Reshaping the T-shaped professional computing graduate brings together community requirements and roles, the skills of professionals, and the target competencies of higher education graduates. It provides a means of clarity that can communicate links between professional skill such as those laid out by SFIA8 and what higher education programs can realistically provide.

Despite the volume of literature, the T-shape is an immature concept. Three areas have been outlined that would be useful in gaining greater acceptance and benefit. An agreed definition of T-shape will make it easier to communicate and implement for both academic managers and teaching staff. Guidance on how to develop and demonstrate T-shaped-ness would assist curriculum designers and developers and ease professional accreditation strategic conversations. Finally, greater understanding and acceptance of its benefits and awareness of its costs will encourage discussion and adoption as a program architecture design tool in universities and their schools and departments.

Better definition, clearer benefits and improved methods can lay the foundation for producing graduates who can better meet the needs of individuals, organizations and the community in the 21st century. These are not simple problems to resolve. Definitions need agreement, better methods require experimentation and active research from a committed critical mass of users, and considerably more research and analysis of cost and benefits. The rewards, however, would seem to be considerable for both graduates and the community. Ultimately, it may be a way of clarifying realistic expectations about what employability and job readiness can be achieved by computing graduates.

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