Evaluation of Technology Achievement Standards for use in New Zealand Secondary School Computing Education

A critical report

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1.1 Terms of Reference:

After becoming concerned with the suitability of the assessment of ICT students at Secondary School level and following discussions with the *Post Primary Teachers Association* (PPTA), the New Zealand Computer Society (NZCS) has undertaken to answer the following two questions:

- Which, if any, of the Technology achievement standards, including those that are specified as being for ICT, are appropriate for assessment of a student who is going on to undertake a degree in Computer Science?
- Which, if any, of the Technology achievement standards, including those that are specified as being for ICT, are appropriate for assessment of a student who is going to be a user of computers in their working life?

The standards requested for comment are:

- NQF level 1 (all generic Technology standards): 90045, 90046, 90047, 90048, 90049, 90050, 90051
- NQF level 2: 90773 (generic) and the ICT-specific ones 90342, 90349, 90367, 90368
- NQF level 3: 90613, 90620, 90676, 90792 (all generic) and 90684, 90685 (ICT-specific)

We will also comment in the same way on the two sample achievement standards drafted by the PPTA ICT Taskforce.

1.2 Executive Summary:

After critically examining the 18 specified *technology achievement standards,* we believe that **none** of the standards reviewed in this report are appropriate to assess either Computer Science or end-user computing at the secondary school level. The ICT specific standards were particularly disappointing, in that virtually no effort has been made to tailor the standards to the ICT disciplines in terms of the language used to describe the standards, the practices referred to, and the assessment modes.

The *PPTA ICT Taskforce* proposed *achievement standards* were found to be relevant, more targeted, and are at an appropriate level of expectation., With some modifications, and replication, they would be a very useful replacement for the collection of ICT-specific standards.

The main failing in almost all of the *technology* standards was that the cognitive level required goes far beyond the NQF level descriptions (Appendix C). Either the standards are not achievable at all, or *merit* and *excellence* are well beyond the grasp of most students.

The second major failing is that the standards seem to be so bound up in *Technological Practice* (Appendix D), that other codes of practice, paradigms, procedures, and techniques are either buried, or excluded. This certainly seems to be true for ICT and Computer Science in particular. None of the achievement "standards" relating to *skills* or *techniques* actually define levels of competence in enough detail for teachers or students to have any idea of what is an acceptable, very good, or excellent level of achievement in any ICT skill or technique. For example, *excellence* is often defined as doing "more", rather than doing it "better".

A third failing is the huge gaps in the coverage of skills and knowledge assessed. Over the 18 standards reviewed, only 3 attempt to assess skills and/or techniques, and 3 assess limited areas of knowledge. The standards are so vague (skills/techniques assessed are not specified, nor skill levels quantified) that one student could gain multiple credits for the same skills across the 3 standards. Very few of the Computer Science or IT topics listed in the Introduction to this report are covered. A full list of those that are not currently covered may be found in the *Conclusions* section of this report.

Computer Science should appeal to brighter science-oriented students. However, the number *achieving* in Physics and Calculus exceed those in ICT by a factor of 5 at NQF level 3. We suspect that there is a huge number of potential computing professionals who have already opted out of the discipline during secondary school, either because of the lack of relevant achievement standards, or because of the unpalatable offering of what they are told **is** relevant for a future computing career.

Computing teachers should not have to cobble together a course assessment from a random collection of unsuitable standards. Like science and mathematics teachers, they should be able to pick up a sensible course assessed via 24 credits of achievement standards, and offer it.

Computing needs a curriculum and its own achievement standards. As a start, consideration should be given to re-aligning Computer Science (at least) with the *Mathematics* curriculum, rather than *Technology*.

2 Introduction:

2.1 NZCS:

The NZCS, as the *professional body of ICT professionals in New Zealand, with the objective of achieving ongoing improvement in the delivery of high quality ICT by organisations and individuals* [1], is well placed to comment on aspects of computer education within New Zealand. At a time when New Zealand (and much of the world) is experiencing a shortage of suitably trained and educated computing professionals, we are pleased to be able to comment on the suitability of the *achievement* standards that are currently used in New Zealand Secondary schools to measure how well students are prepared to tackle *Computer Science* and other computing topics at the tertiary level.

A first step in approaching this discussion is, perhaps, to define what we mean by *Computer Science,* and the skills, attributes, and capabilities needed for the successful study of *Computer Science*. As the second part of this paper considers the suitability of the same *achievement standards* for students who will be applying their computing skills as *end-users* in the work force, a list of some of the keys skills is included here as well. This will give us a base on which to assess the various standards.

2.2 What is Computer Science?

Many people have attempted to define what *Computer Science* is and what skills and knowledge are inherent in the discipline. The *Computer Science Teachers Association* (CSTA) of the *Association of Computing Machinery* (ACM) refers to several of these definitions in their 2005 report — *The New Educational Imperative: Improving High School Computer Science Education* [2, page 18].
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> "… For high school educators, though, the most profound confusion arises when trying to distinguish between the three most common kinds of computing education typical of the 9–12 grade levels. While each of these areas has been known by various names, for the purposes of this discussion we define them as:
> • Educational Technology
> • Information Technology, and
> • Computer Science.
>
> In general, *Educational Technology* can be defined as using computers across the curriculum, or more specifically, using computer technology (hardware and software) to learn about other disciplines. For example, the science teacher may use a computer-based simulation program to provide students with a better understanding of specific physics principles, or an English teacher may use word-processing software to help students improve their editing and revision skills. Tucker, Deek, Jones, McCowan, Stephenson, and Verno (2003) defined ***Information Technology*** as "the proper use of technologies by which people manipulate and share information in its various forms" (p. 6). While Information Technology involves learning about computers, it emphasizes the technology itself. As Shackleford (2005) noted, *Information Technology* specialists "assume responsibility for selecting appropriate hardware and software products, integrating those products

with organizational needs and infrastructure, and installing, customizing and maintaining those resources" (p. 22).

Information Technology courses, therefore, focus on:
• installing and administering computer networks,
• installing, maintaining, and customizing software,
• managing e-mail systems,
• designing web pages, and
• developing multimedia resources and other digital media.

Computer Science, on the other hand, spans a wide range of computing endeavors, from theoretical foundations to robotics, computer vision, intelligent systems, and bio-informatics. According to Shackelford, for example, the work of computer scientists is concentrated in three areas:
• designing and implementing software,
• developing effective ways to solve computing problems, and
• devising new ways to use computers.

Tucker et al. (2003) have also offered a definition of Computer Science that has direct relevance to high school Computer Science education. They defined the discipline as follows: "*Computer Science (CS)* is the study of computers and algorithmic processes, including their principles, their hardware and software designs, their applications, and their impact on society" (p. 6). They argue that in order to fulfill this definition, K–12[1]

Computer Science curricula must include the following elements:
• programming,
• hardware design,
• networks,
• graphics,
• databases and information retrieval,
• computer security,
• software design,
• programming languages,
• logic,
• programming paradigms,
• translation between levels of abstraction,
• artificial intelligence,
• the limits of computation (what computers can't do),
• applications in information technology and information systems, and
• social issues (Internet security, privacy, intellectual property, etc.).

… Tucker et al. (2003) further argued that the goals of a K–12 Computer Science curriculum are to:
• introduce the fundamental concepts of Computer Science to all students, beginning at the elementary school level,
• present Computer Science at the secondary school level in a way that would be both accessible and worthy of a curriculum credit (e.g., math or science),
• offer additional secondary-level Computer Science courses that will allow interested students to study it in depth and prepare them for entry into the work force or college, and

[1] K-12 is a designation for the sum of kindergarten , primary and secondary education used in the United States, Canada, and some parts of Australia.

• increase the knowledge of Computer Science for all students, especially those who are members of underrepresented groups….”

While the definition of *Computer Science* above is comprehensive, for the purposes of this report, one might argue that the above definition of *Information Technology* includes two topics which (in NZ at least) are more in the realm of the (end user) Graphics Designer: viz.

- designing web pages, and
- developing multimedia resources and other digital media.

However, *designing and implementing* ***websites*** is a skill that is clearly in the field of IT, and should be included.

This report, therefore adopts the above definitions of *Computer Science* and *Information Technology* (with the amendments listed in the two paragraphs immediately above).

2.3 End-User Computing

End-user computing is perhaps a little harder to define. It could be argued that “everybody does it”. Even *Computer Scientists* will use a word processor or a spreadsheet from time-to-time, but could have less skill than that of a *power-user* of those products. Some end-users will attempt to develop reasonably sophisticated applications, but these will usually be for their personal use, and rarely conform to what a competent software developer would see as being a “good solution”. In most cases this may not matter as the damage that such “home-DIY-hackers” can do is limited to their own data. However, some power-users have been known to practice their “development skills” at work, with disregard to accepted professional standards, resulting in a negative impact on corporate data management and data integrity.

The CSTA Report continues to define what this report will refer to as *End-users,* in terms of *IT Literacy* and *IT Fluency.*

> “… Two other terms that often appear in discussions of computing education are *Information Technology Literacy* and *Information Technology Fluency* (National Research Council, 1999). As Tucker et al. (2003), indicate: Whereas *IT literacy* is the capability to use *today’s* technology in one’s own field, the notion of *IT fluency* adds the capability to independently *learn* and use *new* technology as it evolves … throughout one’s professional lifetime. Moreover, IT fluency also includes the active use of algorithmic thinking (including programming) to solve problems, whereas IT literacy is more limited in scope (p. 6).”

End-users include people who use digital technology to automate what were — prior to the introduction of computers — manual tasks. This class should also include people who design and develop web pages, as this task is merely an extension of design and publishing to a new media. Such users can often attain their goals without any understanding of how the tool works, much as anyone could drive a car without understanding the internal combustion engine. People using *Educational Technology* as defined in the CSTA report, would clearly be classed as end-users.

We will also define two sub-categories of end-users:

- **Casual User:** An end-user who uses one or more computer applications for personal tasks from time-to-time such as letter writing (word processing), doing web searches (browsing), calculations for a tax return, communication via email or “Skype”, or entertainment. Such users would have limited knowledge of the applications they use, and would often require help via a specific course or other more experienced user, to improve their usage of a particular application, or to solve a problem encountered while using an application. Casual users would fit into the *IT Literacy* category.

- **Power-User:** An end-user who uses one or more computer applications daily, often as part of their job. They will have an in-depth knowledge of their application(s), and would be able to extend their own knowledge via online help, reference to manuals, internet searches, or the "trial and error" approach. They would often be able to solve many software and/or hardware problems that occur in their work. In order to use their tools more efficiently, they would have some understanding of how a computer system works and how information is stored. Some power-users will also dabble in software development, by writing small applications using macros, scripting, and 4GL tools (MS Access, Excel, VBA) for their personal use within a department.

  Continuing with the driving analogy, power-users would compare to a racing car driver, or a commercial truck driver, with a bit of the home-mechanic on the side. Power-users would fit into the *IT fluency* category.

Power-users will often have taken a Computer Science or Information Technology course, for which some of their knowledge and skills will be useful. Some may be self-taught (books, TV, internet), having been motivated by parents, relatives, personal interest, or their peer-group.

2.4 Defining Levels, Achievement, and Standards

Level:

This report uses the word "level" in three or four different ways, depending on the context. Within the New Zealand education system, *level* is used to denote:

- A cognitive or learning *level* within the *New Zealand Curriculum*. These define learning levels from 1 to 8, starting at primary school and moving to *level 8* in secondary school, year 13 (7th form). (Refer to Appendix D). However, it is not clear how the Technology Curriculum Learning objective levels (denoted in this report as ***TC levels***) map onto years at school. The table in appendix D suggests that TC level 1 may map onto the intermediate school level.
- A cognitive or learning *level* within the NZQA defined *National Qualifications Framework* (denoted in this report as ***NQF levels***). The NQF was designed essentially for tertiary qualifications, with an overlap in the senior secondary school providing a "seamless" secondary/tertiary framework of qualifications. (Refer to Appendix C). NQF levels range from 1 to 10, with levels 1 - 3 mapping roughly onto secondary school years 11 - 13, and basic trades training; levels 4 - 6 map onto advanced trade certificate and diplomas. In general, levels 5 - 7 map onto a three year academic undergraduate degree structure, with levels 8 - 10 defining postgraduate levels of learning. There is an assumed correlation between NQF levels 1 - 3 and the TC levels 6 - 8.
- A level of achievement or grade for an *achievement standard*. As in — "an achievement standard may be achieved at one of three levels: *achieved, merit, or excellence*". Again the word "achieved" can be confusing, as it may be used to define the number of students who have "passed" or gained credit in a standard. In this sense, the number "achieving" a standard, includes all the levels of achievement – *achieved, merit, and excellence*.

The word "level" is also used in a more casual sense in such phrases as "tertiary level" or "skill level". It is hoped that with the above prefixes (TC and NQF) used to distinguish the technical definitions, the meaning of other uses of the word *level* will be clear from the context.

Standard:

The word "standard" has at least four different meanings in the English language, but the NZ Ministry of Education and NZQA have defined two assessment "standards", one of which is used in this report.

Starting with the *National Qualifications Framework* (NQF) in the early 1990's, ***unit*** *standards* were registered on the Framework.

- A *Unit Standard* describes what a learner needs to know or what they must be able to achieve in a particular area or field of study. Each standard could list several criteria that would be used to judge competence — all of which needed to be satisfied in order to "pass" (an "all or nothing" situation). Of course, to allow average (or perhaps most) students to achieve a standard, the requirements could be claimed to be quite modest, and some educationalists, and students, complained that there was no reward for doing more than the standard required. There was no recognition of "merit" or "excellence".
- With the advent of NCEA[2] (and the demise of School Certificate), The Ministry of Education developed *Achievement Standard*s to address the "merit/excellence" problem, and created a new set of "standards" targeted at high-level academic achievement. Both *unit standards* and *achievement standards* can be credited towards an NCEA.

In general, students (particularly high-achievers), who want to be accepted into tertiary courses where there is high demand, will choose to be assessed via *achievement standards*, rather than *unit standards* as they can gain *merit* and *excellence* grades which will improve their chances of gaining entry to their chosen tertiary course.

This report, therefore, looks only at *achievement standards* with a view to determine how many are suitable for students who might want to pursue tertiary study in Computer Science. As a side issue, the same standards are assessed for their general usefulness for computer *end-users*.

2.5 Criteria to Assess Achievement Standards

In order to evaluate the potential usefulness and effectiveness of the listed achievement standards, we will state several criteria which need to be satisfied for a *standard* to "pass".

The ministry has published the *characteristics of effective assessment* [15] which are worth considering here.

- **"benefits students** – It clarifies for them what they know and can do and what they still need to learn. …
- **involves students** – They discuss, clarify, and reflect on their goals, strategies, and progress with their teachers, their parents, and one another. …
- **supports teaching and learning goals** – Students understand the desired outcomes and the criteria for success. Important outcomes are emphasised [sic], and the teacher gives feedback that helps the students to reach them.

[2] NCEA - National Certificate of Educational Achievement

- **is planned and communicated** – Outcomes, teaching strategies, and assessment criteria are carefully matched. Students know in advance how and why they are to be assessed. …
- **is suited to the purpose** – Evidence is obtained through a range of informal and formal assessment approaches. These approaches are chosen to suit the nature of the learning being assessed, the varied characteristics and experiences of the students, ….
- **is valid and fair** – Teachers obtain and interpret information from a range of sources and then base decisions on this evidence, using their professional judgment. Conclusions are most likely to be valid when the evidence for them comes from more than one assessment."

In the above list, there is no distinction made between formative and summative assessment, nor is consideration given to the need for controlled assessments as a method of ensuring authenticity. However, it appears that the first three characteristics relate strongly to formative assessments, while the latter three are particularly important for summative assessments.

As Achievement standards are used for formal, summative assessment, the latter three characteristics are particularly relevant to the critique presented in this report. We also question the use of the word "valid", which appears to be confused with concept of "reliability"[3].

Thus the criteria used to critique the standards are:

- **Assessment mode/Validity:** The type of assessment required should be valid for the skills and knowledge being assessed. Where a process or skill is being assessed (for example), it is often more relevant in Computer Science to have a controlled practical test, than to have a theoretical discussion, or to build a portfolio of work.
- **Fairness:** It should be possible for all students to achieve a passing grade provided they have the necessary prerequisites, and they apply themselves to the module material (which is assumed to be appropriate for the achievement standard). In particular, *merit*, and *excellence* should be attainable by a reasonable proportion of the student population being assessed. We would expect at least 5% of the population be able to achieve *excellence*, without the need for extra tuition, or new skills to be employed that are not already required to gain the minimum standard, or merit grade. In other words, a different assessment task should not be required in order to achieve a *merit* or *excellence* grade.

  Fairness also includes the concept of equity. Students from lower decile schools should not be disadvantaged by the style of assessment task. This is particularly true for project work which could require significant parental support in terms of time, transportation, materials, and personal connections. Similarly, there is some evidence that certain types of learning and assessment modes are more suited to males than female (and vice-versa). Thus, there should be a good balance in assessment modes. With external assessment, application of *fairness* is very difficult to achieve, given that there is no stated body of knowledge to be assessed. Also, given the amount of external *portfolio assessment* mandated in the standards reviewed in the following section, we have to ask: How *fair* is it for an external examiner to

[3] A **valid** assessment is one which measures what it is intended to measure. For example, it would not be valid to assess driving skills through a written test alone.

Reliability relates to the consistency of an assessment. A reliable assessment is one which consistently achieves the same results with the same (or similar) cohort of students. Various factors affect reliability – including ambiguous questions, too many options within a question paper, vague marking instructions and poorly trained markers. [16]

mark a *portfolio of evidence* which is produced from a project which they have not observed in progress? How can such an examiner draw valid conclusions without first-hand knowledge of the development process, the participants, and environment involved?

- **Feasibility:** The amount of work required by both the teacher and the students being assessed must be reasonable. For the students, an average of 10 learning hours (both inside and outside of class) per credit is assumed[4]. For the teacher, it must be possible to set, moderate, monitor, authenticate and/or mark assessments without requiring an excessive amount of preparation or other administrative overheads. In particular, where project work is involved, the individual supervision, and loss of "economies of scale", which might apply in a more traditional assessment regime, need to be considered.
- The **grade criteria** need to be measurable, relevant, and able to *reliably* partition achievements into the "acceptable", "above average", and "outstanding" categories. Good criteria should be able to achieve this without requiring the student to do more (at a mediocre level). In other words, they should measure *quality*, rather than *quantity*.
- The **language** used in the standard's documentation should reflect the language used in the discipline being assessed. In particular, a Computer Science teacher, lecturer, or ICT employer should be able to relate the terminology used to their own discipline. More importantly, the description and explanatory notes should also make sense to the average reader — they should be syntactically and semantically correct.
- The **level** should be appropriate so that an average pupil could be expected to achieve the standard, given their level of prior knowledge and experience. The level should adhere closely to the NZQA published definition of NQF levels (refer to Appendix C).
- **Relevance:** The skills, knowledge, concepts, and practice being assessed should be relevant to the discipline, in this case, *Computer Science* and *End-user Computing*.
- **Reliability:** Statement of the standard should enable teachers to develop assessments which will consistently achieve the same results with the same (or similar) cohort of students — nation-wide.
- **Title:** The *standard* title should clearly reflect what is being assessed. This should be clear to the target stake-holders (e.g. employer, tertiary academic enrolment officer, parents) — without reference to supporting documentation, or the actual assessment(s) used in the assessment process.
- **Uniqueness:** The title and description of a standard should uniquely define the body of knowledge and/or skill/competency being assessed. The Achievement criteria should make the cognitive levels required explicit enough so that reference to exemplars is not required to determine the uniqueness of a standard. In short, the standards should be self-contained, and not overlap.

[4] The TEC definition of a full-time student [12] relates 1,200 hours of student learning to 120 NZQA credits of enrolled courses per year.

3 Critique of the Achievement Standards, NQF level 1

3.0 Statistics

For many of the standards critiqued in this section, we quote statistics from the NZQA website [11] and from various examiners' reports. At the end of February 2008, the NZQA statistics page for 2006 was removed, and has now been replaced with the 2007 results. Nevertheless, the url quoted in the references section is still valid.

3.1 AS90045 Develop a technological solution to address a given brief

NQF level 1, 6 credits

This achievement standard involves the development of an outcome through informed planning to address a given brief.

This standard **fails** on most of the stated criteria.

- **Fairness/reliability:** The type and size of the "technological solution" required to satisfy the standard are not quantified. We see no attempt at defining what (how much) is required, although acceptable outcomes include a "working model, prototype, or finished product example".

- **Language/grade criteria:** The wording of the achievement criteria is at best confusing, and appears to show little differentiation between the three grades. " Develop the solution — **guided by** (*achieved*) / **informed by** (*merit*) / **Informed by ongoing** (*excellence*) Planning" — makes little sense. The standard expands on planning as "setting out how key resources (time, expertise, materials, finance etc.) will be used efficiently".. It has the wrong focus at *merit* and *excellence* — what should show *merit* or *excellence* would be reflected in an efficient or more user-friendly solution, not necessarily in more planning. (An optimal solution may be quickly found by an able student — thus there is no opportunity for that student to demonstrate on-going planning). Other qualities of a software solution which should be recognized at the *merit* and *excellence* level include programming structure, style, documentation, adherence to standards, usability, choice of algorithm (efficiency/elegance), and maintainability[5]. None of these concepts are mentioned.

- **Level:** At NQF level 1, the focus must be on **correctness** of the solution to a clearly defined *program specification* which limits the scope and programming techniques required to a very elementary level.
The whole standard is set at the wrong level in terms of the student's knowledge and experience in software development. The "achieved level" contains elements that might be expected at NQF level 5 or 6 in a Computer Science course (but miss a raft of other more fundamental essential elements). The level does not conform to the NQF description of level 1 ("Carry out processes that are limited in range, are repetitive and familiar; are employed

[5] ***Maintainability*** is a characteristic of software relating to how easily it can be modified in order to maintain or enhance its functionality.

within closely defined context, employing recall of a narrow range of knowledge and cognitive skills...” — Appendix C).

- **Relevance:** The reference to “finance” implies that students will have accounting and business knowledge — not something that is assumed in any Computer Science curriculum. In Computer Science there are no “materials” as such to use “efficiently”

  Planning is relevant to developing a software solution, but at NQF level 1, planning should be focused on developing and testing an algorithm in the form of a flowchart, structure diagram, or pseudocode — not on the “big picture” Gantt chart style of planning.

- The **title** will not be recognized by target stake-holders as being relevant to Computer Science. It is also misleading as the standard is really about “planning”, rather than “developing”. The outcome can be anything, as long as it is planned. A better title might be “Demonstrate planning to produce an outcome conforming to a given brief”.

Conclusion: In its present form, this standard is not suitable to assess anything taught in an introductory Computer Science or an end-user computing module. In fact, we find it hard to see it as a valid, reliable assessment standard for any discipline at NQF level 1.

3.2 AS90046 Formulate a brief to address a given issue

NQF level 1, 6 Credits, internal

This achievement standard involves identifying key factors and their implications in relation to a given issue, exploring needs and/or opportunities arising out of the key factors, and formulating a brief for a technological solution that addresses a selected need or opportunity.

This standard **fails** on most of the stated criteria.

- **Level:** Translating the *achievement* criteria in terms of Computer Science and IT, a student could be required to do a full problem analysis that might be expected at NQF level 6 or 7 in a computing course. This standard goes well beyond the NQF level 1 definition ("Carry out processes that are limited in range, are repetitive and familiar; are employed within closely defined context, employing recall of a narrow range of knowledge and cognitive skills..."). The *merit* and *excellence* levels require skills of prioritisation and evaluation. These are skills an experienced graduate software engineer or IT consultant would exhibit.
- **Language/Relevance/Reliability:** The statement of the standard is so vague, that almost anything could be assessed. As such, it will not convey to a prospective employer what area of expertise has been assessed. Reworded and set into a Computing context at NQF level 5 – 7, this standard could be applied to forming a *proposal* (not a *brief*) for selecting and purchasing a computer system, or doing a needs analysis for training, doing risk analysis, or producing a management report on a business process problem. These would be *IT* related tasks, but not really in the realm of Computer Science.

  For a computer *end-user*, this standard is irrelevant at any level.
- **Fairness/Feasibility/Reliability/Assessment mode:** It appears that each student is expected to find their own issue, and develop their argument and brief etc around that issue. Disregarding the fact that the cognitive level is wrong, we wonder how feasible this is for teachers to manage, given the number of different issues that are likely to arise, and how fair it will be for students who may have inadvertently picked a trivial, or perhaps overly complex issue. This type of assessment may be reasonable in a formative context, but for a summative assessment, a controlled case-study analysis would be fairer, easier to manage, and more reliable.
- The **title** will not be recognized by the target stake-holders as being relevant to Computer Science. A student of Computer Science would never "formulate a brief", and would rarely, if ever, "address an issue".

Conclusion: In its present form, this standard is not suitable to assess anything taught in an introductory *Computer Science* or *end-user* computing module.

3.3 AS90047 Develop an outcome by widening the use of an existing Technology

NQF level 1, 6 Credits, internal

This achievement standard involves identifying needs and/or opportunities and related key factors in order to develop an outcome that widens the use of an existing technology.

- **Level:** It is difficult to see how this standard would fit at NQF level 1 in any discipline. It clearly contradicts the NQF level 1 description — "Carry out processes that are limited in range, are repetitive and familiar; are employed within closely defined context, employing recall of a narrow range of knowledge and cognitive skills...".

  One of the *achievement* criteria states "Identify possible needs and/or opportunities and related key factors for the widening use of an existing technology". Now, if all students in a class study the same technology, then a teacher could present these to the class, and the students would need to recall these. However, if students are meant to pick their own technology and do their own discovery, this goes well beyond the NQF cognitive level 1. In terms of software development, if the word "technology" is translated into a "software application", this might involve the analysis, design, and implementation of an enhancement to an existing application. However, it appears the standard expects the student "identify the needs …", rather than be given a statement of the needs as a starting point. This would be a challenge at NQF level 6 in a Computer Science course. *Software maintenance*[6] is a skill, which might be tackled at NQF level 3, but much more specific problems would be required.

- **Feasibility**: We believe that supervising activities that might arise in attempting to achieve this standard would be beyond the skill-level and time allocation of most school teachers, particularly if there were two or more projects involved concurrently.

- **Relevance:** This standard would have no relevance for end-user computing. From a Computer Science perspective, it is difficult to imagine what this standard is attempting to assess. It appears to be assessing research and development skills as well as entrepreneurship. For example, current research (NQF levels 8 – 10) at AUT is investigating new ways of applying RFID tags.

Conclusion: We believe this standard is unsuitable for any discipline at NQF level 1. It is irrelevant for computing end-users, but with some re-wording, it could be adapted for Computer Science at NQF levels 6 – 10. This view is supported by the very small number of students achieving this standard in 2006 (only 438 nation-wide across all six technologies — *Biotechnology*, *Electronics and Control Technology*, *Food Technology, ICT, Materials Technology*, and *Structures & Mechanisms Technology*).

[6] **Software Maintenance** is the process of making changes to software after it is released into production. It includes bug fixes and making enhancements which *widen its use*.

3.4 AS90048 Develop a means for ongoing production of an outcome …

NQF level 1, 6 Credits, internal

This achievement standard involves identifying a means to allow for the ongoing production of an outcome.

This standard fails on most criteria.

- **Level:** The requirement to "identify the means …" and the details provided in the explanatory notes, indicate that the requirements of this standard go well beyond the NQF description of level 1.
- **Relevance:** We believe that this standard would be irrelevant to year 11 – 13 students, regardless of their technology interest. This is something that would normally be covered at tertiary level. If a computer scientist developed a product that s/he wanted to put into production, it is most likely that this person would team up with business and engineering experts to achieve this goal.

  This would also be irrelevant for end-user computing.
- The **title** would not be recognized by computing practitioners as being relevant to Computer Science. Once software has been developed, multiple copies can be produced with little effort, and therefore such a concept is irrelevant to Computer Science.
- **Assessment mode/Reliability:** The mode of assessment is not stated, but one assumes that a brief must be submitted. How the student is to be assessed on their identification of key factors and other discussions is not stated. This suggests that assessment based on this standard may not be reliable.

Conclusion: This standard is set at the wrong level, and is irrelevant to both Computer Science, and end-user computing. This view is supported by the very small number of students achieving the standard in 2006 (only 716 nation-wide across all six technologies).

3.5 AS90049 Demonstrate understanding of technological knowledge

NQF level 1, 4 credits, external

> Candidates are required to submit a portfolio of work that could include a variety of media in any format up to a maximum size of A2. A portfolio is an organised collection of material that clearly communicates candidates' understanding of knowledge relevant to the achievement standard that is being assessed. Examples of this material could include such things as research findings and their analysis …"

This Standard fails on a number of criteria:

- The **title** is so vague that there is absolutely no indication of what is being assessed.
- **The assessment mode** — submission of a portfolio of work — is uncommon in an entry-level Computer Science course, Submission of a *program package* or other form of system software documentation is possible, but the process of doing this is quite different from that described in the standard. Trying to force an artistic design assessment methodology onto Computer Science simply does not work. A portfolio of evidence is not a valid tool to assess Computer Science *knowledge*. It may be used to provide evidence of practical creative skills in an artistic sense, and may — provided authenticity can be verified — demonstrate that the artist has employed particular techniques and styles which could then be assumed to be evidence of the artist's knowledge. There are much better, more efficient, more reliable ways of assessing technical knowledge in a Computer Science curriculum. Writing an essay and/or doing a presentation on a topic, for example, would be a more effective way to assess knowledge.
- **Fairness/Reliability:** How can a student know the biases and preferences of the external examiner? How can the external examiner appreciate the context in which the portfolio was developed? For example, how can the examiner infer from a portfolio, what level of "knowledge" a student has internalised (as opposed to inserting documents into a folder)?
- **Feasibility**: Proving originality — that the portfolio is the student's own work — would be an extremely difficult and time-consuming task for teachers to do this rigourously.
- **Level:** As the standard requires "research and analysis ...", the achievement level does not conform to the NQF level 1 description of "Carry out processes that are limited in range, are repetitive and familiar; are employed within closely defined context, employing recall of a narrow range of knowledge and cognitive skills...". Statements from the Technology Assessment reports of 2005 and 2006 indicate that the skills and knowledge required to "… consider the environment, … consider stakeholder needs, feedback, and opinions, …" were not demonstrated by many students. To us, this reflects that the standard is asking far too much at NQF level 1, rather than that students are under-performing. Statistics from the 2003 & 2004 Assessment reports [10] and NCEA results 2006 [11] are listed below.

Year	No. Entered	Not Achieved	Achieved	Merit	Excellence	Gaining Credit
2006[7]	?	?	?	?	?	3,369
2004	6,095	3,187 (52.3%)	2,188 (35.9%)	542 (8.9%)	177 (2.9%)	2,907 (48%)
2003	2,416	1,348 (55.8%)	838 (34.7%)	179 (7.4%)	51 (2.1%)	1069 (44%)

Conclusion: This standard is an inappropriate assessment standard for Computer Science at NQF level 1. Neither would it provide any useful assessment for computing end-users.

7 After 2004, the assessment reports do not contain achievement statistics. The NCEA results only report the number of people gaining credit without distinguishing *achieved, merit, and excellence*.

3.6 AS90050 Present an outcome developed through technological practice …

NQF level 1, 4 Credits, Internal

This achievement standard involves the presentation of an outcome, with supporting documentation, to show that the outcome addresses the essential requirements of a brief.

This standard fails on several criteria, previously listed under AS90045.

- **Uniqueness:** On the surface this standard appears to be a clone of AS90045, but with fewer credits. Where as AS9045 clearly defines the *evidence* criteria in the achievement criteria table, AS0050 hides this in the explanatory notes. However, AS90050 perhaps has a more rational approach to *merit* and *excellence*, requiring "quality", and "high quality" respectively. But one does wonder why a lack of "quality" should be acceptable at the *achieved* level. The key difference between AS90045 and AS90050 is that the later does not require any evidence of planning — only evidence of a *quality* outcome. It would seem logical, therefore, that these two standards be merged, their credits combined, and suitable achievement criteria extracted so that *achievement* could be awarded by demonstrating a *quality* outcome, and *merit* and *excellence* defined in terms of high-quality planning, outcome, and presentation.
- **Fairness:** Statistics from the 2003 & 2004assessment report [10] and NCEA stats (2006) [11] include the following statistics:

Year	No. Entered	Not Achieved	Achieved	Merit	Excellence	No. Gaining Credit
2006	?	?	?	?	?	5,069 (?%)
2004	6,997	3,187 (51.1%)	2,512 (38.4%)	574 (8.2%)	161 (2.3%)	3,247 (46%)
2003	7,410	2,705 (36.5%)	3,875 (52.3%)	711 (9.6%)	119 (1.6%)	4,708 (64%)

  It is curious to note that the number of students attempting the various standards in 2006 is not published on the website. Is the percentage of students achieving credit getting worse? Overall, the number of students achieving success in this standard is less than acceptable.
- The **title** is not recognisable as being relevant to Computer Science. The methodologies employed or practiced in Computer Science bare little resemblance to those documented under the heading of "technological practice". Also, the title is misleading. This standard merely requires "presentation" of an outcome. And yet, while the assessment statement is focused on "**presentation** of an outcome", it is the *quality* of the **outcome** that differentiates the A/M/E, not the *quality* of the presentation.

Conclusion: Even with the above modifications, this standard is not set at the correct NQF level for an introductory Computer Science course assessment. It would also be completely irrelevant for computing end-users.

3.7 AS90051 Describe the interactions between a technological innovation and Society

NQF level 1, 4 Credits, external portfolio

Candidates are required to submit a portfolio of work that could include a variety of media in any format up to a maximum size of A2.

This achievement standard involves identifying key technological advance(s) underpinning an identified technological innovation, describing how societal factors have impacted on the technological innovation, and describing the impact of the technological innovation on society.

This standard has some relevance to both Computer Science and end-user computing.

However:

- **Assessment mode/Reliability:** As for AS90049, submission of a portfolio of evidence is not a good method of assessment for this learning outcome. An essay, report, poster, case-study, or oral presentation, might be a better — and certainly easier — way to assess this area of learning. Also, it is doubtful that any reliability can be achieved via this mode.
- **Level:** The cognitive level implied in the title as “Describe …” correctly reflects NQF level 1, and this is supported by the *achieved criteria* (Identify, Describe). But, at the *merit* and *excellence* levels, “explain the key technological advances underpinning an innovation” would go well beyond NQF level 1 for computer technologies in particular.
- **Fairness:** The “analyse the two-way interaction between the on-going development of the innovation and society to determine the key events and their impact on the evolution of the innovation, both to date and in likely future scenarios” specified for *excellence*, would sit more comfortably at NQF level 7 or 8, provided the number of credits were at least doubled.

Across all six technologies, this standard was achieved by only 396 students in 2006, indicating either that there is little interest in this topic, or that the level of knowledge, skills, and effort required is unreasonable. The (incomplete) statistics below leaves the reader to guess what the trend is.

Statistics from the 2003 & 2004 assessment report [10] and NCEA stats (2006) [11] include the following:

Year	No. Entered	Not Achieved	Achieved	Merit	Excellence	No. Gaining Credit
2006	?	?	?	?	?	396 (?%)
2004	1,678	1242 (74.0%)	356 (21.2%)	70 (4.2%)	10 (0.6%)	436 (26%)
2003	2,416	1,348 (55.8%)	838 (34.7%)	179 (7.4%)	51 (2.1%)	1,068 (44%)

Conclusion: This standard, although relevant to Computer Science and end-users in a broad sense, would not be a fair assessment tool in terms of the amount of work required in building the portfolio and (from a teacher’s perspective) verifying its authenticity. Also, the requirements for the *merit* and *excellence* grades would not be achievable by many (if any) in the computing discipline.

4 Critique of the Achievement Standards, NQF level 2

4.1 *AS90342* *Develop and model a conceptual design in ICT*

NQF level 2, 6 credits, internal

> This achievement standard involves the formulation of a brief, and the use of planning, to develop and model a conceptual design to address an identified issue in information and communication technology.

This standard has several failings which include:

- **Uniqueness/Relevance:** Although this standard is labeled "ICT-specific", the wording is identical to standards 90339 through to 90344 — *Biotechnology*, *Electronics and Control Technology*, *Food Technology, ICT, Materials Technology*, and *Structures & Mechanisms Technology* — except for ONE word in each which identifies the discipline area. Clearly no consideration has been given to the specific disciplines' practices, methodologies, bodies of knowledge, or areas of focus.
- **Language:** The language criticisms made in standard 90045 apply equally here. The use of the word "brief" is ambiguous to a computer scientist in a software development environment. The word "model" in itself presents an interpretation problem. Would a *data model* (entity-relationship diagram), or a logic diagram suffice? Or maybe a prototype application is intended.
- **Level:** Normally an analyst would be **given** a brief by the client (the analyst would not develop the brief), from which s/he would develop a specification and other documents that would eventually lead to a conceptual design/model. Such requirements are well beyond the capabilities of a NQF level 2 Computer Science student, and would normally be expected at NQF level 6 or 7. (NQF level 2 Description: "Carry out processes that are moderate in range, are established and familiar, offer a clear choice of routine responses, employing basic operational knowledge, readily available information, known solutions to familiar problems, and little generation of new ideas …")
- **Grade Criteria:** Criticisms of the *merit* and *excellence* criteria that were made in standard 90045 also apply here. There should be more emphasis on the technical quality of the model — its simplicity, generality, ease of implementation, expandability, and possibly elegance.

Conclusion: This standard is inappropriate for both computer end-users, and Computer Science students at NQF level 2.

4.2 AS90349 Develop and implement a one-off solution in ICT

NQF level 2, 6 credits, internal

> This achievement standard involves the formulation of a brief, and the use of planning, to develop and implement a one-off solution to address an identified issue in information and communication technology.

Although the title suggests that this standard is relevant for Computer Science, it fails as a computing assessment standard for several reasons:

- **Language:** Apart from the title, the language used to describe the assessment criteria, and the methodology have not been modified from the generic standards to reflect a NQF level 2 Computer Science context.

  It is curious that the word "one-off" is used in the title. The explanatory notes seem to suggest that an iterative, prototyping, or "agile" approach is not to be used — " …. Implementation of a single constructed solution [which] fully resolves the issue….". We wonder how this differs from a "Technological outcome" as specified in AS90045. Is this suggesting that the student would not be allowed to make improvements (to say the user interface) after the first successful, bug-free compile? Usually a "one-off" solution in a software development environment refers to a program that is a "quick-and-dirty" solution to address a very specific "one-off" problem — say data conversion to transfer data from an old system to a new one. In this situation, very little effort would be spent on the design, documentation, and considerations for efficiency and maintainability. While, it is appreciated that the word "one-off" may be hinting at limiting the scope or size of the product produced, the ramifications on the reduced quality of the product would be abhorrent to a Computer Scientist. However, such an interpretation would contradict most of the assessment criteria. On the other hand, reading between the lines in AS90792 (Develop a proposal for a production process for … a client's one-off solution), this term might refer to a *prototype*.

- **Uniqueness/Level:** There appears to be little in the statement of this standard that would differentiate it from the level 1 AS90046. The only difference between this standard and AS90342 is that a solution is implemented, rather than just modelled.

- **Fairness:** The complexity of the problem being addressed is not defined. It would seem that implementation of a "Guess a number between 1 – 10" game, would be as acceptable as a problem involving complex calculations such as "calculate the number of days that have elapsed between any two calendar dates".

- **Grade Criteria:** Criticisms of the *merit* and *excellence* criteria that were listed for AS90045 also apply here. Key quality factors of the final product are not considered.

- **Relevance**: The notion that this unit could be used for a Computer Science project is clearly negated when you read the Ministry published *Teacher Guidelines.* Here we discover that the project is to plan and implement an event:

  > "…. Students will identify an issue within the context of the international weekend that they can explore and develop an event management plan for. They will then implement the event and evaluate the success of their management plan…. Assessment is integrated into a unit of work on event management that could take approximately ten weeks. Assessment …involves the gathering and presentation of research and findings including the

> requirements of key and wider stakeholders, discussions on how the information is useful or otherwise to the students practice, evaluations, modifications, reasons for decisions, trials, mock ups, models, sketches, interviews and other evidence of complete practice undertaken. …..As part of the technological practice undertaken in a unit employing this achievement standard as an assessment tool, students need to not only develop a one off solution, **but also implement it,** in order to evaluate its effectiveness and make any further changes if required. This means that they will carry out the event and demonstrate how it meets the specifications of the brief and addresses the concerns of the key stakeholders and those in the wider community. For example: A student developing a management plan for a drama performance would need to implement the performance before finally evaluating its success or otherwise by gaining feedback from a range of stakeholders. Trialing of the management plan throughout performance rehearsals would allow for improvements to be made prior to the final performance."

It is clear from the above that this unit is about management skills or social engineering, and the use of ICT is merely incidental to this assessment by way of using a telephone, email, word processor, spreadsheet and/or project management tool. We cannot see how Computer Science or software development would fit into this, unless the student developed an *event management system*. However, the effort involved in planning and implementing the event would submerge any such software development. At best, this might suit a skilled computer end-user, but alas, none of the computing skills employed are assessed in this standard.

- The **title** of this standard is misleading. It should be named "Plan and implement a one-off event using appropriate tools".

Conclusion: This standard is unusable in its current form. With a clearer definition, more relevant achievement criteria focussed at the appropriate cognitive level, clarification of the problem complexity to be addressed, and rephrasing in terms of the computing discipline, it could become useful to NQF level 2 Computer Science students. The re-written standard might be relevant a *power end-user* computing student, provided no external client was involved.

4.3 AS90367 Examine technological knowledge in ICT practice

NQF level 2, 4 credits, external portfolio

> This achievement standard involves examining technological knowledge underpinning the development of an information and communication technology outcome through identifying the knowledge and explaining how this knowledge informs one's own technological practice.

This standard fails as a valid assessment tool for Computer Science in a number of areas:

- **Assessment mode:** As mentioned before, a portfolio of work is not a valid assessment tool to assess *knowledge* in a Computer Science curriculum.
- The **title** is so vague that there is absolutely no indication of what is being assessed.
- **Uniqueness/Language:** There has been no attempt to translate this standard from a generic standard to one which relates to ICT or Computer Science, apart from occasionally prefixing the term "technology" with "information and communication". However, reading between the lines, one might guess that in a software development context, this standard might be requesting submission of systems development documentation, accompanied by a reflection on the methodology used, and problems encountered during the development of a software product.
- **Level/Fairness:** On a different level, this standard might be asking the student to understand the technologies involved in tools such as a compiler or interpreter. It would be very difficult for a student to demonstrate their understanding of the differences in these two tools via a portfolio. It is also unlikely that they would employ both types of tools in a single development project. It is also unclear as to whether an understanding of the hardware technologies used in the development process is required. Does the student need to reflect on the IDE[8] used or perhaps the operating system environment?

  Of course, the complexity of the work involved here also depends on the "outcome" which is expected. No hint is given as to what an "outcome" might be in the Explanatory Notes apart from "… outcome refers to that of a person or organisation other than the student". This rather incomplete definition of an "outcome" leads the reader to surmise that the outcome is to be developed for a **client**. With this requirement, the development becomes much more challenging for the student and the supervising teacher, and would be well beyond the scope expected at NQF level 2. Even without an external client, the requirements to reflect on the methodologies used, and the impact on the development process, would still be closer to NQF level 6 or 7. At NQF level 2, the focus should still be on producing a correct solution to a problem, using a limited range of tools — not on reflection of how the tools affect the development process.

[8] IDE - Integrated Development Environment - A text editor which is integrated with a code compiler, debugger, and associated development/testing tools, giving a developer an efficient work environment.

Statistics from the 2003 & 2004 assessment report [10] and NCEA stats (2006) [11] include the following:

Year	No. Entered	Not Achieved	Achieved	Merit	Excellence	No. Gaining Credit
2006	?	?	?	?	?	71
2004	286	174 (60.8%)	84 (29.4%)	20 (7.0%)	8 (2.8%)	112 (39.2%)
2003	394	280 (71.1%)	84 (21.3%)	24 (6.1%)	6 (1.5%)	114 (28.9%)

The 2006 result is an indictment of the standard's relevance, and achievability. The combined total achieving the equivalent standards in biotechnology, electronics and control, food, and structures and mechanisms (4 standards) was only **91**.

Conclusion: This standard is an inappropriate assessment standard for Computer Science at NQF level 2. Neither would it serve as a useful assessment standard for computing end-users. From the statistics quoted above, it also appears to be unsuitable for other technology disciplines.

4.4 AS90368 Demonstrate skills in information and communication technology

NQF level 2, 4 credits, internal

> This achievement standard involves demonstrating skills within an information and communication technology application when developing a technological outcome(s) to address an identified issue(s).

This standard has potential for assessing both Computer Science and end-user students, but has some flaws which limit its effectiveness as an assessment tool:

- **Title/Language:** The title and description are too vague to indicate what skills are being assessed. Why for example, is the implied plural used on "outcome(s)" and "issue(s)"? If the standard requires multiple demonstrations of skills over several development outcomes and issues, then say so. Otherwise, make it singular.

  The list of application tools does not include spreadsheets, or word processor scripting languages, but could be extended to include these, one assumes. The list implies that the use of other 3GL/4GL[9] development environments was not intended, so that this standard is aimed at the power end-user, rather than the budding software developer.
- **Fairness:** The fact that "The *issue* needs to be identified by the student" and "… will generate a range of needs or opportunities for technological practice.", implies that this is a very open-ended assessment, where the range of skills, knowledge, tools, and techniques will vary considerably within a single class. This poses a challenge for teachers who might be supervising 20 different projects concurrently. It is difficult to see that any uniform level of achievement can be inferred from gaining this standard.
- **Level:** The standard does not give any guidance on how the skill level should be measured, or indeed, what skills are being assessed. AS90368 is not a *standard* in any technological meaning of the word.

  The *merit* criteria is curiously convoluted, in that either multiple tools may be used, or a single tool can be used "to enhance the technological practice…". Both parts of this are flawed. Using multiple tools may be a side-effect of the issue chosen to be addressed. Or perhaps the student may elect to solve the same problem using the same skills but with two different tools. The alternative criteria — "… use these to enhance the technological practice undertaken when developing a technological outcome(s) or the technological outcome(s) itself' — is a most confusing statement. Does this mean the student will use more advanced functions – e.g. uses the *sum* function instead of using multiple "+'s" in a formula of a spreadsheet? The *excellence* criteria merely removes the "or" from the *merit* criteria.

Conclusion: This standard is most suitable for computing power end-users, but will provide no assurance that any particular skill level has been achieved.

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[9] A "**3GL**" or **Third Generation Computer Language** — also known as "High-level language" — is a language which enables programmers to code using constructs which are closer to their more familiar language such as English, or the problem domain such Business (COBOL), or Maths (FORTRAN). Earlier generations of languages (machine and assembly language), were extremely challenging to learn and use. More recently "4GLs" — **Fourth Generation Langauages** — have become popular with both software developers, and power-users, as much more can be done with fewer lines of code, and often little or no understanding of what is happening at the machine level. Examples of 4GLs include database query languages, report writers, and spreadsheet programs.

4.5 AS90773 *Examine how technological practice is influenced by responsibilities …*

NQF Level 2, 4 credits, external portfolio

> This achievement standard focuses on identifying operating practices that are influenced by technologist responsibilities to the wider community, and explaining how this knowledge informs one's own technological practice undertaken to address an identified issue(s).
>
> Mode of Assessment: submitted portfolio of work that could include a variety of media in any format up to a maximum size of A2.

This standard fails on several points:

- **Mode of assessment:** As for AS90049 and AS9051, the method of assessment — submission of an externally-marked portfolio of work — is not appropriate in a Computer Science context.
- **Relevance/Fairness:** This topic requires significant "world-experience" and discipline knowledge to even begin to see its relevance to Computer Science — experience and knowledge that will not exist amongst the potential candidates for this standard. The explanatory notes for this standard enumerate countless *operating practices* that should be "identified, explained, and discussed:
  - preparation of briefs
  - project management, eg plans of action, Gantt charts and critical path analysis
  - fostering innovation, eg focus groups, idea generation and screening
  - prototype testing, eg surveys, trial marketing
  - outcome manufacture
  - implementation of technological outcomes, eg commissioning, acceptance testing, guarantees, and warranty periods."

  At NQF level 2, Computer Science students will have experienced none of these, and will not have any understanding of their relevance. These tools will become relevant to IS/IT majors (but not Computer Science) students, as they explore these in tertiary study at NQF levels 6 and 7. The situation gets worse, as the explanatory notes indicate a requirement for understanding and interpretation of "legal responsibilities including:
  - Acts (eg Fair Trading Act 1986, Consumer Guarantees Act 1993, Health and Safety in Employment Act 1992, Privacy Act 1993, Labour Relations Act 1995, Resource Management Act 1996, Hazardous Substances and New Organisms Act 1996)
  - Standards (eg ISO standards – 9000, 14000 series, Standards New Zealand (SNZ) standards)"

  The fact that only 80 students [11] nationwide achieved this standard in 2006 across all 6 technologies, implies that either:
  - It is not relevant to their perceived educational path, or (more likely)
  - They see that this standard requires far too high a level of knowledge and effort.

Conclusion: Although the topic is relevant to *tertiary-level* IT/IS specialists (but less so for Computer Science), the method of assessment, the scope, and level are not appropriate. For *computing end-users*, the standard is neither relevant nor appropriate at NQF level 2.

5 Critique of Achievement Standards, NQF level 3

5.1 AS90613 Develop a conceptual design to address a client issue

NQF level 3, 8 credits, internal

> This achievement standard involves the use of project management tools to support brief development, modelling, testing and evaluation of a conceptual design that addresses a client issue.

This standard is relevant to Computer Science, but is inappropriate for the following reasons:

- **Fairness:** The need for a client with an appropriate issue may disadvantage students who do not have the necessary parental support to help find such a client and to maintain regular communication via face-to-face meetings (transportation cost and time issues). This standard was achieved by only 771 students in 2006 across all six technologies. The number achieving in ICT alone, is not available.
- **Feasibility:** Supporting more than two concurrent projects of this nature will be a challenge for most teachers.
- **Level:** The cognitive skill-level needed to develop such a software model, taking into consideration the factors listed in the explanatory notes, and liaising with a client, is really at NQF level 6 or 7.
- **Uniqueness:** This standard is a clone of AS90342 *Develop and model a conceptual design in ICT* (NQF level 2, 6 credits). The main difference between the two (apart from the credits and level) is that this standard explicitly mentions a project management tool in the achievement criteria, and AS90342 implies its use in the explanatory notes by reference to Gantt charts. We see no reason why both of these standards could not be used to assess the same project, as the same cognitive level and work effort are needed for both standards — but the designated NQF level of the standards would need to be set higher.

Conclusion: This standard is relevant to Computer Science but is inappropriate to assess Computer Science students at NQF level 3. It would also be unmanageable for a teacher to supervise, and may disadvantage some students with respect to locating and communicating with a suitable client.

The standard has no relevance to casual end-users, nor even power-end users who would not be expected to develop a product *for a client* at any time in the future.

5.2 AS90620 Develop a one-off solution to address a client issue

NQF level 3, 8 credits, internal

This achievement standard involves the use of project management tools to support brief development, and the development, implementation and evaluation of a one-off solution that addresses a client issue.

- **Uniqueness:** This is a clone of the ICT specific standard AS90349. In essence it suffers from the same deficiencies. Like the NQF level 2 standard, AS90349, it also has a "twin sister" — AS90613 — for which the model for the solution is assessed. Although this appears redundant, perhaps it means that an incomplete solution can still gain some credits. But why duplicate AS90620 with an equally bad AS90349? (or was it the other way around?)
- **Level/Fairness:** The need for a client raises the level to well beyond NQF level 3, and adds unreasonable expectations on the students and teachers.
- **Language:** Why a "one-off" solution? Reading between the lines in standard AS90792, it might be inferred that a "one-off solution" is a *prototype.* Again the language used obfuscates the intention of this standard for the computer scientist.
- **Grade criteria:** Similar objections for the *merit* and *excellence* criteria apply as for the NQF level 1 AS90342. What would be appropriate would be to evaluate a greater depth of skill in the implementation — not in the ability to *demonstrate* its fitness to the client (*achieve*), the client and key stakeholders (*merit*) or the client, key stakeholders and the wider community (*excellence*). A *merit* or *excellence* solution should be more technologically competent; e.g: be easier to maintain, well documented, more user friendly, more functionality etc. For a program, the fitness for a user is the prime consideration. A NQF level 3 student's program is unlikely to have any impact on the wider community. Thus an "excellent solution" could not be awarded *excellence*, based on the stated criteria. The wording of the criteria indicates that it is the technique used during the development process that is being assessed. This might be relevant if a physical product was being manufactured or built, but in software development, good typing technique is what is required. We don't think this what the standard in trying to measure. Perhaps "technique" is referring to a software development methodology (agile methods, extreme programming, prototyping, …?) or maybe this is object-oriented vs procedural?
- **Fairness/Relevance:** In 2006, only 757 achieved success across all 6 technologies (no stats available for ICT students). This is a very low percentage of the school population, and reflects poorly on the relevance and achievability of this standard. But in comparison with some of the other standards reviewed here, this is perhaps a *technology* success story.

Conclusion: Although (after translation) this could be relevant to *Computer Science*, this standard is not an appropriate assessment tool at NQF level 3. Also, it is not relevant to *end-users*, who will not be expected to develop a product *for a client* in the future.

5.3 AS90676 Describe technologists' responsibilities to the wider community

NQF level 3, 4 credits, internal

This achievement standard focuses on describing responsibilities (including legal, ethical and moral) to the wider community and the impact this has on the practice undertaken by different technologists.

This topic is relevant to Computer Science, but is an inappropriate assessment standard at NQF level 3:

- **Uniqueness:** As for AS90051 (NQF level 1) and AS90773 (NQF level 2), the "2 way influence between computing and community" is worthy of study. However the assessment is almost identical to AS90773 (although the title of the standard is different).
- **Assessment mode:** As mentioned previously, a *portfolio of work* is not a suitable way to assess this topic.
- **Language:** The definition of "technologists" in the explanatory notes indicates that this means "two or more", but does not indicate whether these people should be from the same or different fields of technology. If multiple fields are implied, then the scope of the standard expands considerably. On the other hand, if two technologists are from the same field, it suggests that students will be basing their learning on a very small, and perhaps, non-representative sample.
- **Level:** Students at NQF level 3 will have no "real world" experience, and will not see the relevance of this topic, nor appreciate most of the issues that we would expect to be encountered. Setting the level at (NQF) 6 and changing the assessment mode to a dissertation, might make this standard useful.
- **Uniqueness:** Because of the similarity with AS90773 (NQF level 2), AS90676 and AS90773 should be merged (ie: don't offer a standard at NQF level 2, but offer something similar — but with a more focused topic-area — for NQF level 3). A written external assessment, (with a range of topic areas suggested for each year) would elevate the status of this content area.
- **Fariness/Relevance:** This standard was achieved by only 42 students in 2006 across all six technologies [11].

Conclusion: This standard has clearly failed. The scope of the topic needs to be narrowed, and more closely reflect the students' level of understanding and interest. It is not appropriate to assess either *Computer Science* or *computing end-users* at NQF level 3. It would appear students in the other technology disciplines agree.

5.4 AS90684 Explain knowledge that underpins an ICT outcome

NQF level 3, 4 credits, external portfolio.

This achievement standard involves explaining knowledge that underpins the development of an existing information and communication technology (ICT) outcome.

This topic is relevant to Computer Science, but several factors make it inappropriate to assess Computer Science skills and knowledge:

- **Uniqueness:** This is similar to AS90049 (NQF level 1) and AS90367 (NQF level 2). The criticisms made to those standards apply equally to this one.
- **Assessment mode:** Using a portfolio of evidence is not a valid way of assessing "explaining knowledge" in Computer Science.
- **Fairness/Relevance:** In 2006, only 17 students achieved this ICT standard, and a total of 99 students across the other 5 equivalent technology-specific standards [11]. These numbers indicate either that students are not interested in the topic, that schools are not prepared to use it, or that the standard is not achievable by most students at this level.
- **Language:** What is an "ICT outcome"? Is that a MS Word document, or an Information System application? Or maybe a web page, or someone's electronic calendar? The explanatory notes say it "is one that has been developed and implemented by a technologist(s)." As we have never met a "technologist" who developed AND implemented an ICT outcome, we suspect students will have difficulty here too.
- **Grade Criteria:** *Achieve* requires **- "Explain the knowledge** that underpins the development of an existing ICT outcome", while merit ask the student to also "**Explain how** it has been **synthesized** …", and *excellence* requests "… **discuss** the underpinning knowledge and **how it has been synthesized**…". We fail to see a significant difference between "explain" and "discuss" (compare & contrast). What knowledge are you comparing and contrasting? How do you "compare and contrast" the "synthesis" of an outcome?
- **Level:** Just understanding how one might tackle this standard probably requires NQF level 7 skills.

Conclusion: This standard is not an appropriate assessment standard for *Computer Science* or *computing end-users* at NQF level 3. The statistics also seem to indicate that this type of standard has failed the other technologies as well.

5.5 AS90685 Demonstrate techniques in information and communication technology

NQF level 3, 4 credits, internal

This achievement standard involves demonstrating techniques when developing an information and communication technology (ICT) outcome(s).

This topic is relevant to Computer Science, but AS90685 is not really a "standard" that can be used to assess ICT "techniques":

- **Fairness:** This is NOT a "standard". Rather it is a template for perhaps 100 standards. By encapsulating the assessment of all ICT disciplines, and "techniques" into one assessment standard, the effect will be that most techniques that a student masters will not be assessed, and the student will not get credit for most of what they know and can do in the field of ICT. This is like having one standard for the field of athletics — you can get credit for running, (merit for faster), but there is no recognition for hurdles, pole vault, etc.
- **Language/Uniqueness:** This is very similar to AS90368 (Demonstrate skills in information and communication technology, NQF level 2, 4 credits), the difference being a "skill" at NQF level 2, becomes a "technique" at NQF level 3. Our previous understanding of a "technique" was that it was the method of implementing a skill as in — "both have very good tennis skills, but their backhand techniques are different". Or in word processing, two students have the skill to cut-and-paste, but one uses the technique of menu selections, and the other uses the control-key technique.

  The "technique" mystery continues as the notes define a *technique* as "a combination of skills carried out in a particular order for a particular purpose". (Here is a new use for the word "skill". Previously we regarded a skill as an *attribute*, rather than an *action*). Again, in a software development context, a *technique* could refer to particular algorithm to implement a function (e.g. a binary search technique). Here there is no skill involved, except typing, or perhaps cut & paste. But the previous paragraph states that "*Techniques* in ICT refer to things such as database programmes [sic], CAD programmes [sic] …". Other similar standards define these things as "applications", not "techniques".
- **Level:** There is no indication of the level of skill/technique required. For example, in Mathematics, at NQF level 1 and NQF level 2, there are standards on graphs. The required content has an increasing level of difficulty (with some overlap — the *merit/excellence* end of level 1 skills may count towards *achieved* at level 2).
- **Fairness:** Although no standard software development tools (e.g. java, C, C++, assembler) are listed, it is assumed that these tools could be used to achieve this standard — albeit, with a higher level of skill (sorry, technique) being required.

Conclusion: By cloning separate standards from this *template*, useful assessment tools could be developed which actually measure specific skills/techniques relating to specific disciplines within the ICT umbrella. As it stands, AS90685 serves no useful purpose to fairly assess *Computer Science* or *end-user* computing.

5.6 AS90792 Develop a proposal for a production process for a client

NQF level 3, 6 credits, internal

This achievement standard involves the development of a proposal for a production process for the multi-unit production of a client's one-off solution(s).

This standard is not suitable for assessing Computer Science or end-user computing for the following reasons:

- **Uniqueness/Relevance:** Like the NQF level 1 standard, AS90048, proposing a "multi-unit production process" to a client is not relevant to Computer Science or end-user computing.
- **Level:** The analysis (cost/benefit), and resource estimations and availability criteria required to achieve this standard go beyond the cognitive level described for NQF level 3. The *merit* and *excellence* criteria would fit well at NQF levels 7 and 8 perhaps.
- **Fairness:** The need to find a client who has a "one-off" solution needing a production process will disadvantage some students who do not have suitable support/resources at home.
- **Language:** "Modes of production" are referred to in the explanatory notes. These include "batch production". An IT person would immediately think in terms of batch versus Interactive or real-time systems. But of course, these concepts are irrelevant to the intent of this module.
- **Fairness/Relevance:** In 2006, this standard was achieved by only 63 students across all six technologies.

Conclusion: This topic is neither relevant nor appropriate for Computer Science or end-user computing students at NQF level 3. It would appear to be irrelevant (or impossible) for students in the other technology areas as well.

6 Critique of PPTA ICT Taskforce Sample Achievement Standards

6.1 Sample Standard 1: Demonstrate knowledge of Computer Systems

NQF level 3, 4 Credits, External

This achievement standard requires students to demonstrate knowledge of computer systems and to compare past computer systems with contemporary computer systems.

We have some comments which may be useful towards improving the effectiveness of this standard:

- The **title** should really be: "Demonstrate knowledge of **PC** systems".
- **Fairness:** The scope of the assessment needs to be narrowed, particularly if only 4 credits are offered. We would recommend focussing on desktop PCs only, as getting into laptops and handheld devices becomes very complex, very proprietary, and expensive if you are contemplating practical work. Another standard could be defined to look specifically at handhelds, but really, studying the PC and its history, covers the key principles — handhelds etc follow similar principles. Again, to limit the scope, the history really shouldn't extend beyond the first PCs in the 1980's. It is also a much easier task to track the progression in PC technologies.

  Although the explanatory notes refer to software, this widens the scope again. It may be better to remove assessment of the software component of a PC system, and just focus on the hardware. This would lead to a new title such as "Demonstrate knowledge of PC Hardware". Another standard could be devised to address PC software. Does this standard imply assessment of skills in PC DOS batch file scripting?
- **Grade criteria:** We are also concerned that too much may be expected to *achieve* this standard. It is essential that all students who wish to progress in PC hardware have a good knowledge of contemporary hardware, but past technology is of less importance. Therefore, we recommend that the *achievement* criteria be reduced to "Demonstrate knowledge of contemporary PC systems and underlying technologies." Similarly, the *merit* criteria could become "Demonstrate knowledge of contemporary and past PC systems and underlying technologies", with the *excellence* criteria adding the comparison (but not "detailed analysis"). A course that is run at AUT, for example, covers PC hardware (and history) **only,** with some DOS/Windows, as a 15 credit module (150 hours of student learning).
- **Assessment mode:** Why an external assessment? It will be a much more effective module if you can have a practical assessment (disassemble/re-assemble a PC within a time limit), as well as some theory test. There is so much detail and technical facts that could be asked in a theory exam, that it would be extremely difficult to set an external theory exam nationwide — unless the exam was open book, and everyone used a prescribed text (and had a detailed syllabus). The text used at AUT in the introductory PC hardware Diploma course — *Upgrading and repairing PCs*, Scott Mueller — is 1,628 pages long, without looking at laptops, handhelds, or computer hardware that existed before 1980.

If internal assessment is used for this type of module, a combination of a practical assessment, an essay assignment, and a theory test would be ideal, but the credits need to be much higher. Again, you may want to separate the hardware knowledge (theory) from the hardware skills (practical) as a way of making it easier to quantify what is being assessed, and at what level. Two new titles come to mind: “Demonstrate knowledge of PC hardware concepts”, and “Demonstrate knowledge of PC hardware skills”. Both of these standards could be used to assess a single PC technology course.

Conclusion: This standard is very relevant to potential hardware support personnel and power-users. With the changes recommended above, this would provide useful replacements for some of the current Technology achievement standards.

6.2 Sample Standard 2 Develop a computer program to solve a problem

NQF 3, 6 Credits**,** internal assessment

This achievement standard requires the use of a software development process to create a computer program to solve a problem.

We would suggest a few changes:

- **Title:** The title is too generic. In order to allow multiple development paradigms and languages to be recognised, we need to be more specific.

For example, this could be defined as **five** different standards:

1. Develop a single-module computer program to solve a problem using an assembly language.
2. Develop a single-module computer program to solve a problem using a procedural Third Generation Language.
3. Develop a single-module computer program to solve a problem using an object-oriented Third Generation Language.
4. Develop a single-module computer program to solve a problem using an end-user application (4GL).
5. Develop a single-module computer program to solve a problem using a scripting language.

   With these titles, the reader can see what type of development tool has been assessed and that the program is a limited application. Also, students would be able to get recognition for different skills and knowledge. It would also make it easier to design courses to follow in a logical progression.

Other standards on this theme could be: “Modify a program to extend the functionality …”.

- **Level:** At NQF level 1 or 2, similar standards could be defined, which restrict the constructs (e.g. no array or file references, no nested loop), and is qualified with "Develop a computer program from a provided logic diagram to solve a problem using a …"). This could be assessed internally in a controlled test environment, where on-line help, (or reference manual) could be used to look up syntax if necessary. The code being developed would only use constructs and techniques that had been covered in class.
- **Grade Criteria:** We suggest that the sole criterion for *achieved* be that the program works according to specification; *merit* should relate to the quality of the code — style, documentation, standards, maintainability etc; *excellence* should include the development process and adherence to standard practice with respect to appropriate design and development methodology.

Conclusion: With the changes suggested above, this standard would be a useful *template* for additional achievement standards for potential software developers.

7 Conclusions and Observations:

The report Card:

None of the Technology achievement standards reviewed in this report were found to be appropriate to assess either *Computer Science* or *end-user* computing at the secondary school level. The ICT specific standards were particularly disappointing, in that virtually no effort has been made to tailor the standards to the ICT disciplines in terms of the language used to describe the standards, the practices referred to, and the assessment modes.

The *PPTA ICT Taskforce* proposed *achievement standards* were found to be relevant, more targeted, and are at an appropriate level of expectation., With some modifications and replication as outlined in section 6, these would be a very useful replacement for the existing collection of ICT specific Technology standards.

The main failing in almost all of the *Technology standards* is that the cognitive level required goes far beyond the NQF level descriptions. Either the standards are not achievable at all, or the *merit* and *excellence* criteria are well beyond the grasp of all students, given the (implied) number of learning hours per credit.

For example, in NQF level 1, a quick scan of the national statistics indicates that both AS90045 and AS90046 by and large are used to assess the same group of students. In 2006, 5,475students *achieved* in AS90045 (Develop a Solution), but only 4,161 *achieved* in AS90046 (formulate a Brief). The difference is 1,314 or 24%. That is one quarter of those able to develop a solution could not develop a brief. This must raise questions about the ability (or motivation) of NQF level 1 students to apply the more advanced cognitive skills of analysis, synthesis, and evaluation with respect to technology.

This anomaly raises questions about how well NZQA moderated the standards we reviewed with respect to cognitive level of difficulty. It must also be confusing to teachers that the *NQF Cognitive Levels of Achievement* (Appendix C) are not congruent with the levels of the *Technology Curriculum Achievement Objectives*[10] (Appendix D).

The second major failing is that the standards seem to be so bound up in the *Technological Practice* (Appendix D) that other codes of practice, paradigms, procedures, and techniques are either buried, or excluded. This certainly seems to be true for ICT and *Computer Science* in particular. On reflection, this might be because Computer Science is NOT a "technology" — it is more closely related to mathematics and science, than it is to soft materials, food technology and hard materials. Unlike the other traditional disciplines, computing students will not have been exposed to the basic concepts, tools, techniques, and methodologies of this discipline when they reach NQF level 1. Computing needs a curriculum presence and its own achievement standards, so that students can start from the beginning and learn about their own methodologies and codes of practice.

None of the achievement "standards" relating to *skills* or *techniques* actually define levels of competence in enough detail for teachers or students to have any idea of what is an acceptable, very good, or excellent level of achievement in any ICT skill or technique. For example, *excellence* is often defined as doing "more", rather than doing it "better". The NZQA Generic Computing standards and the International Computer Driver's Licence (ICDL) [7] do this reasonably well, but for serious consideration by high-achievers, useful *achievement* standards are needed to reward and

[10] In theory, the cognitive skills required at TC levels 6, 7, and 8 should map onto NQF levels 1, 2, and 3.

encourage excellence. Another place to look for standards definitions in the ICT area is the US based International Society for Technology in Education (ISTE) website [3], and their standards [4]. Also the NACCQ [5] collection of computing programmes and modules [6] (approved for NCEA credit) would be a good starting point to formulate some real computing achievement standards.

The bias towards the non-ICT "technological" disciplines the Ministry of Education's online glossary is immediately obvious. For example, the term *biotechnology* is defined, but not *"ICT", "IT", "Computer Science", "Computing", "Software Engineering", "Information Systems", "Management Systems"*. Curiously, the term *specification* is there, and could be interpreted in a *Computer Science* context, but other terms frequently referred to in the *standards* such as *brief* and *portfolio* are not.

More non-ICT bias can be found on the *Suggested Learning and Assessment Examples for TC levels 1 and 2* web page [19]. Here it is suggested that "Letter boxes" would be a suitable area of study for "Materials; Structures; [and] Information and Communication [Technology]".

For TC levels 3 and 4 a "FESTIVE TABLE

,… Materials; Food; Information and Communication [technology]" is suggested, but thankfully, the second example — A Maori Hangi — does not include a reference to ICT. Finally, at TC levels 5 & 6 (NQF levels 1) we do get a relevant suggestion - "EXAMPLE 2: COMPUTERS …Students use a computer system, including the manuals, to identify and describe the relationship between the internal hardware components, the operating system, and the applications software. They investigate how computers use binary numbers to switch electrical devices, …." It is unclear how students will achieve these goals without the underpinning knowledge which is clearly missing from the curriculum, and evidenced by the difficulty which first year university Computer Science (NQF Level 5) students have with this area of study.

It seems that little or no consideration was given to relating the cognitive level of difficulty as described in the NQF levels, with those implied in the *Technology Curriculum Achievement Objectives*. We believe that this is the crux of the problem. Whereas a year 11 student may be capable of creating a "product" in *food technology*, or *hard materials technology* and operate at TC L6, the same student, in a *Computer Science* context, would be operating at (or below) TC L1 and be quite incapable of producing a software product, let alone have any knowledge of the software development tools and their effect on his/her *technological practice*. There is an implicit assumption that ALL technological endeavours and disciplines operate at the same cognitive level — that the food technologist, the wood worker, computer scientist, and an IT technician use the same cognitive skills in each of their disciplines. This is clearly an invalid assumption.

Another failing is the huge gaps in the coverage of skills and knowledge assessments. Over the 18 standards reviewed, only three attempt to assess skills and/or techniques, and 3 assess limited areas of knowledge. The standards are so vague (skills/techniques assessed are not specified, nor skill levels quantified) that one student could gain credits for the same skills across multiple standards with no correlation between the *achieved*, *merit*, and *excellence* grades. Because of the lack of useful targeted standards, students who develop a range of skills (e.g. assembly language programming, Java, Visual Basic, C++, MS Access DBMS, webpage design and implementation), can not gain full recognition for these skills, as they would if they were studying, say, English, French, German in languages, or calculus and statistics in the mathematics discipline. Perhaps a bigger challenge for teachers is the lack of any uniformity of what knowledge and skills a student has from a previous year of study, or when transferring from another school. Like Mathematics, Software Development is a cumulative discipline. Each new skill and technique builds on previous ones. If you don't know what students know, how can you build and present a relevant course?

Very few of the *Computer Science* or IT topics listed in the Introduction to this report are covered. Ones that are missing include:

- Algorithms,
- Artificial intelligence,
- Boolean algebra and switching circuits,
- Data communication and networking concepts,
- Data normalisation,
- Data structures,
- File systems and database theory,
- Installing, maintaining, and customizing software,
- Logic skills,
- Number & coding systems,
- Numerical analysis,
- Operating systems,
- Programming languages,
- Programming paradigms,
- Programming standards and style,
- Software and software support concepts and technique,
- Software development methodologies
- System security issues and techniques,
- Testing and debugging,
- The limits of computation (what computers can't do),
- Translation between levels of abstraction,
- User Interface Design.

Statistics:

The numbers of students achieving the various standards tells us something about what teachers and students are choosing for assessments. (Unfortunately, as "not-achieved" numbers are not published currently, it is difficult to discover how many students actually attempted the various standards.) In fact, one has to ask why statistics for the external achievement standards have not been published in the assessment reports after 2004. Are the numbers getting worse? It appears that it is not just *computing* assessment and achievement that are in trouble in our secondary schools. *Technology* achievement standards are being ignored at level 3 in most "traditional" technologies, indicating their difficulty of use, and impossible-to-achieve criteria.

Computer Science should appeal to brighter students. Many students currently taking, (for example) Physics and Calculus would benefit from high school programming courses. Standards in the science/mathematics subject areas have an explicit body of knowledge and do not rely on teachers patch-working courses so that they fit the *Technology Curriculum Achievement Objectives* and *Technological Practice* (Appendix D). The number achieving in Physics at NQF level 3 was around 4,000 in 2006 and slightly higher in Calculus. Numbers achieving credit in the two ICT-specific level 3 standards were 17 (for 90684) and 724 (for 90685) with at least some of those in the end-user category, not Computer Science. We suspect that there is a huge number of potential computing professionals who have already opted out of the discipline during secondary school, either because of the lack of relevant achievement standards, or because of the unpalatable offering of what they are told **is** relevant for a future computing career.

Computer Science Teachers:

It is evident that currently there are only a few teachers in NZ secondary schools with the necessary skill-level and discipline knowledge, although these are more likely to reside in Science and Mathematics than in the Technology discipline. If (non-technology) teachers are to be enticed to teach a 24 credit course in *Computer Science*, they should not be put in the position of trying to make unworkable standards work. Computing teachers should not have to cobble together a course assessment from a random collection of unsuitable standards. Like science and mathematics teachers, they should be able to design a sensible course based on 24 achievement standard credits, and offer it.

The Digital Technologies Guidelines:

The *Digital Technologies Guidelines* (DTG)[11] project [8], building in the work initiated by the Fluency in IT (FITNZ) project [9] is an attempt at tackling some of these problems. However, like painting over flaking paintwork adhering to rotten timber, the result is destined to be disappointing, ineffective, and short-lived. We believe it will not succeed because it is too narrow in scope and short-sighted in terms of the problems that need to be addressed.

To have a remote chance of success, the Guidelines must start at year 1 NOT year 8. The core competencies (referred to as “core applications” and “Digital literacy”), must be in place before students reach high school. The NZ curriculum gives no hint as to what should be achieved year-by-year, so any attempt at establishing a coherent course of study in the lower secondary school is doomed to failure, no matter how good the DTG looks on paper.

The Beacon Practice Project

The Beacon Practice project within the GIF (Growth and Innovation Framework) Technology Education initiative, [13] has produced some wonderful resources, and examples of the work done are available online. The motivation for establishing this project appears to have been the recognition that the resource requirements of the *Technology Curriculum* and the associated *achievement standards* were well beyond the grasp of many Technology teachers. Supporting this view is a statement extracted from the Beacon Project Case Study BP604 [14] “Teachers in these schools saw the opportunity ... to address some major issues that both schools were facing in their teaching of ICT within the framework of technology education." Their focus included “Simplifying NCEA assessment”, and “Getting the balance right between ICT skills/knowledge and technological practice”. Having viewed some of this excellent resource material, we believe that provided you have outstanding dedicated teachers, and scholarship-level students, wonderful results will be achieved. However, for the average teacher, and majority of the school population, putting these resources into practice is still not achievable. Too much effort needs to be expended just to get around the assessment system and the *Technology Code of Practice*.

[11] The DTG has recently been rebadged from the Digital Technologies Framework (DTF)

***Computer Science* needs a curriculum presence with its own achievement standards.** Without this, we see the downward trend of Computer Science tertiary enrolments in New Zealand continuing. As a nation, we are spurning massive opportunities that come with having highly skilled computing professionals in our workforce — something we can ill-afford to do.

In light of the strong connection of Computer Science with Mathematics, and its initial beginnings in the New Zealand Bursary Applied Mathematics course of the 1980's, realigning the Computer Science discipline with the *Mathematics curriculum*, might be a first step towards addressing this problem. *Information Systems* and *Information Management* probably sit best in a business environment, while *Information Technology*, with its roots in the "hard" technology space, is now more aligned with the business community. End-users, having gained initial computer literacy, may enhance their skills within their chosen disciplines, which may be outside the realm of *Technology*.

Final Observations on the Technology Achievement Standards:

Over all of the Technology standards reviewed, we observed that there is an excessive emphasis on *Technology Practice*, which for all of the ICT disciplines, is totally irrelevant at the secondary school level. There is also a complete lack of congruence with respect to the levels of the Technology Curriculum Objectives (6 - 8) and the NQF levels 1 - 3. Indeed, there is no correlation between the levels of the non-technology areas of learning Curricula and the Technology Curriculum with respect to cognitive levels of learning. Perhaps none was intended. At a quick glance, one might even align TC levels 1 - 8, with NQF levels 1 - 8, and discover that by and large, the TC levels were still at a higher cognitive level than the corresponding NQF levels.

Classifying Computing Teaching, Learning, and Assessing in New Zealand Schools:

The New Zealand Curriculum document ignores ICT completely. There is no reference to ICT, IT, Information Technology, or computing anywhere in the document. The sole reference to computing is found in the "Using language, symbols, and texts" section of the Key Competencies document [17]: "… They **confidently use ICT** … to access and provide information and to communicate with others." But nowhere does it say that students should use ICT *competently*, or *appropriately*. We have observed many secondary school graduates who claim to be ICT literate, who *confidently* (mis) *use* spreadsheets as a word processor (hard-coding totals and products instead of using formulae), and word processors as typewriters (underlining, instead of bolding, pressing the space-bar instead of centering or tabbing, entering multiple newlines instead of a form-feed, and typing a table of contents instead of generating one).

A large number of primary and secondary schools have established either stand-alone end-user computer skills-training, or (at primary level particularly) are using appropriate software tools to enhance and stimulate learning within the context of reading, writing, numeracy, problem solving, and researching. But the coverage is far from uniform. There is no guarantee that all (or even most) students arriving at a secondary school (year 9) will be competent typists, and skilled users of a word processor, spreadsheet program, and a web browser.

Computer Science is essentially about designing algorithms to solve problems that may be translated into code to run on a computer. This process is often referred to as "software development". Before this can be contemplated, software developers, must have been exposed to examples of software in action, and be competent *power end-users*. They also need a solid grounding in mathematical concepts including number systems, algebra, and logic, plus principles of electrical phenomena (physics), and have good reading and writing skills.

To get Computing back on track, and achieve the status it had over 30 years ago, we need:

1. A revised NZ curriculum which includes references to specific ICT skills and competencies to be achieved before reaching secondary school (NZC levels 1 - 3). This might be included in the DTG or embedded in the appropriate areas of learning Curriculum document. Further competencies could be added at levels 4 - 8 to address the needs of computer end-users.

2. A *Computing* syllabus needs to be created. Here we use the word "computing" to include both *power end-users* and *Computer Science.* We realize that like Medicine, Law, and Engineering, it is not feasible to study a rigorous Computer Science curriculum at secondary school. Instead, a more generic (as in "General Science") subject is needed as a vehicle for enthusiastic *computer end-users* to study the subject more seriously, and discover what aptitude and key skills are required for this discipline. Some people taking this subject may want to continue their study at tertiary level either in Computer Science, Software Engineering, Information Systems, or Business Computing, but many may be happy to just use their skills as *power end-users* in other discipline areas. Such a syllabus would sit quite comfortably inside the Mathematics curriculum which already is reasonably prescriptive in its format.

3. Appropriate *achievement standards* to assess computing — particularly *Computer Science* — skills, knowledge, and competencies. These could be converted from the existing Generic Computing *unit standards* or developed from scratch to fill in the many gaps. In general, we do not see that it is feasible or desirable to convert any of the Technology standards reviewed in this document to usable achievement standards for computing.

   Another option that some schools might consider is offering a course based on the Cambridge International Exam in Computing [18]. This is a completely self-contained course with teaching and assessment guides, plus an internationally recognized qualification.

4. **Competent Teachers:** Existing Mathematics and Science teachers may be interested in teaching this subject. With a clearly defined syllabus, and suitable achievement standards attracting high-performing students, teachers from polytechnics and universities may also be interested in helping out on a part-time or short-term secondment basis. In-service training courses will be needed to bring some teachers up to speed with current computing paradigms and methods.

The non-power-user community needs attention too. End-user computing fits best in the discipline area that uses the tool. For example, word processing could be studied and assessed as a part of English, while spread-sheeting is closely related to accounting. Studying Electronic devices (digital and analogue) is closely related to Physics (more so than Technology), and digital media and graphics design fits best in the Arts area. Using Information Management systems (including database) fits well in a business studies context, but we see no harm in leaving designing and building such systems until tertiary level, although introductory database systems design could be introduced in a Computer Science curriculum.

Other "IT" subjects may not need coverage at all. Although it is recognized that some vendor Certifications (e.g. CISCO CCNA/CCNE) might be credited to NCEA in the future, it is unlikely that there would be any demand (or need) to consider the IT support area covered by the UK's Office of Government Commerce *IT Infrastructure Library* (ITIL).

8 Recommendations:

Based on the observations and findings of this report, the NZCS recommends that the Ministry of Education:

1. Creates appropriate *achievement standards* to address the assessment vacuum that exists in the area of Computer Science at the secondary school level.

2. Recognizes that Computer Science is NOT a "technology". Computer Science is about computation (numeracy), logic, and the study of algorithms and problem solving within a computational paradigm. It needs a syllabus which defines a coherent body of knowledge, relevant practices, and associated achievement standards.

3. Removes computing from the grasp of the *technology curriculum* and align it with subject areas that are more relevant to the various disciplines. For *Computer Science*, Mathematics is the logical choice. *End-user computing* fits best with the subject areas that use the tools.

4. Establishes a rationale for defining achievement level criteria. For example, in achievement standards which require *production of a product*, the **sole criterion** for *achieving* should be that the product works according to specification (bar minor deficiencies) - i.e. is *fit for purpose*. *Merit* criteria should require that the product works (as for *achieved*) and has desirable qualities (such as well-documented, efficient, easy to use, robust, maintainable, extendable, …) and *excellence* requires the previous criteria plus planning and other deliverables which relate to the particular practice (not necessarily Technology) that is being assessed.

5. Creates externally assessed Achievement standards which assess a common body of knowledge under exam conditions similar to those available in the Mathematics curriculum.

6. Re-moderates the *technology achievement standards* with a view to aligning the cognitive levels to the NQF level definitions.

7. Surveys technology, computing, and potential computing teachers to gain insight on their perceptions of the value, relevance, and effectiveness of the existing *technology achievement standards* with respect to their effect on teaching workload and morale, and student attitudes towards computing as a future career.

8. Surveys year 10 - 13 students (and their parents) across the country to determine what motivates them into choosing (or not choosing) computing as an area of study at tertiary level.

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Appendix A: Authors' Background Information

Gordon Grimsey, MSc, DipBDP, DipTch, MNZCS

- NZCS representative: *Digital Technologies Guidelines National Advisory Group* (2007-)
- Principal Lecturer and IT Resource Coordinator in the *School of Computing & Mathematical Science*, AUT, (1979 – present).
- Taught a range of introductory hardware & software concepts, and programming classes using a variety of languages (COBOL, RPG, Basic, Fortran, Pascal, Delphi, Java) to both full-time, part-time, and short course students, including school leavers and mature students.
- AUT Student liaison representative for NZCS (1999 – present)
- Committee member, NZCS Auckland branch (2002 – present)
- Established the NZCS National Tertiary ICT Scholarship Scheme (2005)
- Manukau Polytechnic (MIT): Contract Analyst/Programmer (part-time 1991-2000)
- Programme Leader, *National Diploma in Business Computing* (1990-1998)
- Member, NACCQ NDBC subcommittee (1992-1998)
- Critiqued NZQA developed Unit standards proposed to replace NDBC modules (1992)
- Tutored secondary school girls in the SPLAT programming language for the AUT annual *Young Women's Programming Competition*, YWPC (1988 - 1999)
- Developed a simple programming language (SPLAT) for use in the AUT YWPC (1988)
- Part-time lecturer, University of Auckland Stage 2 Programming Laboratory (1985-1996)
- ATI Special Methods Computing Trainer, assisting with initial training of poly Tech Computing tutors throughout NZ (1981-1985)
- UEB Analyst/Programmer (Technical Refresher leave, 1984)
- AAVA, NZCDP National Computer Fundamentals Examiner (1982-83)
- Teacher, Auckland Grammar School (1970-1978)
  Mathematics (F3 - F7), Physics (Bursary), Computing (SFC and Bursary)
- AGS Position of Responsibility: Computing & F3 Mathematics (1975-1978)
  (Established one of the first Computing courses in NZ Secondary Schools)
- Seconded by Dept of Education to advise on Computing in Secondary Schools (1976).

Margot Phillipps, BSc, BA, DipTchg, MNZCS

- Computing and Mathematics Teacher, Lynfield College (2002 – present)
- International Representative (Worldwide excluding north America) on the Board of the CSTA
- Executive Director New Zealand Olympiad in Informatics (2007, 2008)
- Team Leader, New Zealand Team at IOI (2006, Mexico and 2007, Croatia)
- Member of Fluency in IT (First attempt at the new framework in ICT) (2006)
- Lead School Teacher for New Framework, co-ordinated by Cognition (2007,2008)
- Panelist and Workshop presenter at AUT annual *IT Symposium* (2005,2006,2007)
- Senior Lecturer, Unitec (2000-2002) Taught a range of degree level 1 and 2 Programming and Database Courses
- Instigated, organized, and tutored in the AUT Young Women's Programming competition for NZ school girls (1988 - 1999)
- Senior Lecturer, AUT and Student Liason Officer (1985-1999) Taught a range introductory level Programming ,Database, Applications and Systems Courses
- Analyst/Programmer – Auckland and greater London, (1976-1982)

Appendix B Other Contributors: *(Editors and Reviewers)*

This report has been reviewed and edited by a large number of NZCS members including the following (Full profiles below):

Tony Clear, MNZCS, Associate Head, School of Computing and Mathematical Sciences, AUT University

David Cowman, MNZCS, Deputy President of New Zealand Computer Society

Dr Sally Jo Cunningham, FNZCS, Associate Professor in Computer Science, Waikato University

Dr Stephen MacDonell, MNZCS, Professor of Software Engineering, AUT University

Dr Alan McKinnon, MNZCS, Professor of Software and Information Science, Lincoln University

Ian Mitchell, FNZCS, ICT Consultant

Dr James Noble, MNZCS, Professor of Computer Science and Software Engineering, Victoria University of Wellington

Dr Gillian Reid, FNZCS, Lecturer, University of Auckland Graduate School of Enterprise

Don Robertson, MNZCS, New Zealand Computer Society President

Dr Hank Wolfe, FNZCS, Associate Professor in Information Science, University of Otago

Professor Wai Albert Yeap, FNZCS, Assoc Head, School of Computing and Mathematical Sciences, AUT University

Full profiles:

Tony Clear, MPhil Auck., MA(Hons) Victoria., DipTchg., MNZCS., MACM., MIEEE

- Associate Head, School of Computing and Mathematical Sciences at AUT University.
- More than 25 years experience in the Information Technology field
- Tony began his career as a teacher of high school mathematics, English and languages, then held professional roles in the IT industry ranging from Software Developer to Manager in Software Development and other IT functions.
- Has been actively involved in academic leadership roles and curriculum development in computing at AUT University over the last fourteen years. This curriculum interest in computing has also extended to the high school level, where he was an active member of the FITNZ project, and was instrumental in initiating the annual *IT Symposium* for high school computing teachers held at AUT University.
- Is a member of the NACCQ national executive committee, and past chair of the NACCQ Research and Support Working Group.
- Research areas include collaborative computing, computing education research and professional issues in the computing field.
- Has been a programme committee member for several major computing education conferences. He serves on the editorial boards of *Computer Science Education*, *The New Zealand Journal of Applied Computing and IT*, *The Bulletin of Applied Computing and IT*, and contributes a regular column to the *ACM SIGCSE Bulletin*.

David Cowman, MNZCS

- NZCS Deputy President, 2008
- ICT Manager for the Central Plateau's largest accounting firm
- Previously Founder and Director of an ICT consultancy
- Has held several ICT-related positions in Local Authorities
- Formerly a Primary and Secondary School teacher.

Dr Sally Jo Cunningham, PhD, FNZCS

- Associate Professor in Computer Science, Waikato University
- Over 100 peer reviewed research publications in Computer Science and Computer Science Education
- Tertiary teaching in Computer Science, 1985 – present; has taught a variety of courses ranging from introductory programming to specialist postgraduate to service courses for non-computing students
- Board of Directors, New Zealand Lotteries Commission, 2004 – Jan 2007
- Director, AHA Software (2000 – present)
- Research Fellow, University of Illinois at Urbana-Champaign Graduate
- School of Library and Information Science, 2004 – 2006 (top ranked LIS School in the USA)
- Committee Member, Waikato/BOP Branch of the NZCS, 1992-1993, 1995 - present
- National Council Member, NZCS, 1995 – 2002
- Journal on Educational Resources in Computing: Associate Editor, 2004 – present
- PhD, Louisiana State University, 1990; major subject Computer Science, minor subjects Information Science and Asian History
- B.S., University of Tennessee, 1984; major in Computer Science, minor in Mathematics
- B.A., University of Tennessee, 1984; major in Humanities (Asian Studies).

Dr Stephen MacDonell, BSc, MSc (Otago), PhD (Cambridge)

has been Professor of Software Engineering at *AUT University* since 2002. In that time he has taught undergraduate software engineering classes and postgraduate research methods classes. Prior to joining AUT, Stephen held several appointments at the *University of Otago*, after starting there as a Postdoctoral Fellow in 1993. Moving to a lecturing role in 1994, he advanced to the position of *Associate Professor* in 2002. While at Otago Stephen co-ordinated and taught first-year classes of 1200 students - taught in 3 lecture streams of 400, as well as senior undergraduate and postgraduate groups. Stephen was *Head of the Department* of *Information Science* at Otago from 1999 to 2001. During his time at AUT Stephen has also held the roles of *Head of the School of Information Technology*, *Associate Head of School* (IS and IT), and *Associate Dean* (Development) in the *Faculty of Design and Creative Technologies*.

Stephen teaches primarily in the areas of information systems development, project management, software engineering and software measurement, and information technology research methods. He undertakes research in software metrics and measurement, project planning, estimation and management, software forensics, and the application of empirical analysis methods to software engineering data sets. With Andrew Gray and Dennis Frailey, Stephen has authored a chapter on software engineering management in the IEEE's Guide to the Software Engineering Body of Knowledge (SWEBOK).

Dr Alan McKinnon, BE, PhD (Cant), MNZCS

Professor of Software and Information Technology, Lincoln University, Christchurch

Currently Teaching

- Computer Concepts and Organisation,
- Development of Effective Programmes,
- Visual Data Analysis,
- Concepts and Organisation of Databases, and
- a 600 level paper on Image Processing.
- Academic and Professional Background
- Member of Canterbury Branch Committee of the NZCS
- Former NZCS Branch Chairman, National Councillor and convenor of the Technical committee.

Current Research and Publications

- Modelling of biological systems and using models to interpret biological data
- Modelling of ACTH production by the pituitary gland
- Magnesium dynamics in dairy cows.

Ian Mitchell, MSc (Nuclear Physics, Auckland), FNZCS

- ICT consultant, active member of the iE3 Group Limited
- Past President, NZCS

Employment History

- **2000-2003 Managing Own Software House** — developed web services technologies addressing CRM, Event Management, Corporate Directory Tools, and Content Management; had assignments as an expert Witness relating to ICT issues.
- **1998-2000 CEO, PHAROS Systems Limited** (NZ & USA)
- **1997-1998 Independent Consultant** — consulted to Fujitsu (NZ) Limited; has been a regular presenter at ITMG conferences; delivered the MBA IT paper for the University of Otago
- **1991-1996 Assignments** — Taught courses for APIU; review of systems and procurement process for Tasman Express (shipping); review of the IT Strategic Plan of the Auckland City Council and conducted Information Awareness Seminars; Government IT Systems for The Republic of Kiribati; Digital Equipment Corporation (NZ) Ltd: Review of IT Strategy (Internal Systems); NZ Rail Limited: Audit of the evaluation process for an EDI systems strategy; Fujitsu (Japan): Development of the specification for PEOPL - a proposed commercial 4GL with pervasive and object-oriented features; designed Time & Cost Billing System with a practice management component in New Zealand's largest patent attorney practice; prepared ISO9000 process documentation for software development and assisted in selecting CASE tool for Fujitsu (NZ); Lectured at the University of Auckland in undergrad Software Engineering and in the post-graduate Diploma of Business (IS); Surveyed the NZ computer industry on Views on Government Policy on IT for the Ministry of Commerce.; Presented a seminar — *Management and IT in the 1990s* — at the University of Auckland; prepared standards documents for software development.

- **1987-91 Managing Consultant of 5GL International Ltd** — owned and managed a software house developing in Informix 4GL under UNIX with a staff of 24; designed and supervised the development of a major suite of innovative management financials incorporating EIS, Performance Measurement and Workflow features.
- **1980-86 Independent Consultant** — Consulted to The Audit Office on the Report on Computing in the Public Sector; presented seminars on Computer Audit, Software Methodologies, Business Analysis, UNIX, Managing Computing etc; lectured at the University of Auckland in the Management Studies Department on Transaction Processing.
- **1978-80 J P Scott & Associates - Branch Manager** — established an education company as a subsidiary, ComEdCo; taught systems analysis and COBOL; consulted in both clinical and administrative areas to the Department of Health.
- **1975-78 L D Nathan & Co Ltd - Systems Development Manager**
- **1972-75 Information & Management Sciences Ltd - Managing Director** — developed software for law practices which was sold to a consortium of all the trading banks in NZ; developed software for the largest market research company in NZ.
- **1969-1971 International Data Limited - General Manager** — with 51 staff, developed financials software for several large businesses e.g. Wilson & Horton Ltd.
- **1966-68 Mason Bros Limited - DP Manager** — developed the computing operation for NZ's largest engineering company; helped in the calculations behind the Manapouri Hydro Power scroll casings - the largest steel rolling job ever completed in New Zealand.
- **1964-66 IBM World Trade Corp — Systems Engineer**.

Dr Robert James Noble, B.Sc.(Hons) Ph.D VUW

Present Position:

- Professor of Computer Science (Software Engineering) within the School of Mathematical and Computing Sciences at Victoria University of Wellington

Research:

- **Software Design** especially Object-Oriented and Aspect-Oriented approaches to design.
- **Programming Languages** especially Ownership Types and Pluggable Type systems.
- **Design Patterns** including Small Memory Systems; User Interaction; Agile Development.
- **Human Computer Interaction** including Interface Design, Interaction Design, Usability.
- **Software Visualisation** and **Visual Languages** including language design and analysis .
- **Development Methodologies** especially Agile approaches involving users and customers.
- **Philosophy** of Computer Science and Software Engineering, in particular semiotics of computation and postmodern approaches to software design.
- Over 190 publications.

Teaching Experience:

- Developed lectures for a first year course on introductory computing
- Lead development of a new second-year course on Software Design & Engineering
- Lead development of new third year course on User Interface Design
- Developed a new stream of a third year stream on Agile Methodologies
- Redeveloped a fourth year course on Object-Oriented Paradigms

- Taught international tutorials on Agile Software Engineering, Usage-Centred User Interface Design, Visual Languages, Software Visualisation, Semiotics, Design Patterns, Small Memory Systems, Postmodern Software Development.

Previous Employment:

- Associate Professor, Computer Science, Victoria University of Wellington, 2003
- Senior Lecturer, Computer Science, Victoria University of Wellington, 2002
- Lecturer, Computer Science, Victoria University of Wellington, 1999 —2001
- Research Scientist, Microsoft Research Institute, Macquarie University, 1996-99
- Postdoctoral Research Fellow, Center for Object Technology, Applications, and Research
- Department of Computing Sciences, University of Technology, Sydney, 1995-96
- Lecturer, Department of Computing Sciences, UTS, 1995
- Teaching Assistant/Tutor/Assistant Lecturer, Victoria University of Wellington, 1989-94
- Programmer, Coopers & Lybrand, November 1986 - November 1988.

Non-Academic Appointments

- Panel member for Royal Society of New Zealand Marsden Fund Mathematical and Information Sciences (MIS) panel, 2006-2008.
- Foundation Editor-In-Chief, Springer-Verlag Transactions on Pattern Languages of Programming. 2007-present
- Editorial Board member of journals: IEE Software, Systems Signs and Actions, Intl. Journal Agile and Extreme Software development
- Director of the Hillside Group, a US-based non-profit organization that promotes the study of design patterns worldwide, since 2001.

External Examiner for Masters & Doctoral Theses at The University of New South Wales, 2006; The University of Madeira, Portugal, 2006; Monash University, 2005; The University of Sheffield, 2005; Flinders University of South Australia, 2005; The University of Auckland 2004, 2003; Dublin City University, 2004; The Royal Melbourne Institute of Technology, 2002.

Industrial Courses:

- Object-Oriented Techniques That Really Work. Robert Biddle, James Noble, Ewan Tempero. Presented to various New Zealand companies, 2000-2002.

Dr Hank Wolfe BSc(Am Uni Wash DC), PhD(Otago), FNZCS

- Associate Professor, Information Science, University of Otago.
- has been an active computer professional for 47 years specializing in computer security, with an international reputation in the field of forensics, encryption, surveillance, privacy and computer virus defences.
- has provided advice on security matters to major government bodies within New Zealand and to Australian, Panamanian, Singaporean and U.S. Government organizations; and additionally to New Zealand businesses and the major New Zealand ISPs.
- has conducted and supervised computer security audits of more than one-hundred New Zealand businesses and government bodies.

- speaks on security and privacy issues (both technical and policy) regularly at international conferences.
- primary research interest is centered around the emerging discipline of computer forensics as well as private communications techniques, which focus on the implementation of various cryptographic algorithms that are currently available and the associated hardware and software necessary to implement such systems.

Dr Gillian Reid, B Com (Ak), MBA (Henley/Brunel), PhD (Information Systems, Ak)
Fellow of the BCS, Fellow of the NZCS, Member of the Institute of Directors.

Current Professional Activities:

- Honorary Lecturer in the Computer Science Dept at University of Waikato
- Assistant Secretary General of the South East Asian Regional Computer Confederation (SEARCC) - an executive director position.
- Selwyn Group Positions:
  - Deputy Chairperson, and Director of the Board of Trustees
  - Chair of Board ICT Steering Committee, driving the strategic use of ICT in the Group
  - Chairperson and Director of Selwyn Care Ltd (the commercial arm of the Selwyn Group)

Previous Profession Responsibilities:

- President of SEARCC 2001-2003
- President of the NZ Computer Society 1999-2001
- NZQA National Moderator for Polytechnic Sector Business Computing programme

Employment History

- **University of Auckland Graduate School of Enterprise** (2003 - present)
- Part-time Lecturer on both Master of Management and MBA Programmes (Research Processes, Policy Development, Strategic Management)
- **EDS Asia Pacific Ltd**
  Team Manager – Distributed Systems Project Managers
  Service Enablement & Deployment – Telecom Account (2001-2002)
  NZ Manager – Customer Solutions Office, Implementation Services Group (2002)
  Team Manager – Distributed Systems Project Managers
  Business Manager - Solutions Delivery Group – Telecom Account (2000-2001)
- **ICT and Business Consultant** - Communication Services (1999 - present)
- General Manager – Development - **QED Software Ltd** (1999)
- Information Services Manager - **Sky City Ltd** (1995 - 1999)
- **Auckland Institute of Technology (AIT)**
  - Head of IT Development, Faculty of Commerce (1994-1995)
  - Head of Computer Studies Dept (1990-1994)
  - MIS Manager (1989-1990)
  - Lecturer/Senior Lecturer/Principal Lecturer in IT (1976-1989)
- **Computer programmer,** Operator, Systems Designer, Systems Analyst, Trainer, pre and post sales consultant - various IT companies in the U.K. and NZ (1969-1975)

Primary research activities:

- Use of ICT in a variety of business environments, and associated issues.

Other Professional Activities

- **Fulbright Scholar** to the USA (1998- - 1990) - investigate developments in the use of IT for academic and administrative support within Universities and Community Colleges)
- Academic Study Leave (March - May 1994)
  WCL (World Communications Laboratory Secretariate), on a study of Courseware and Hypermedia developments within the NZ education environment.
- **Senior Examiner** (South Pacific), Systems Analysis & Design for the BCS (1983 - 2002)
- Member of **NZ Government Task Force** (1985) to evaluate tenders for a comprehensive computer-based finance system for the NZ Polytechnic sector.

Don Robertson, MNZCS

- Director/Senior Consultant
- President, NZ Computer Society
- Member, Wellington Chamber of Commerce

Qualifications:

- NZIM Advanced Management Diploma
- Target Account Selling Methodology
- Project Management Methodologies

Summary:

Don has worked for 36 years in the IT industry including 2 years in UK & Europe (ICL) and 2 years in Australia (DEC). His career in the IT industry began in 1971 and his primary focus has been the delivery of exceptional service to customers. Don's roles have included all facets of the IT industry covering: Sales & Marketing, Executive Management, Business & IT Consulting, Programme, Project & Development Management, Security, Technical.

Work History:

- 2000-Present owner ROBERTSON LOGIC Ltd: Director & Senior Consultant & owner/Director & Marketing & Development Manager for Aliquando Ltd.
- 1998-2000 for COMTEX Group: Business Development Manager for ACC facilities management.
- 1993-1998 for DIGITAL EQUIPMENT Corporation: General Manager Compaq Alliance, Programme Change Manager, NZ Service Country Manager, Branch Manager.
- 1989-1993 for GCS Ltd: Marketing & Business Manager Distributed Systems.
- 1989-1989 for ELECTRONIC COMPONENTS Ltd: Wellington Branch & Sales Manager
- 1984- 1989 for DATACOM EQUIPMENT Ltd: National Customer Service Manager & National Marketing Manager
- 1970- 1984 for INTERNATIONAL COMPUTERS Ltd: Logistics Manager, Service Desk Manager, Project Manager and various Technical Engineering and support roles

Most Recent Projects:

- Implementation of PMO for Meridian Energy
- Programme Manager Meridian Energy
- Project Manager Web application Meridian Energy
- Revise Business Continuity plans NZRS
- Outsource Contract Renegotiation NZRS
- Supplier Performance Review NZRS
- Security policy/procedures for NZRS
- Setup new Software Company Aliquando Ltd
- RFI/RFP Outsourced Services and Contract development/negotiation consulting for NZRS.

Professor Wai Albert Yeap, PhD (AI, Essex), B.Sc. (Hons), (Computer Systems, Essex)

- **Professional Affiliations/Memberships**

  Royal Society of NZ (member)

  NZ Computer Society (Fellow)

  Association for the Advancement of Artificial Intelligence (member)

- **Present Appointments**

  Assoc Head, School of Computing & Mathematical Sciences, AUT, Feb 2007 – present

  Hon. Professor, University of Tunku Abdul Rahman, Malaysia – Dec 2006 - present

  Professor of Information Technology, School of IT, AUT, Aug 2000 – present

  Director, Centre for AI Research, AUT, 2007 – present

  Member, Advisory Board, AUT Technology Park, 2002 – present

- **Previous Appointments**

  Visiting Professor, Department of Artificial Intelligence, University of Malaya –2007-April 2008

  Director, Institute for IT Research, AUT, 2002 – 2006

  Visiting Professor, School of Computing, National University of Singapore, 1999/2000

  Visiting Professor, Dept of Computer Science, JiNan University, China, Oct, 1998

  Senior Lecturer, University of Otago/Department of Computer Science, 1994 to 2000

  Lecturer, University of Otago/ Department of Computer Science, 1985-1993

  Lecturer, University of Essex /Department of Computer Science, 1984

- **Research Projects (brief summary)**

  inexact reasoning, medical expert systems, cognitive maps/robotics, vision, intelligent tutoring systems, natural language, concept formation and mind research.

  developed a computational theory of how humans compute a representation of their environment

  current main research work is to develop a new theory of language comprehension and to use that as a new platform for developing new technology. The theory is concerned with how humans acquire their first language.

- **International Recognitions**

  Conference Co-chair, Australasian Conference on AI, Auckland, Dec 2008.

  Member, Editorial Board, Spatial Cognition and Computation Journal 2008-2012

  Keynote Speaker: International Conference on Robotics, Vision, Information and Signal Processing (ROVISP), from 29-30 Nov. 2007, at Park Royal Hotel, Penang

  Member, Editorial Board, International Journal of Information and Communication Technology since 2007

  Chair of the Steering Committee for the Pacific Rim International Conference on AI. 2004-present.

  Conference Co-chair, Pacific Rim International Conference on AI, Auckland, NZ, August 2004

  Organising Chair, A Workshop on Robotics & Cognitive Approaches to Spatial Mapping, Auckland University of Technology, February, 2002

  Area of Research Excellence Award at the University of Otago for the years 1998-2000

  Steering Committee Member for the Pacific Rim International Conference on Artificial Intelligence, 1990 – present (a biannual conference)

  Plenary speaker, International Conference on Advanced Investment Technology, 1999

  Best paper Award, European Meeting on Cybernetics and Systems Research, 1990.

Appendix C: National Qualifications Framework (NQF) Levels of Achievement

(referenced on 22/1/2008) http://www.nzqa.govt.nz/framework/levels.html

C1 Level descriptors

There are ten levels involved in a qualification - 1 is the least complex and 10 the most. Levels depend on the complexity of learning. They do not equate to 'years spent learning' but reflect the content of the qualification.

Year/ TC lvl	NQF LEVEL	PROCESS	LEARNING DEMAND	RESPONSIBILITY
Year 10/12? (Fm 4-6?) TC Level 6	NQF 1	**Carry out processes that:** • are limited in range • are repetitive and familiar • are employed within closely defined contexts	**Employing:** • recall • a narrow range of knowledge and cognitive skills • no generation of new ideas	**Applied:** • in directed activity • under close supervision • with no responsibility for the work or learning of others
Year 11/13? (Form 5-7) TC Level 7	NQF 2	**Carry out processes that:** • are moderate in range • are established and familiar • offer a clear choice of routine responses	**Employing:** • basic operational knowledge • readily available information • known solutions to familiar problems • little generation of new ideas	**Applied:** • in directed activity • under general supervision and quality control • with some responsibility for quantity and quality • with possible responsibility for guiding others
Year 12/13? (Form 6-7) TC Level 8	NQF 3	**Carry out processes that:** • require a range of well developed skills • offer a significant choice of procedures • are employed within a range of familiar contexts	**Employing:** • some relevant theoretical knowledge • interpretation of available information • discretion and judgement • a range of known responses to familiar problems	**Applied:** • in directed activity with some autonomy • under general supervision and quality checking • with significant responsibility for the quantity and quality of output • with possible responsibility for the output of others

Year 13? (Form 7) Post Secondary school Certificate Diploma Pre-degree	NQF 4	**Carry out processes that:** • require a wide range of technical or scholastic skills • offer a considerable choice of procedures • are employed in a variety of familiar and unfamiliar contexts	**Employing:** • a broad knowledge base incorporating some theoretical concepts • analytical interpretation of information • informed judgement • a range of sometimes innovative responses to concrete but often unfamiliar problems	**Applied:** • in self-directed activity • under broad guidance and evaluation • with complete responsibility for quantity and quality of output • with possible responsibility for the quantity and quality of the output of others
First year undergrad degree level	NQF 5	**Carry out processes that:** • require a wide range of specialised technical or scholastic skills • involve a wide choice of standard and non-standard procedures • are employed in a variety of routine and non-routine contexts	**Employing:** • a broad knowledge base with substantial depth in some areas • analytical interpretation of a wide range of data • the determination of appropriate methods and procedures in response to a range of concrete problems with some theoretical elements	**Applied:** • in self-directed and sometimes directive activity • within broad general guidelines or functions • with full responsibility for the nature, quantity and quality of outcomes • with possible responsibility for the achievement of group outcome.
Second year undergrad degree level	NQF 6	**Carry out processes that:** • require a command of wide-ranging highly specialised technical or scholastic skills • involve a wide choice of standard and non-standard procedures, often in non-standard combinations • are employed in highly variable routine and non-routine contexts	**Employing:** • specialised knowledge with depth in more than one area • the analysis, reformatting and evaluation of a wide range of information • the formulation of appropriate responses to resolve both concrete and abstract problems	**Applied:** • in managing processes • within broad parameters for defined activities • with complete accountability for determining and achieving personal and/or group outcomes
Third year undergrad degree level	NQF 7	**Carry out processes that:** • require a command of highly specialised technical or scholastic and basic research skills across a major discipline • involve the full range of procedures in a major discipline • are applied in complex, variable and specialised contexts	**Requiring:** • knowledge of a major discipline with areas of specialisation in depth • the analysis, transformation and evaluation of abstract data and concepts • the creation of appropriate responses to resolve given or contextual abstract problems	**Applied:** • in planning, resourcing and managing processes • within broad parameters and functions • with complete accountability for determining, achieving and evaluating personal and/or group outcomes

Postgrad degree (Masters) PG Dip	NQF 8	**Involves skills and knowledge that enable a learner to:** • provide a systematic and coherent account of the key principles of a subject area; and • undertake self-directed study, research and scholarship in a subject area, demonstrating intellectual independence, analytic rigour and sound communication
Postgrad degree (Masters) PG Dip	NQF 9	**Involves knowledge and skills that enable a learner to:** • demonstrate mastery of a subject area; and • plan and carry out - to internationally recognised standards - an original scholarship or research project. Demonstrated by: • The completion of a substantial research paper, dissertation or in some cases a series of papers.
PhD level	NQF 10	**Involves knowledge and skill that enable a learner to:** • Provide an original contribution to knowledge through research or scholarship, as judged by independent experts, applying international standards.

Appendix D: Technology curriculum achievement objectives

(http://nzcurriculum.tki.org.nz/the_new_zealand_curriculum/learning_areas/technology/technology_curriculum_achievement_objectives#level%201)

D1 TC Level 1

<table>
<tr>
<td>Intermediate School?</td>
<td>
Technological practice
Students will:
Planning for practice
Outline a general plan to support the development of an outcome, identifying appropriate steps and resources.
Brief development
Describe the outcome they are developing and identify the attributes it should have, taking account of the need or opportunity and the resources available.
Outcome development and evaluation
Investigate a context to communicate potential outcomes. Evaluate these against attributes; select and develop an outcome in keeping with the identified attributes.
Technological knowledge
Students will:
Technological modelling
Understand that functional models are used to represent reality and test design concepts and that prototypes are used to test technological outcomes.
Technological products
Understand that technological products are made from materials that have performance properties.
Technological systems
Understand that technological systems have inputs, controlled transformations, and outputs.
Nature of technology
Students will:
Characteristics of technology
Understand that technology is purposeful intervention through design.
Characteristics of technological outcomes
Understand that technological outcomes are products or systems developed by people and have a physical nature and a functional nature.
</td>
</tr>
</table>

D2 TC Level 2

Intermediate School?	**Technological practice** *Students will:* **Planning for practice** • Develop a plan that identifies the key stages and the resources required to complete an outcome. **Brief development** • Explain the outcome they are developing and describe the attributes it should have, taking account of the need or opportunity and the resources available. **Outcome development and evaluation** • Investigate a context to develop ideas for potential outcomes. Evaluate these against the identified attributes; select and develop an outcome. Evaluate the outcome in terms of the need or opportunity. **Technological knowledge** *Students will:* **Technological modelling** • Understand that functional models are used to explore, test, and evaluate design concepts for potential outcomes and that prototyping is used to test a technological outcome for fitness of purpose. **Technological products** • Understand that there is a relationship between a material used and its performance properties in a technological product. **Technological systems** • Understand that there are relationships between the inputs, controlled transformations, and outputs occurring within simple technological systems. **Nature of technology** *Students will:* **Characteristics of technology** • Understand that technology both reflects and changes society and the environment and increases people's capability. **Characteristics of technological outcomes** • Understand that technological outcomes are developed through technological practice and have related physical and functional natures.

D3 TC Level 3

Intermediate or lower Secondary school? Year 8 - 9?	**Technological practice** *Students will:* **Planning for practice** • Undertake planning to identify the key stages and resources required to develop an outcome. Revisit planning to include reviews of progress and identify implications for subsequent decision making. **Brief development** • Describe the nature of an intended outcome, explaining how it addresses the need or opportunity. Describe the key attributes that enable development and evaluation of an outcome. **Outcome development and evaluation** • Investigate a context to develop ideas for potential outcomes. Trial and evaluate these against key attributes to select and develop an outcome to address the need or opportunity. Evaluate this outcome against the key attributes and how it addresses the need or opportunity. **Technological knowledge** *Students will:* **Technological modelling** • Understand that different forms of functional modelling are used to inform decision making in the development of technological possibilities and that prototypes can be used to evaluate the fitness of technological outcomes for further development. **Technological products** • Understand the relationship between the materials used and their performance properties in technological products. **Technological systems** • Understand that technological systems are represented by symbolic language tools and understand the role played by the "black box" in technological systems. **Nature of technology** *Students will:* **Characteristics of technology** • Understand how society and environments impact on and are influenced by technology in historical and contemporary contexts and that technological knowledge is validated by successful function. **Characteristics of technological outcomes** • Understand that technological outcomes are recognisable as fit for purpose by the relationship between their physical and functional natures.

D4 TC Level 4

Lower secondary school Year 9 - 10? (Form 3/4?)	**Technological practice** *Students will:* **Planning for practice** • Undertake planning that includes reviewing the effectiveness of past actions and resourcing, exploring implications for future actions and accessing of resources, and consideration of stakeholder feedback, to enable the development of an outcome. **Brief development** • Justify the nature of an intended outcome in relation to the need or opportunity. Describe the key attributes identified in stakeholder feedback, which will inform the development of an outcome and its evaluation. **Outcome development and evaluation** • Investigate a context to develop ideas for feasible outcomes. Undertake functional modelling that takes account of stakeholder feedback in order to select and develop the outcome that best addresses the key attributes. Incorporating stakeholder feedback, evaluate the outcome's fitness for purpose in terms of how well it addresses the need or opportunity. **Technological knowledge** *Students will:* **Technological modelling** • Understand how different forms of functional modelling are used to explore possibilities and to justify decision making and how prototyping can be used to justify refinement of technological outcomes. **Technological products** • Understand that materials can be formed, manipulated, and/or transformed to enhance the fitness for purpose of a technological product. **Technological systems** • Understand how technological systems employ control to allow for the transformation of inputs to outputs. **Nature of technology** *Students will:* **Characteristics of technology** • Understand how technological development expands human possibilities and how technology draws on knowledge from a wide range of disciplines. **Characteristics of technological outcomes** • Understand that technological outcomes can be interpreted in terms of how they might be used and by whom and that each has a proper function as well as possible alternative functions.

D5 TC Level 5

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<tr>
<td>Secondary School

Years 10-12?

(Form 4-6)?</td>
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Technological practice
Students will:
Planning for practice
• Analyse their own and others’ planning practices to inform the selection and use of planning tools. Use these to support and justify planning decisions (including those relating to the management of resources) that will see the development of an outcome through to completion.
Brief development
• Justify the nature of an intended outcome in relation to the need or opportunity. Describe specifications that reflect key stakeholder feedback and that will inform the development of an outcome and its evaluation.
Outcome development and evaluation
• Analyse their own and others’ outcomes to inform the development of ideas for feasible outcomes. Undertake ongoing functional modelling and evaluation that takes account of key stakeholder feedback and trialling in the physical and social environments. Use the information gained to select and develop the outcome that best addresses the specifications. Evaluate the final outcome’s fitness for purpose against the brief.
Technological knowledge
Students will:
Technological modelling
• Understand how evidence, reasoning, and decision making in functional modelling contribute to the development of design concepts and how prototyping can be used to justify ongoing refinement of outcomes.
Technological products
• Understand how materials are selected, based on desired performance criteria.
Technological systems
• Understand the properties of subsystems within technological systems.
Nature of technology
Students will:
Characteristics of technology
• Understand how people’s perceptions and acceptance of technology impact on technological developments and how and why technological knowledge becomes codified.
Characteristics of technological outcomes
• Understand that technological outcomes are fit for purpose in terms of time and context. Understand the concept of malfunction and how “failure” can inform future outcomes.
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D6 TC Level 6

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NQF Level 1

Years 10 - 13?

(Form 4-6)?

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Technological practice

Students will:

Planning for practice

- Critically analyse their own and others' past and current planning practices in order to make informed selection and effective use of planning tools. Use these to support and justify ongoing planning that will see the development of an outcome through to completion.

Brief development

- Justify the nature of an intended outcome in relation to the need or opportunity and justify specifications in terms of key stakeholder feedback and wider community considerations.

Outcome development and evaluation

- Critically analyse their own and others' outcomes to inform the development of ideas for feasible outcomes. Undertake ongoing experimentation and functional modelling, taking account of stakeholder feedback and trialling in the physical and social environments. Use the information gained to select, justify, and develop a final outcome. Evaluate this outcome's fitness for purpose against the brief and justify the evaluation, using feedback from stakeholders.

Technological knowledge

Students will:

Technological modelling

- Understand the role and nature of evidence and reasoning when managing risk through technological modelling.

Technological products

- Understand how materials are formed, manipulated, and transformed in different ways, depending on their properties, and understand the role of material evaluation in determining suitability for use in product development.

Technological systems

- Understand the implications of subsystems for the design, development, and maintenance of technological systems.

Nature of technology

Students will:

Characteristics of technology

- Understand the interdisciplinary nature of technology and the implications of this for maximising possibilities through collaborative practice.

Characteristics of technological outcomes

- Understand that some technological outcomes can be perceived as both product and system. Understand how these outcomes impact on other outcomes and practices and on people's views of themselves and possible futures.

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D7 TC Level 7

NQF Level 2 Years 11-13? (Form 5-7)?	**Technological practice** *Students will:* **Planning for practice** • Critically analyse their own and others' past and current planning and management practices in order to develop and employ project management practices that will ensure the effective development of an outcome to completion. **Brief development** • Justify the nature of an intended outcome in relation to the issue to be resolved and justify specifications in terms of key stakeholder feedback and wider community considerations. **Outcome development and evaluation** • Critically analyse their own and others' outcomes and evaluative practices to inform the development of ideas for feasible outcomes. Undertake a critical evaluation that is informed by ongoing experimentation and functional modelling, stakeholder feedback, and trialling in the physical and social environments. Use the information gained to select, justify, and develop an outcome. Evaluate this outcome's fitness for purpose against the brief. Justify the evaluation, using feedback from stakeholders and demonstrating a critical understanding of the issue. **Technological knowledge** *Students will:* **Technological modelling** • Understand how the "should" and "could" decisions in technological modelling rely on an understanding of how evidence can change in value across contexts and how different tools are used to ascertain and mitigate risk. **Technological products** • Understand the concepts and processes employed in materials evaluation and the implications of these for design, development, maintenance, and disposal of technological products. **Technological systems** • Understand the concepts of redundancy and reliability and their implications for the design, development, and maintenance of technological systems. **Nature of technology** *Students will:* **Characteristics of technology** • Understand the implications of ongoing contestation and competing priorities for complex and innovative decision making in technological development. **Characteristics of technological outcomes** • Understand that technological outcomes are a resolution of form and function priorities and that malfunction affects how people view and accept outcomes.

D8 TC Level 8

NQF Level 3 Years 11-13? (Form 5-7)?	**Technological practice** *Students will:* **Planning for practice** • Critically analyse their own and others' past and current planning and management practices in order to develop and employ project management practices that will ensure the efficient development of an outcome to completion. **Brief development** • Justify the nature of an intended outcome in relation to the context and the issue to be resolved. Justify specifications in terms of key stakeholder feedback and wider community considerations. **Outcome development and evaluation** • Critically analyse their own and others' outcomes and fitness-for-purpose determinations in order to inform the development of ideas for feasible outcomes. Undertake a critical evaluation that is informed by ongoing experimentation and functional modelling, stakeholder feedback, trialling in the physical and social environments, and an understanding of the issue as it relates to the wider context. Use the information gained to select, justify, and develop an outcome. Evaluate this outcome's fitness for purpose against the brief. Justify the evaluation, using feedback from stakeholders and demonstrating a critical understanding of the issue that takes account of all contextual dimensions. **Technological knowledge** *Students will:* **Technological modelling** • Understand the role of technological modelling as a key part of technological development, justifying its importance on moral, ethical, sustainable, cultural, political, economic, and historical grounds. **Technological products** • Understand the concepts and processes employed in materials development and evaluation and the implications of these for design, development, maintenance, and disposal of technological products. **Technological systems** • Understand operational parameters and their role in the design, development, and maintenance of technological systems. **Nature of technology** *Students will:* **Characteristics of technology** • Understand the implications of technology as intervention by design and how interventions have consequences, known and unknown, intended and unintended. **Characteristics of technological outcomes** • Understand how technological outcomes can be interpreted and justified as fit for purpose in their historical, cultural, social, and geographical locations.

Appendix E: Selected Achievement standards to be Evaluated

E1 Achievement Standard AS90045 Version 3

Subject Reference	Technology 1.1		
Title	Develop an outcome through technological practice to address a given brief		
NQF Level 1	**Credits** 6	**Assessment**	Internal
Subfield	Technology		
Domain	Technology - General Education		
Status	Registered	**Status date**	18 December 2007
Planned review date	28 February 2009	**Date version published**	18 December 2007

This achievement standard involves the development of an outcome through informed planning to address a given brief.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Outline key stages and their resources in the development of an outcome. • Develop an outcome guided by planning, with evidence showing how essential requirements of the given brief are addressed.	• Review and refine key stages and the allocation of their resources in the development of an outcome. • Develop an outcome that is informed by planning. Present evidence that shows how the requirements of the given brief are addressed.	• Develop an outcome that is informed by ongoing planning and re-evaluation. Present evidence that shows how the requirements of the given brief are addressed, and how any interactions between factors are resolved in making key decisions.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum,* Learning Media, Ministry of Education, 1995, TC Level 6, and *Hangarau i roto i te Marautanga o Aotearoa,* Te Tahuhu o te Matauranga, 1999.

2 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and The Health and Safety in Employment Act 1992.

3 Further details of definitions listed below can be found at http://www.tki.org.nz/ncea.

4 *An outcome* is developed through undertaking technological practice for a specific purpose. This requires students to consider such things as:

- ongoing consideration of stakeholder opinions, brief refinement, research, idea design and development, ongoing planning, outcome development and evaluation
- environmental factors that may impinge on its development, including where the outcome will be finally located.

To develop an *outcome*, students will need to develop and apply knowledge and skills that are specific to the context in which the outcome is developed.

5 An outcome must be presented using one of the following:

- working model
- prototype
- finished product example.

6 *Planning* is used to inform the technological practice undertaken to develop an outcome. Planning must reflect the dynamic and evolving nature of this development, incorporating ongoing evaluation and subsequent modifications/refinement of both the practice and the outcome. Its form therefore will be dependent on the nature of the technological practice being undertaken and could change significantly during a project.

During development work, ongoing planning should be undertaken and changes made to allow the remaining time and resources to be used to achieve the desired technological outcome.

Planning sets out how key resources (which may include, but are not limited to, time, expertise, materials and finance) will be used efficiently during the development of a technological outcome. It establishes key milestones (intermediate project accomplishment points that are usually also key decision points), and states how each resource is *used* to achieve each milestone stage. It also establishes how consultation with stakeholders will be carried out to ensure that all constraints and requirements are met.

Evidence of planning needs to be demonstrated throughout the student's entire technological practice. Planning tools may include plans of action, Gantt charts, flow charts, block sequence diagrams, journal notes.

7 A *given brief* is one presented to the students. The given brief may require refinement during the undertaking of technological practice to allow an outcome that is fit for purpose to be developed.

A *brief* is a clear description of both the desirable outcomes sought and the constraints to be met by a successful outcome. A brief commences with a conceptual statement of the need, issues or opportunity being addressed, but also contains the detailed specifications against which the success or otherwise of the outcome can be tested. Ideally, the brief is fully researched and defined in advance of development of the outcome, but often, as the development work proceeds, the knowledge and understanding of the technologist improves and therefore *refinements* (usually improvements) are made to the brief and its specifications.

8 *Develop* includes all aspects of technological practice. Develop may include such things as: interactions with key stakeholders, brief refinement, research, idea design and development, ongoing planning, outcome development, evaluation. This encompasses the three interrelated strands of *Technology in the New Zealand Curriculum*.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by NZQA before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E2 Achievement Standard AS90046 Version 3

Subject Reference	Technology 1.2		
Title	Formulate a brief to address a given issue		
NQF Level 1	**Credits** 6	**Assessment**	Internal
Subfield	Technology		
Domain	Technology - General Education		
Status	Registered	**Status date**	18 December 2007
Planned review date	28 February 2009	**Date version published**	18 December 2007

This achievement standard involves identifying key factors and their implications in relation to a given issue, exploring needs and/or opportunities arising out of the key factors, and formulating a brief for an outcome that addresses a selected need or opportunity.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Identify key factors and their main implications in relation to a given issue.	• Prioritise key factors, explaining their implications and main interactions in relation to a given issue.	• Prioritise key factors, explaining their implications and interactions, and justify the prioritisation in relation to a given issue.
• Use key factors to identify possible needs and/or opportunities.	• Use prioritised key factors to identify possible needs and/or opportunities.	• Use prioritised key factors to evaluate possible needs and/or opportunities.
• Formulate a brief that addresses a selected need or opportunity and the main implications of the identified key factors.	• Formulate a brief that addresses a selected need or opportunity and the implications of the prioritised key factors.	• Formulate a brief that clearly states all that is required to resolve the given issue.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995, TC Level 6, and *Hangarau i roto i te Marautanga o Aotearoa,* Te Tahuhu o te Matauranga, 1999.

2 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and The Health and Safety in Employment Act 1992.

3 Further details of definitions listed below can be found at http://www.tki.org.nz/ncea.

4 A *brief* is a clear description of both the desirable features sought and the constraints to be met by a successful outcome. A brief commences with a conceptual statement of the need, issues or opportunity being addressed, but also contains the detailed *specifications* against which the success or otherwise of the outcome can be tested. Ideally, the brief is fully researched and defined in advance of development of the outcome, but often, as the development work proceeds, the knowledge and understanding of the technologist improves and therefore *refinements* (usually improvements) are made to the brief and its specifications.

5 *Formulating a brief* includes all aspects of technological practice including such things as: identification of, and ongoing interactions with, key stakeholders; identifying needs and opportunities; research; identification of key factors and their implications; brief refinement. This encompasses the three interrelated strands of *Technology in the New Zealand Curriculum*.

6 The *given issue* associated with this achievement standard is to be one that is shared by a range of stakeholders, one of which may be the student. Suitable given issues will require students to consider the environment in which the outcome will be developed and situated, including the differing views and opinions of stakeholders.

7 *Key factors* are those that contribute both directly and indirectly to a given issue and include:
- broader factors, such as legal, social, cultural, political, environmental and economic, including consideration of global and future trends, and culture of technological innovation
- stakeholder factors, such as beliefs, ethics, values, ability to access knowledge and skills, and social position
- knowledge
- bases that relate to the given issue.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by NZQA before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E3 Achievement Standard AS90047 Version 3

Subject Reference	Technology 1.3		
Title	Develop an outcome by widening the use of an existing technology		
NQF Level 1	**Credits** 6	**Assessment**	Internal
Subfield	Technology		
Domain	Technology - General Education		
Status	Registered	**Status date**	18 December 2007
Planned review date	28 February 2009	**Date version published**	18 December 2007

This achievement standard involves identifying needs and/or opportunities and related key factors in order to develop an outcome that widens the use of an existing technology.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Identify possible needs and/or opportunities and related key factors for the widening of the use of an existing technology. • Develop an outcome to address the essential requirements of the brief that widens the use of an existing technology.	• Prioritise possible needs and/or opportunities and related key factors for the widening of the use of an existing technology. • Develop an outcome that addresses the requirements of the brief that widens the use of an existing technology. Discuss the outcome in terms of its potential future impact.	• Evaluate possible needs and/or opportunities for the widening of the use of an existing technology. • Develop an outcome that addresses the requirements of the brief that widens the use of an existing technology. Evaluate the outcome for its potential future impact.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995, TC Level 6, and *Hangarau i roto i te Marautanga o Aotearoa,* Te Tahuhu o te Matauranga, 1999.

2 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and The Health and Safety in Employment Act 1992.

3 Further details of definitions listed below can be found at http://www.tki.org.nz/ncea.

4 *Widen the use of an existing technology* requires students to develop an outcome that adapts, modifies or integrates existing technology(ies) into a new outcome.

5 For the purposes of this achievement standard, *existing technologies* refer to either technological products, eg, a hairdryer, hangi food, vacuum flask, and database, or their components, eg, the heating coil of the hairdryer, the system of cooking the hangi food, the insulation system of the vacuum flask, and the computer program for the database.

6 *Develop* includes all aspects of technological practice. Develop may include such things as: interactions with key stakeholders, identification of key factors and their implications, identification of needs and opportunities, brief refinement, research, idea design and development, ongoing planning, outcome development, evaluation. This encompasses the three interrelated strands of *Technology in the New Zealand Curriculum*.

7 An *outcome* is developed through undertaking technological practice for a specific purpose. This requires students to consider things such as:
- ongoing consideration of stakeholder opinions, brief refinement, research, idea design and development, ongoing planning, outcome development and evaluation
- environmental factors that may impinge on its development, including where the outcome will be finally located.

To develop an *outcome*, students will need to develop and apply knowledge and skills that are specific to the context in which the outcome is developed.

8 An *outcome* must be presented using one of the following:
- simulation, eg computer model, scale working model
- working model
- prototype
- finished product example.

9 *Key factors* are those that contribute both directly and indirectly to the existing technology and include:
- broader factors, such as legal, social, cultural, political, environmental and economic, including consideration of global and future trends, and culture of technological innovation
- stakeholder factors, such as beliefs, ethics, values, ability to access knowledge and skills, and social position
- knowledge bases underpinning the development and use of the given technology.

10 A *brief* is a clear description of both the desirable outcomes sought and the constraints to be met by a successful outcome. A brief commences with a conceptual statement of the need, issues or opportunity being addressed, but also contains the detailed *specifications* against which the success or otherwise of the outcome can be tested. Ideally, the brief is fully researched and defined in advance of development of the outcome, but often, as the development work proceeds, the knowledge and understanding of the technologist improves and therefore *refinements* (usually improvements) are made to the brief and its specifications.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by NZQA before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference	0226

E4 Achievement Standard AS90048 Version 3

Subject Reference	Technology 1.4
Title	Develop a means for ongoing production of an outcome developed through technological practice
NQF Level 1	**Credits** 6 **Assessment** Internal
Subfield	Technology
Domain	Technology - General Education
Status	Registered **Status date** 18 December 2007
Planned review date	28 February 2009 **Date version published** 18 December 2007

This achievement standard involves identifying a means to allow for the ongoing production of an outcome.

Achievement Criteria

Achievement	**Achievement with Merit**	**Achievement with Excellence**
• Identify key factors that underpin the suitability of an outcome for ongoing production and make design adjustments to ensure its suitability.	• Identify and describe key factors that underpin the suitability of an outcome for ongoing production and make design adjustments to ensure its suitability.	• Identify and describe key factors that underpin the suitability of an outcome for ongoing production and make design adjustments to ensure its suitability.
• Formulate a brief for the ongoing production of the outcome.	• Use understanding of identified key factors in the formulation of a brief that addresses the need for the ongoing production of the outcome.	• Use understanding of the interrelationships between identified key factors in the formulation of a brief that addresses the constraints imposed by the need for ongoing production of the outcome.
• Identify the stages of, and a means to allow for, the ongoing production of an outcome.	• Explain the stages of, and a means to allow for, the ongoing production of an outcome and how these address the requirements of the brief.	• Justify the stages of, and a means to allow for, the ongoing production of an outcome and how these address the requirements of the brief.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995, TC Level 6, and *Hangarau i roto i te Marautanga o Aotearoa,* Te Tahuhu o te Matauranga, 1999.

2 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and The Health and Safety in Employment Act 1992.

3 Further details of definitions listed below can be found at http://www.tki.org.nz/ncea.

4 In developing a *suitable* means for ongoing production, the design of the outcome will need to be revisited. This will include such things as its method of construction, and the materials used in its construction.

5 A *brief* is a clear description of both the desirable outcomes sought and the constraints to be met by a successful outcome. A brief commences with a conceptual statement of the need, issues or opportunity being addressed, but also contains the detailed *specifications* against which the success or otherwise of the outcome can be tested. Ideally, the brief is fully researched and defined in advance of development of the outcome, but often, as the development work proceeds, the knowledge and understanding of the technologist improves and therefore *refinements* (usually improvements) are made to the brief and its specifications.

6 *Means to allow for ongoing production* includes consideration of procedures for uniformity of quality, tolerance for variations, and organisation of the production process, eg equipment needs, labour needs, material supplies, economic viability and regulatory compliance. The ongoing production process may be presented using annotated flow charts, layout diagrams and written explanations.

7 *Key factors* that determine the suitability of an outcome for ongoing production include such things as:

- the design features of the outcome, eg selection of materials, satisfaction of the target market, aesthetic appeal, consideration of ergonomics
- resource implications, eg labour needs, materials, energy requirements
- stakeholder factors, such as beliefs, ethics, values, and their desires for the outcome
- knowledge and skill bases that may underpin the ongoing production of the outcome
- broader factors, such as legal, social, cultural, political, environmental and economic, including consideration of global and future trends, and culture of technological innovation.

Quality Assurance

- register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E5 Achievement Standard AS90049

Subject Reference Technology 1.5

Title Demonstrate understanding of technological knowledge

NQF Level 1 **Credits** 4 **Assessment** External

Subfield Technology

Domain Technology – General Education

Registration date 7 November 2003 **Date version published** 7 November 2003

Mode of Assessment Submitted Portfolio

This achievement standard involves the demonstration of understanding of relevant technological knowledge that has been accessed and applied in a technology programme.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Demonstrate understanding of relevant technological knowledge.	• Demonstrate in-depth understanding of relevant technological knowledge.	• Demonstrate in-depth understanding of a wide range of relevant technological knowledge.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995, TC Level 6, and *Hangarau i roto i te Marautanga o Aotearoa,* Te Tahuhu o te Matauranga, 1999.

2 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand schools,* Learning Media, Ministry of Education, 1998 and The Health and Safety in Employment Act 1992.

3 The evidence for this achievement standard is to be collated over time and presented for assessment. It is a collection of knowledge that the student has accessed and applied in their technology programme. This knowledge should be drawn from the three strands of the *Technology in the New Zealand Curriculum* (technological knowledge and understanding, technological capability, and technology and society). The evidence for this knowledge should be generated from the undertaking of technological practice.

4 *Relevant* means linked to the technology programme and informs the technological practice undertaken by the student. Informed technological practice requires students to process knowledge for the purpose of aiding the development of their technological outcome. This includes the accessing, selection and application of knowledge throughout their technological practice.

5 *Technological knowledge* includes:

- *conceptual* technological knowledge, which is knowledge 'of and about' technology, eg an awareness 'of' the existence 'of' a product and 'about' the principles underpinning how it works
- *procedural* technological knowledge, which is knowledge of 'how to do' or 'how to use'.

6 Evidence of understanding of *technological knowledge* includes awareness of the existence of legislation, regulations, codes of practice and codes of ethics, and understanding of the constraints they impose.

7 Further details of definitions that relate to this achievement standard can be found at http://www.tki.org.nz/ncea.

8. **Format of assessment**

- Candidates are required to submit a portfolio of work that could include a variety of media in any format up to a maximum size of A2.
- A portfolio is an organised collection of material that clearly communicates candidates' understanding of knowledge relevant to the achievement standard that is being assessed. Examples of this material could include such things as:
- research findings and their analysis
- photographic evidence of outcomes (such as mock-ups and prototypes that illustrate the knowledge that has underpinned the development of a technological outcome)
- knowledge of technological innovations and the two way interactions these have had with society
- graphical illustrations (eg computer graphics, design sketches and drawings, photographs, video clips)
- transcripts of audio conversations (not the audiotapes themselves)
- CD or other digital media
- visual diary.

The material submitted for assessment should be each candidate's own. It should clearly communicate the candidate's understanding in order to gain the NQF level 1 technology external achievement standard entered. Candidates may present evidence of understanding knowledge that comes from one or more units of work.

Where candidates are submitting evidence for assessment against more than one external standard it would be beneficial if the evidence presented for each standard is clearly identified.

Where evidence of candidates' technological outcome helps to demonstrate understanding of knowledge, then evidence of the outcome should be included. This does not need to be the outcome itself but could be in the form of photographs/short video clips, which show the development of the outcome as well as the outcome itself.

The use of teacher-directed worksheets to record student evidence, while appropriate for teaching purposes, may constrain the candidate evidence submitted for external assessment. Evidence submitted for assessment should be such that the assessors can be confident that they are making a judgement about an individual candidate's understandings. Teachers need to be mindful of this when using such templates in technology units/programmes. Information from sources other than their own such as; photocopied notes and teacher handouts, findings from other candidates and information from the Internet and/or texts, should have their source acknowledged within the submitted evidence presented for assessment.

Authenticity

Schools are required to verify that the material presented for external assessment is each candidate's own. Teachers and candidates are required to complete and sign an Authenticity Form. A copy of this form can be found on the technology page of the NZQA website at www.nzqa.govt.nz/ncea/assessment/resources/technology/index.html

Special notes

Evidence presented should be a collection of knowledge that candidates have accessed and applied in their technology programme. The evidence submitted should be generated from the undertaking of technological practice and will include knowledge drawn from the three stands of the technology curriculum (technological knowledge and understanding, technological capability, and technology and society).

This evidence should demonstrate that candidates have understandings of:

- relevant knowledge
- relevant legislation and regulations
- relevant codes of practice and codes of ethics and the constraints they impose. Both conceptual (knowledge of and about technology) and procedural (knowledge about how to do or how to use) technological knowledge should be demonstrated in this evidence. The evidence presented for this achievement standard may include such things as:
- portfolios documenting candidates technological practice
- draft books/journals
- photo evidence of mock ups
- photo evidence that shows the development of the outcome
- photo evidence (either as printouts or on CD) of final outcome
- evidence generated on computer technologies (eg computer simulations, web pages, databases, graphic images)
- video / transcript of audiotapes.

Some examples of the opportunities candidates have to access and demonstrate the use of technological knowledge can be found on the technology webpage of the NZQA website at www.nzqa.govt.nz/ncea/assessment/resources/technology/index.html

To gain achievement with excellence, a wide range of in-depth knowledge associated with a context/issue should have been considered in the development of the outcome. It is the accumulation of a wide range of in-depth knowledge associated with a context/issue, which allows candidates to make informed and justifiable decisions at an excellence level. For example, candidates demonstrating understandings of in-depth knowledge within their practice could compare two or three materials, the most suitable material being selected because of its properties, suitability for the identified application and/or location, as well as its ability to meet other key factors such as cost.

The evidence for this standard may come from a number of units undertaken throughout the programme or may be drawn from the same unit of work as that used to provide evidence for achievement standard 90051.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference	0226

E6 Achievement Standard AS90050 Version 4

Subject Reference	Technology 1.6		
Title	Present an outcome developed through technological practice that addresses the requirements of a brief		
NQF Level 1	**Credits** 4	**Assessment**	Internal
Subfield	Technology		
Domain	Technology - General Education		
Status	Registered	**Status date**	18 December 2007
Planned review date	28 February 2009	**Date version published**	18 December 2007

This achievement standard involves the presentation of an outcome, with supporting documentation, to show that the outcome addresses the essential requirements of a brief.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Present an outcome, with supporting documentation, to show that the outcome addresses the essential requirements of a brief.	• Present a quality outcome, with supporting documentation, to show that the outcome addresses the requirements of a brief.	• Present a high-quality outcome, with supporting documentation, to show that the outcome addresses the requirements of a brief.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Ministry of Education, 1995, TC Level 6, and *Hangarau i roto i te Marautanga o Aotearoa,* Te Tahuhu o te Matauranga, 1999.

2 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and The Health and Safety in Employment Act 1992.

3 Evidence for this achievement standard will involve the student presenting a brief (including specifications of the stakeholder requirements), a self-produced final product (or its representation), and supporting documentation of the evaluation and analysis of the product against the brief. The brief may be provided by the teacher or developed by the student.

4 Further details of definitions listed below can be found at http://www.tki.org.nz/ncea.

5 An *outcome* is one that is developed through undertaking technological practice for a specific purpose. This requires students to consider such things as:

- ongoing consideration of stakeholder opinions, brief refinement, research, idea design and development, ongoing planning, outcome development and evaluation
- environmental factors that may impinge on the outcome of its development, including where the outcome will be finally located.

To develop an *outcome*, students will need to develop and apply knowledge and skills that are specific to the context in which the outcome is developed.

6 A *brief* is a clear description of both the desirable features sought and the constraints to be met by a successful outcome. A brief commences with a conceptual statement of the need, issues or opportunity being addressed, but also contains the detailed *specifications* against which the success or otherwise of the outcome can be tested. Ideally, the brief is fully researched and defined in advance of development of the outcome, but often, as the development work proceeds, the knowledge and understanding of the technologist improves and therefore *refinements* (usually improvements) are made to the brief and its specifications.

7 The *quality of the outcome* is judged in relation to the requirements of the brief. It is expected that the brief used is sufficiently demanding for a NQF Level 1 student. A *quality outcome* is one that is fit for the purpose for which it was intended and conforms to relevant codes of practice. A *high-quality outcome* is fit for the purpose for which it was intended, conforms to relevant codes of practice and, in addition, demonstrates such things as creativity, flair, elegance and innovation.

8 A *code of practice* is a set of recommendations for good practice developed and agreed by experienced practitioners, set at the appropriate level, in the technological area. Relevant codes of practice are those applicable to the community of practice associated with the development of the outcome.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by NZQA before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E7 Achievement Standard AS90051 Version 3

Subject Reference	Technology 1.7		
Title	Describe the interactions between a technological innovation and society		
NQF Level 1	**Credits** 4	**Assessment**	External
Subfield	Technology		
Domain	Technology - General Education		
Status	Registered	**Status date**	18 December 2007
Planned review date	28 February 2009	**Date version published**	18 December 2007

Mode of Assessment Submitted Portfolio (refer to AS4049 for a format description).

This achievement standard involves identifying key technological advance(s) underpinning an identified technological innovation, describing how societal factors have impacted on the technological innovation, and describing the impact of the technological innovation on society.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Identify the key technological advance(s) underpinning an innovation. • Describe the impact of societal factors on the direction of the development of the technological innovation. • Describe the impact of the technological innovation on society.	• Explain the key technological advance(s) underpinning an innovation. • Explain the two-way interaction between the ongoing development of the innovation and society, and how these shape (or have shaped) the evolution of the innovation.	• Explain the key technological advance(s) underpinning an innovation. • Analyse the two-way interaction between the ongoing development of the innovation and society to determine the key events and their impact on the evolution of the innovation, both to date and in likely future scenarios.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995, TC Level 6, and *Hangarau i roto i te Marautanga o Aotearoa,* Te Tahuhu o te Matauranga, 1999.

2 *Technological innovation* for this achievement standard refers to any technological outcome (product, system or environment) that influences the lives, lifestyles and environments of many individuals and communities. The *technological innovation* used for this achievement standard can be either recent or historical (covering a broader time span or area of interest), but must have had a significant impact on society.

3 In this achievement standard, a *societal factor* (and the use of the word 'society') is to be interpreted in the broadest sense to include environmental factors. Using this broad definition, societal factors that may influence the development of a technological innovation include:

- physical – geographical location, climate, natural and built environment
- socio-political – local, regional and national government systems, urbanisation, economic structures
- technological advances – miniaturisation of electronic components, new materials
- socio-cultural – religious affiliations, gender, ethnicity.

4 The context could include both New Zealand and global situations.

5 *Explain* means to describe with reason(s).

Quality Assurance

- Providers and Industry Training Organisations must be accredited by NZQA before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E8 NCEA NQF level 2 Assessment Specifications

General Information

Domain Technology
NQF Level 2
Mode of Assessment Submitted portfolio
For Year 2008
Submission Date 5 November 2008

This document contains the assessment specifications for achievement standards 90360, 90361, 90363, 90365, **90367**, 90371, 90373 and **90773**.

Format of the assessments
Candidates are required to submit a portfolio of work that could include a variety of media in any format up to a maximum size of A2.
A portfolio is an organised collection of material that clearly communicates candidates' understanding of knowledge relevant to their technological practice. Examples of this material includes such things as:

- research findings and their analysis
- artefacts (such as mock-ups and prototypes that illustrate the development of the technological solution
- photographic evidence of outcomes (such as mock-ups and prototypes that illustrate the knowledge that has underpinned the development of a technological solution)
- graphical illustrations (eg computer graphics, design sketches and drawings, photographs, video clips)
- transcripts of audio conversations (not the audiotapes themselves)
- CDs or other digital media
- visual diaries.

The material submitted for assessment should be each candidate's own. It should clearly communicate the candidate's understanding of knowledge and how it has informed their technological practice. Candidates may present evidence of understanding knowledge that comes from one or more units of work, and is used for assessment against more than one achievement standard. Where an outcome helps to demonstrate understanding of knowledge, evidence of the outcome may be included.
The assessors need to be confident they are making a judgement about an individual candidate's understanding at NQF level 2. Teachers should be careful about including teacher-directed worksheets for external assessment purposes.

Specific Information for Individual External Achievement Standards

Achievement Standard Number 90773
Candidates are expected to explore how the practices of technologist(s) within an identified setting(s) are influenced by their responsibilities to the wider community and to explain how this knowledge has impacted on their own technological practice.
Explanatory note 4 of the achievement standard provides some guidelines as to the range of operating practices that can be considered. This list is not definitive and candidates are encouraged

to explore operating practices relevant to their own technological practice. Candidates need to identify how the knowledge gained informs their own technological practice.
Teachers and/or candidates may identify the operating practices explored.
For achievement with excellence, candidates must demonstrate an understanding of the nature of the interaction between the operating practices of the technologist(s) and their responsibilities and how this knowledge has interacted with their own practice. Candidates will need to demonstrate how the quality of their outcome has been influenced by the interactions between operating practices and responsibilities to the wider community. The wider community includes living organisms and the environments they live in that might be affected by the practice of the technologist including the outcomes that they develop.

Achievement Standard Number 90367
In demonstrating understanding of technological knowledge in a specific area, it is expected that candidates will address an individually identified issue. Evidence presented will relate to their own technological practice. Technological knowledge underpinning the development of a technology outcome other than that of the candidate will be used to inform the candidate's own technological practice.

Technological knowledge that underpins the development of a technological outcome includes knowledge of:

- what key resources have been used and how and why they have been included; key resources may include:

- labour	- practicing technologists	- machines
- tools	- people	- time
- components	- materials	- techniques,

- technological principles and how these combine to enable the outcome to function to meet its specifications; aspects considered may include:

- fitness for purpose	- reliability	- optimisation
- ergonomics	- efficiency	- aesthetics,

For achievement with excellence, candidates should discuss the technological knowledge underpinning the development of at least two technology outcomes and demonstrate how the quality of their outcome has been influenced by the interactions between the knowledge gained and their practice.

E9 Achievement Standard AS90342 Version 2

Subject Reference	Information and Communication Technology 2.1
Title	Develop and model a conceptual design in information and communication technology

NQF level 2 **Credits** 6 **Assessment** Internal

Subfield Technology

Domain Technology – General Education

Registration date 18 January 2005 **Date version published** 18 January 2005

This achievement standard involves the formulation of a brief, and the use of planning, to develop and model a conceptual design to address an identified issue in information and communication technology.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Identify key factors and their implications in formulating a brief to address an identified issue. • Use planning to guide ongoing development work.	• Prioritise key factors, explaining their implications and interactions, in formulating a brief to address an identified issue. • Use planning to develop, review, and revise ongoing planning to aid the development work.	• Prioritise key factors, explaining their implications and interactions, in formulating a brief to address an identified issue. • Use planning to develop, review, and revise ongoing development work and to pre-empt anticipated problems and/or overcome actual problems and/or maximise opportunities.
• Use modelling media to develop and model a conceptual design and demonstrate its fitness for purpose to address the identified issue.	• Use modelling media to develop and model a conceptual design and demonstrate its fitness for purpose to address the identified issue and concerns of key stakeholders.	• Use modelling media to develop and model a conceptual design and demonstrate its fitness for purpose to address the identified issue and concerns of key stakeholders. Justify the viability of the conceptual design as a potential outcome.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995; TC Level 7, and *Hangarau i roto i te Marautanga o Aotearoa,* Te Tāhuhu o te Mātauranga, 1999.

2 Useful information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and in the Health and Safety in Employment Act 1992.

3 The *issue* needs to be identified by the student from a teacher-given context. The issue may be personal to the student, or one owned by others. This issue will generate a range of needs or opportunities for technological practice.

4 A *conceptual design* is a description of an intended technological outcome (product, system, or environment).

5 *Develop and model* includes all aspects of technological practice from the identification of the issue through to the modelling of the conceptual design. *Model* means to investigate and construct a representation to explain, explore, and test the characteristics sought in a fully developed conceptual design. Modelling can be used for ongoing evaluation throughout the development of a conceptual design.

6 *Modelling media* may include (but are not limited to) the following – two- or three-dimensional physical models (full-sized or scaled), computer simulations using a range of computer and audio-visual mediums, folios, OHTs, sketches with written explanatory notes.

7 A *brief* is a clear description of both the desirable outcomes sought and the constraints to be met by a successful technological outcome. A brief commences with a conceptual statement of the need, issues, or opportunity being addressed, and also contains the detailed specifications against which the success or otherwise of the outcome can be tested. Ideally, the brief is fully researched and defined in advance of development of the technological outcome but often, as the development work proceeds, the knowledge and understanding of the technologist improves sufficiently that refinements (usually improvements) are made to the brief and its specifications.

8 *Planning* is used to structure technological practice into manageable stages and establish key milestone dates and expected outcomes. Planning includes such things as identifying how key resources, which may include (but are not limited to) time, expertise, materials and finance, are allocated and used efficiently during the development of a technological outcome. Planning is critical to ensure that effective consultation with stakeholders will be carried out so that all constraints and requirements are met and/or opportunities are optimised. Tools that are used for planning will depend on the nature and the stage of the technological practice being undertaken. Planning tools include such things as plans of action, Gantt charts, flow charts, block sequence diagrams, journal notes.

Planning must reflect the dynamic and evolving nature of development work due to the ongoing evaluations and subsequent modifications and/or refinements. Regular reviews of planning tools should be undertaken and required changes made to ensure remaining time and resources are allocated to achieve the desired technological outcome.

9 Evidence of planning needs to be demonstrated throughout the student's entire technological practice.

10 *Key factors* are those that contribute both directly and indirectly to a specific technological practice and may include:

- broader factors, such as legal, social, cultural, political, environmental and economic factors including consideration of global and future trends, and culture of technological innovation
- stakeholder factors, such as beliefs, ethics, values, ability to access knowledge and skills, and social position
- knowledge and skills available that may underpin the development and use of the given technology.

11 *Viability of the conceptual design* refers to the capacity to meet the specifications of the brief, address possible social and environmental impact(s), meet likely future demand, and address availability of resources for its maintenance.

12 *Key stakeholders* are those stakeholders who have a vested interest in the identified issue.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E10 Achievement Standard AS90349 Version 2

Subject Reference		Information and Communication Technology 2.2			
Title		Develop and implement a one-off solution in information and communication technology			
NQF level	2	**Credits**	6	**Assessment**	Internal
Subfield	Technology				
Domain	Technology – General Education				
Registration date	18 January 2005	**Date version published**	18 January 2005		

This achievement standard involves the formulation of a brief, and the use of planning, to develop and implement a one-off solution to address an identified issue in information and communication technology.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Identify key factors and their implications in formulating a brief to address an identified issue. • Use planning to guide ongoing development work.	• Prioritise key factors, explaining their implications and interactions, in formulating a brief to address an identified issue. • Use planning to develop, review and revise ongoing development work.	• Prioritise key factors, explaining their implications and interactions, in formulating a brief to address an identified issue. • Use planning to develop, review and revise ongoing development work and to pre-empt anticipated problems and/or overcome actual problems and/or maximise opportunities.
• Develop and implement the one-off solution to demonstrate its fitness for purpose in addressing the issue.	• Develop and implement the one-off solution to demonstrate its fitness for purpose in addressing the issue and concerns of key stakeholders.	• Develop and implement the one-off solution to demonstrate its fitness for purpose in addressing the issue and concerns of key stakeholders. Justify the viability of the solution.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995; TC Level 7, and *Hangarau i roto i te Marautanga o Aotearoa*, Te Tāhuhu o te Mātauranga, 1999.

2 Useful information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools*, Learning Media, Ministry of Education, 1998; and in the Health and Safety in Employment Act 1992.

3 The *issue* needs to be identified by the student from a teacher-given context. The issue may be personal to the student, or one owned by others. This issue will generate a range of needs or opportunities for technological practice.

4 *One-off solution* means a solution for which the implementation of a single constructed solution fully resolves the issue. A one-off solution is a completed product, system, or environment.

5 *Develop and implement* includes all aspects of technological practice from the identification of the issue through to the implementation and evaluation of the one-off solution. *Implement* means to locate and test the solution in its intended environment to demonstrate its fitness for purpose.

6 A *brief* is a clear description of both the desirable outcomes sought and the constraints to be met by a successful technological outcome. A brief commences with a conceptual statement of the need, issues, or opportunity being addressed, and also contains the detailed specifications against which the success or otherwise of the outcome can be tested. Ideally, the brief is fully researched and defined in advance of development of the technological outcome but often, as the development work proceeds, the knowledge and understanding of the technologist improves sufficiently that refinements (usually improvements) are made to the brief and its specifications.

7 *Planning* is used to structure technological practice into manageable stages and establish key milestone dates and expected outcomes. Planning includes such things as identifying how key resources, which may include (but are not limited to) time, expertise, materials and finance, are allocated and used efficiently during the development of a technological outcome. Planning is critical to ensure that effective consultation with stakeholders will be carried out so that all constraints and requirements are met and/or opportunities are optimised. Tools that are used for planning will depend on the nature and the stage of the technological practice being undertaken. Planning tools include such things as plans of action, Gantt charts, flow charts, block sequence diagrams, journal notes.

Planning must reflect the dynamic and evolving nature of development work due to the ongoing evaluations and subsequent modifications and/or refinements. Regular reviews of planning tools should be undertaken and required changes made to ensure remaining time and resources are allocated to achieve the desired technological outcome.

8 Evidence of planning needs to be demonstrated throughout the student's entire technological practice.

9 *Key factors* are those that contribute both directly and indirectly to a specific technological practice and may include:

- broader factors, such as legal, social, cultural, political, environmental and economic factors including consideration of global and future trends, and culture of technological innovation
- stakeholder factors, such as beliefs, ethics, values, ability to access knowledge and skills, and social position
- knowledge and skills available that may underpin the development and use of the given technology.

10 *Viability of the one-off solution* refers to the capacity to meet the specifications of the brief, address possible social and environmental impact(s), meet likely future demand, and address availability of resources for its maintenance.

11 *Key stakeholders* are those stakeholders who have a vested interest in the identified issue. Key stakeholders will value and expect a high quality solution.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E11 Achievement Standard AS90367 Version 2

Subject Reference	Information and Communication Technology 2.6
Title	Examine technological knowledge in information and communication technology practice
NQF level 2	**Credits** 4 **Assessment** External
Subfield Technology	
Domain Technology – General Education	
Registration date 18 January 2005	**Date version published** 18 January 2005

Format of the assessments

Candidates are required to submit a portfolio of work that could include a variety of media in any format up to a maximum size of A2. A portfolio is an organised collection of material that clearly communicates candidates' understanding of knowledge relevant to their technological practice.

> This achievement standard involves examining technological knowledge underpinning the development of an information and communication technology outcome through identifying the knowledge and explaining how this knowledge informs one's own technological practice.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Identify the technological knowledge that underpins the development of an information and communication technology outcome. • Explain how this knowledge informs own technological practice in addressing an identified issue(s).	• Explain the technological knowledge that underpins the development of an information and communication technology outcome. • Explain how this knowledge informs own technological practice in addressing an identified issue(s).	• Discuss the technological knowledge that underpins the development of information and communication technology outcomes. • Discuss how this knowledge informs own technological practice in addressing an identified issue(s).

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995; TC Level 7, and *Hangarau i roto i te Marautanga o Aotearoa,* Te Tāhuhu o te Mātauranga, 1999.

2 Useful information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and in the Health and Safety in Employment Act 1992.

3 *Information and communication technology outcome* refers to that of a person or organisation other than the student.

4 The *issue* needs to be identified by the student from a teacher-given context. The issue may be personal to the student, or one owned by others. This issue will generate a range of needs or opportunities for technological practice.

5 Terms
Explain means describe in detail.
Discuss means compare and contrast.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E12 Achievement Standard AS90368 Version 2

Subject Reference Information and Communication Technology 2.7

Title Demonstrate skills in information and communication technology

NQF level 2 **Credits** 4 **Assessment** Internal

Subfield Technology

Domain Technology – General Education

Registration date 18 January 2005 **Date version published** 18 January 2005

This achievement standard involves demonstrating skills within an information and communication technology application when developing a technological outcome(s) to address an identified issue(s).

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Demonstrate skills within an information and communication technology application when developing a technological outcome(s).	• Demonstrate skills within different information and communication technology applications when developing a technological outcome(s). or Demonstrate skills within an information and communication technology application and use these to enhance the technological practice undertaken when developing a technological outcome(s) or the technological outcome(s) itself.	• Demonstrate skills within different information and communication technology applications and use these to enhance the technological practice undertaken when developing a technological outcome(s) or the technological outcome(s) itself.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995; TC Level 7, and *Hangarau i roto i te Marautanga o Aotearoa,* Te Tāhuhu o te Mātauranga, 1999.

2 Useful information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and in the Health and

Safety in Employment Act 1992.

3 *Applications,* in information and communication technology, refer to things such as:

- database programmes
- computer aided drafting programmes
- Three-dimensional (3D) modelling programmes
- webpage design programmes
- graphic enhancement programmes
- animation of two-dimensional (2D) and 3D models
- video/picture capturing, enhancement and reproduction technologies
- sound recording/creating technologies.

4 *Skills* within different information and communication technology applications includes such things as:

- accessing data
- conversion of data through manipulation (changing) data into useful information
- collation and synthesis of data.

5 The developed technological outcome(s) must address an identified issue. The *issue* needs to be identified by the student from a teacher given context. The issue may be personal to the student, or one owned by others. This issue will generate a range of needs or opportunities for technological practice.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E13 Achievement Standard AS90613 Version 2

Subject Reference		Technology 3.1			
Title		Develop a conceptual design to address a client issue			
NQF level	3	**Credits**	8	**Assessment**	Internal
Subfield	Technology				
Domain	Technology – General Education				
Registration date	18 January 2006	**Date version published**	22 February 2006		

This achievement standard involves the use of project management tools to support brief development, modelling, testing and evaluation of a conceptual design that addresses a client issue.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Identify key factors and their implications in developing a brief that addresses a client issue. • Use project management tools to guide development work. • Develop a conceptual design that addresses the requirements of the brief.	• Identify and prioritise key factors, explaining their implications and interactions, in developing a brief that addresses a client issue. • Use project management tools to review and revise the development work. • Develop a conceptual design that addresses the requirements of the brief.	• Identify and justify the prioritisation of key factors, explaining their implications and interactions, in developing a brief that addresses a client issue. • Use project management tools to review and revise the development work to pre-empt anticipated problems and/or overcome actual problems and/or maximise opportunities. • Develop a conceptual design that addresses the requirements of the brief.
• Use modelling to evaluate and demonstrate to the client how the conceptual design is potentially fit for purpose.	• Use modelling to evaluate, and demonstrate to the client and other key stakeholders, how the conceptual design is potentially fit for purpose.	• Use modelling to evaluate, and demonstrate to the client, other key stakeholders and wider community stakeholders, how the conceptual design is potentially fit for purpose.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995, TC Level 8; and *Hangarau i roto i te Marautanga o Aotearoa,* Te Pou Taki Kōrero, Te Tāhuhu o te Mātauranga, 1999.

2 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and the *Health and Safety Code of Practice for State Primary, Composite and Secondary Schools,* Learning Media, Ministry of Education, 1993.

3 *Key factors* are those that contribute both directly and indirectly to a specific technological practice and may include:

- client and other stakeholder factors such as beliefs, ethics, values, ability to access knowledge and skills, and social position
- broader factors such as legal, social, cultural, political, environmental and economic including consideration of global and future trends, and culture of technological innovation
- resource factors such as availability and accessibility of equipment, knowledge and skills.

4 Brief development entails:

- exploration and critical evaluation of a client issue to identify an authentic need or opportunity
- the development of an initial brief that identifies the constraints and opportunities on the conceptual design and the practice that can be undertaken to develop it. The initial brief should communicate the nature of the conceptual design(s) for the resolution or realisation of the identified need or opportunity
- identifying and accessing skills and knowledge that will be needed to refine the brief and fully investigate the identified opportunities and constraints with consideration of key and wider community stakeholder perspectives
- ongoing brief refinement and/or modification based on the student's developing understanding of the social and physical environment in which practice is undertaken, and in particular on feedback from key and wider community stakeholders. The student should develop an understanding of the need for the conceptual designs to be 'fit for purpose' in its broadest sense, and develop their brief in accordance with this
- development of a final brief that will provide specifications for the student, teacher, and key and wider community stakeholders and which includes a means of evaluating the conceptual design presented as being fit for purpose.

5 Fit for purpose is a term used to judge the ability of the conceptual design's potential to serve its purpose to 'do the job' within the intended location, where the 'job to be done' is clearly defined by the brief. Referring to potentially fit for purpose in its broadest sense within technology education, extends this usage to include the determination of the 'fitness' of the practices involved in the development of the conceptual design, as well as the 'fitness' of the outcome, should the conceptual design be implemented. Exploration of relevant codes of practice, legal requirements, and understandings of ethical and cultural ways of practising, will therefore be important aspects of establishing potential fit for purpose. In demonstrating fit for purpose the student is expected to incorporate and evaluate feedback

from relevant stakeholders.

6 A *client issue* is one that relates to a person or group. The client cannot be the student. However, if the client is representing a group, eg sports team manager, the student may be a non-leading member of this group, eg team member. The issue must generate a range of needs or opportunities for technological practice.

7 *Project management tools* are used to manage the overall technological development. This involves planning and effective communication between the student, client and other stakeholders.

8 The project management tools used will be dependent on the nature and the stage of the technological practice being undertaken. Tools could include such things as plans of action, Gantt charts, flow charts, block sequence diagrams, reflective journals, visual diaries, communication and management software.

9 A *conceptual design* describes an intended technological outcome (product, system or environment) and may be described using communicative tools such as 2D and 3D visual representations, written text, and oral communication.

10 *Modelling* a conceptual design involves the investigation and construction of a representation to explain, explore and evaluate the conceptual design idea against the specifications of the brief. Modelling can be used for ongoing trialing throughout the development of a conceptual design to test and evaluate aspects such as aesthetics, functionality, ergonomics and economic feasibility. Different models may need to be used to test different aspects. Modelling may use, but is not limited to, the following: two or three-dimensional physical models (full-sized or scaled) and computer simulations using a range of computer and audio-visual mediums.

11 *The client* is a key stakeholder. Other key stakeholders are those who are directly implicated in the development work, or would be directly impacted should the conceptual design be implemented. Wider-community stakeholders are those who are or may be indirectly implicated in the development work, or who would be impacted should the conceptual design be implemented.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E14 Achievement Standard AS90620 Version 2

Subject Reference		Technology 3.2			
Title		Develop a one-off solution to address a client issue			
NQF level	3	**Credits**	8	**Assessment**	Internal
Subfield	Technology				
Domain	Technology – General Education				
Registration date	18 January 2006	**Date version published**	22 February 2006		

This achievement standard involves the use of project management tools to support brief development, and the development, implementation and evaluation of a one-off solution that addresses a client issue.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Identify key factors and their implications in developing a brief that addresses a client issue. • Use project management tools to guide development work. • Develop a one-off solution that addresses the requirements of the brief.	• Identify and prioritise key factors, explaining their implications and interactions, in developing a brief that addresses a client issue. • Use project management tools to review and revise the development work. • Develop a one-off solution that addresses the requirements of the brief.	• Identify and justify the prioritisation of key factors, explaining their implications and interactions, in developing a brief that addresses a client issue. • Use project management tools to review and revise the development work to pre-empt anticipated problems and/or overcome actual problems and/or maximise opportunities. • Develop a one-off solution that addresses the requirements of the brief.
• Implement the one-off solution to evaluate and demonstrate to the client that it is fit for purpose.	• Implement the one-off solution to evaluate and demonstrate to the client, and any other key stakeholders that it is fit for purpose.	• Implement the one-off solution to evaluate and demonstrate to the client, and any other key and wider-community stakeholders, that it is fit for purpose, and to explore the viability of the solution.

Explanatory Notes

3 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995, TC Level 8; and *Hangarau i roto i te Marautanga o Aotearoa,* Te Pou Taki Kōrero, Te Tāhuhu o te Mātauranga, 1999.

4 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools*, Learning Media, Ministry of Education, 1998; and the *Health and Safety Code of Practice for State Primary, Composite and Secondary Schools,* Learning Media, Ministry of Education, 1993.

5 *Key factors* are those that contribute both directly and indirectly to a specific technological practice and may include:

- client and other stakeholder factors such as beliefs, ethics, values, ability to access knowledge and skills, and social position
- broader factors such as legal, social, cultural, political, environmental and economic including consideration of global and future trends, and culture of technological innovation
- resource factors such as availability and accessibility of equipment, knowledge and skills.

6 Brief development entails:

- exploration and critical evaluation of a client issue to identify an authentic need or opportunity
- the development of an initial brief that identifies the constraints and opportunities on the one-off solution and the practice that can be undertaken to develop it. The initial brief should communicate the nature of the one-off solution(s) for the resolution or realisation of the identified need or opportunity
- identifying and accessing skills and knowledge that will be needed to refine the brief and fully investigate the identified opportunities and constraints with consideration of key and wider community stakeholder perspectives
- ongoing brief refinement and/or modification based on the student's developing understanding of the social and physical environment in which practice is undertaken, and in particular on feedback from key and wider community stakeholders. The student should develop an understanding of the need for the one-off solution to be 'fit for purpose' in its broadest sense, and develop their brief in accordance with this
- development of a final brief that will provide specifications for the student, teacher, and key and wider community stakeholders and which includes a means of evaluating the one-off solution presented as being fit for purpose.

7 Fit for purpose is a term used to judge the ability of the one-off solution to serve its purpose to 'do the job' within the intended location, where the 'job to be done' is clearly defined by the brief. Referring to fit for purpose in its broadest sense within technology education extends this usage to include the determination of the 'fitness' of the practices involved in the development of the one-off solution, as well as the fitness of the one-off solution itself, for the identified purpose. Exploration of relevant codes of practice, legal requirements and understandings of ethical and cultural ways of practising, will therefore be important aspects of establishing fit for purpose. In demonstrating fit for purpose the student is expected to incorporate and evaluate feedback from relevant stakeholders.

8 A client issue is one that relates to a person or group. The client cannot be the student. However, if the client is representing a group, eg sports team manager, the student may be a non-leading member of this group, eg team member. The issue must generate a range of needs or opportunities for technological practice.

9 *Project management tools* are used to manage the overall technological development. This involves planning and effective communication between the student, client and other stakeholders.

10 The project management tools used will be dependent on the nature and the stage of the technological practice being undertaken. Tools could include such things as plans of action, Gantt charts, flow charts, block sequence diagrams, reflective journals, visual diaries, communication and management software.

11 *A one-off solution* is a technological outcome that is developed to meet the need or realise the opportunity as defined in the brief. Implementation of a one-off solution should be evaluated in terms of its fitness for purpose in addressing the identified client issue.

12 *The client* is a key stakeholder. Other key stakeholders are those who are directly implicated in the development work, or would be directly impacted by the implementation of the one-off solution. Wider-community stakeholders are those who are or may be indirectly implicated in the development work, or would be impacted by the implementation of the one-off solution.

13 *Viability* refers to such things as the sustainability of the one-off solution for the estimated life cycle in terms of the potential social and environmental impact, likely future demand, and the availability of resources for maintenance and disposal.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E15 Achievement Standard AS90676 Version 2

Subject Reference	Technology 3.4
Title	Describe technologists' responsibilities to the wider community
NQF level 3	**Credits** 4 **Assessment** External
Subfield	Technology
Domain	Technology – General Education
Registration date 18 January 2006	**Date version published** 22 February 2006

Assessment by submitted portfolio.

This achievement standard focuses on describing responsibilities (including legal, ethical and moral) to the wider community and the impact this has on the practice undertaken by different technologists.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Describe technologists' responsibilities to the wider community and the impact of these on their practice.	• Explain technologists' responsibilities to the wider community and the impact of these on their practice.	• Discuss technologists' responsibilities to the wider community and the impact of these on their practice.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995, TC Level 8; and *Hangarau i roto i te Marautanga o Aotearoa,* Te Pou Taki Kōrero, Te Tāhuhu o te Mātauranga, 1999.

2 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and the *Health and Safety Code of Practice for State Primary, Composite and Secondary Schools,* Learning Media, Ministry of Education, 1993.

3 A *technologist* is defined as a professional involved in the design and/or development of technological outcomes. The technologist cannot be the student. *Technologists* means two or more different technologists.

4 Responsibilities to the *wider community* include:
- legal responsibilities including:

- Acts (eg Fair Trading Act 1986, Consumer Guarantees Act 1993, Health and Safety in Employment Act 1992, Privacy Act 1993, Employment Relations Act 2000, Resource Management Act 1991, Hazardous Substances and New Organisms Act 1996)
- Standards (eg ISO standards – 9000, 14000 series, Standards New Zealand (SNZ) standards)

- ethical responsibilities including:
  - professional (eg stipulated by codes of ethics developed by professional associations)
  - cultural and/or religious protocols (eg in keeping with the accepted practices of cultures and religions)
- moral responsibilities driven by the beliefs and values of the technologist.

5 *Impacts of the responsibilities to the wider community on practice* may involve:
- appraisal of technologists' practice
- understanding of how operating practices, beliefs, values and ethics in the wider community promotes and/or constrains the technologists' practice.

6 *Explain* means describe in detail giving reasons.
Discuss means compare and contrast.

Quality Assurance
- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.
- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E16 Achievement Standard AS90684 Version 2

Achievement Standard

Subject Reference		Information and Communication Technology 3.6			
Title		Explain knowledge that underpins an information and communication technology outcome			
NQF level	3	**Credits**	4	**Assessment**	External
Subfield	Technology				
Domain	Technology – General Education				
Registration date	18 January 2006	**Date version published**	22 February 2006		

Assessment by submission of a portfolio of work.

This achievement standard involves explaining knowledge that underpins the development of an existing information and communication technology (ICT) outcome.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Explain the knowledge that underpins the development of an existing ICT outcome.	• Explain the underpinning knowledge and how it has been synthesised in the development of an existing ICT outcome.	• Discuss the underpinning knowledge and how it has been synthesised in the development of two or more existing ICT technology outcomes.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995, TC Level 8; and *Hangarau i roto i te Marautanga o Aotearoa,* Te Pou Taki Kōrero, Te Tāhuhu o te Mātauranga, 1999.

2 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and the *Health and Safety Code of Practice for State Primary, Composite and Secondary Schools*, Learning Media, Ministry of Education, 1993.

3 *An existing ICT outcome* is one that has been developed and implemented by a technologist(s). A *technologist* is defined as a professional involved in the design and/or development of a technological outcome. The student cannot be the technologist.

4 *Knowledge* that underpins the development of an existing ICT outcome includes such things as:

- knowledge of the key resources (including such things as people, time, components, and materials) that have been used
- knowledge of codes of practice, codes of ethics, and legislation
- knowledge from other disciplines, eg science, social science, arts
- techniques and procedures used to develop and implement the technological outcome.

5 *Explain* means describe in detail giving reasons.

Discuss means compare and contrast.

Synthesise refers to the ability to bring together knowledge, skills, ideas and methods from different sources to advance one's practice but not necessarily to produce a more complex outcome. This emphasis is about knowledge and the way it is used, not the quality of the outcome. Therefore, for achievement with merit or achievement with excellence, the student is able to demonstrate access to a wide variety of knowledge and the discerning use of knowledge relevant to the existing technological outcome.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E17 Achievement Standard AS90685 Version 2

Achievement Standard

Subject Reference		Information and Communication Technology 3.7			
Title		Demonstrate techniques in information and communication technology			
NQF level	3	**Credits**	4	**Assessment**	Internal
Subfield	Technology				
Domain	Technology – General Education				
Registration date	18 January 2006	**Date version published**	22 February 2006		

This achievement standard involves demonstrating techniques when developing an information and communication technology (ICT) outcome(s).

Achievement Criteria

Achievement	**Achievement with Merit**	**Achievement with Excellence**
• Demonstrate techniques when developing an ICT outcome(s).	• Demonstrate complex techniques when developing an ICT outcome(s).	• Demonstrate a combination of complex techniques that lead to a high quality ICT outcome(s).

Explanatory Notes

2 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995, TC Level 8; and *Hangarau i roto i te Marautanga o Aotearoa,* Te Pou Taki Kōrero, Te Tāhuhu o te Mātauranga, 1999.

3 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and the *Health and Safety Code of Practice for State Primary, Composite and Secondary Schools,* Learning Media, Ministry of Education, 1993.

4 *Techniques* in ICT refer to things such as:

- database programmes
- CAD programmes
- 3 dimensional (3D) modelling programmes
- webpage design programmes
- graphic enhancement programmes
- animation of 2 dimensional (2D) and 3D models
- video/picture capturing, enhancement and reproduction technologies
- sound recording/creating technologies
- producing a website or multi-media CD with effective navigation tools embedded to manage a range of data inputs, eg pictures, text, sound, animations, movies
- developing a multiple layout database incorporating scripts and/or calculations to aid the navigation or data summary/presentation
- using macros in a package interacting with data from an external database or source, eg another file or data logging device
- advanced computer programming, eg programming to control environment responsive systems
- producing a print media solution containing original graphics and text to a commercial standard, and suitable for commercial printing
- developing computer simulations
- creating complex 3D models, eg each 3D model includes a combination of elements such as multiple textures, animations to show function or form.

5 *Technique* refers to a combination of skills carried out in a particular order for a particular purpose. The selection of techniques is context specific. *Complex techniques* require a combination of techniques carried out in a particular order for a particular purpose.

6 A *high quality ICT outcome* is one that is fully fit for purpose, and in addition displays attributes that show a combination of complex techniques have been implemented successfully. 'Fit for purpose' is a term used to judge the ability of the ICT outcome to serve its purpose to 'do the job' within the intended location, where the 'job to be done' is clearly defined by the brief. Referring to 'fit for purpose' in its broadest sense within technology education, extends this usage to include the determination of the fitness of the practices involved in the development of the ICT outcome, as well as the fitness of the ICT outcome itself, for the identified purpose. Exploration of relevant codes of practice, legal requirements and understandings of ethical and cultural ways of racticing, will therefore be important aspects of establishing 'fit for purpose'. In demonstrating 'fit for purpose' the student is expected to incorporate and evaluate feedback from relevant stakeholders.

7 Techniques in ICT may be demonstrated in the production of models, prototypes, one-off solutions or products from multi-unit production.

8 Techniques performed need to be performed in keeping with relevant codes of practice that include:

- legal responsibilities including:
  - Acts (eg Fair Trading Act 1986, Consumer Guarantees Act 1993, Health and Safety in Employment Act 1992, Privacy Act 1993, Employment Relations Act 2000, Resource Management Act 1991, Hazardous Substances and New Organisms Act 1996)
  - Standards (eg ISO standards – 9000, 14000 series, Standards New Zealand (SNZ) standards)
- ethical responsibilities including:
  - professional (eg stipulated by codes of ethics developed by professional associations)
  - cultural and/or religious (eg in keeping with the accepted practices of cultures and religions)
- moral responsibilities driven by the beliefs and values of the technologist.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E18 Achievement Standard AS90773 Version 1

Subject Reference	Technology 2.4
Title	Examine how technological practice is influenced by responsibilities to the wider community

NQF level 2 **Credits** 4 **Assessment** External

Subfield Technology

Domain Technology – General Education

Registration date 18 January 2005 **Date version published** 18 January 2005

This achievement standard focuses on identifying operating practices that are influenced by technologist responsibilities to the wider community, and explaining how this knowledge informs one's own technological practice undertaken to address an identified issue(s).

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Identify operating practices that are influenced by technologist responsibilities to the wider community.	• Explain how operating practices are influenced by technologist responsibilities to the wider community.	• Discuss the interaction between operating practices and technologist responsibilities to the wider community.
• Explain how this knowledge informs own technological practice in addressing an identified issue(s).	• Explain how this knowledge informs own technological practice in addressing an identified issue(s).	• Discuss how this knowledge informs own technological practice in addressing an identified issue(s).

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995; TC Level 7, and *Hangarau i roto i te Marautanga o Aotearoa,* Te Tāhuhu o te Mātauranga, 1999.

2 Useful information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and in the Health and Safety in Employment Act 1992.

3 The *issue* needs to be identified by the student from a teacher-given context. The issue may be personal to the student, or one owned by others. This issue will generate a range of needs or opportunities for technological practice.

4 *Operating practices* are methods for carrying out technological practice that have either evolved within a community of practitioners (eg product developer, event manager, landscape designer, ICT systems developer) or are widely applicable across communities. They include practices such as:

- preparation of briefs
- project management, eg plans of action, Gantt charts and critical path analysis
- fostering innovation, eg focus groups, idea generation and screening
- prototype testing, eg surveys, trial marketing
- outcome manufacture
- implementation of technological outcomes, eg commissioning, acceptance testing, guarantees, and warranty periods.

5 Responsibilities to the wider community include:

- legal responsibilities including:
  - Acts (eg Fair Trading Act 1986, Consumer Guarantees Act 1993, Health and Safety in Employment Act 1992, Privacy Act 1993, Labour Relations Act 1995, Resource Management Act 1996, Hazardous Substances and New Organisms Act 1996)
  - Standards (eg ISO standards – 9000, 14000 series, Standards New Zealand (SNZ) standards)
- ethical responsibilities including:
  - professional (eg stipulated by codes of ethics developed by professional associations)
  - cultural and/or religious (eg in keeping with the accepted practices of cultures and religions)
- moral responsibilities driven by the beliefs and values of the technologist.

6 Terms
Explain means describe in detail.
Discuss means compare and contrast.

Replacement Information
This achievement standard replaced AS90359.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.

- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

E19 Achievement Standard AS90792 Version 1

Subject Reference Technology 3.3

Title Develop a proposal for a production process for a client

NQF level 3 **Credits** 6 **Assessment** Internal

Subfield Technology

Domain Technology – General Education

Registration date 18 January 2006 **Date version published** 22 February 2006

This achievement standard involves the development of a proposal for a production process for the multi-unit production of a client's one-off solution(s).

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
• Identify suitability of the client's one-off solution(s) for multi-unit production. Identify necessary design adaptations to the one-off solution(s) to ensure it is suitable for multi-unit production. • Identify key factors and their implications in developing a brief for the multi-unit production of a client's one-off solution(s).	• Identify suitability of the client's one-off solution(s) for multi-unit production. Identify and explain necessary design adaptations to the one-off solution(s) to ensure it is suitable for multi-unit production. • Identify and prioritise key factors, explaining their implications and interactions, in developing a brief for the multi-unit production of a client's one-off solution(s).	• Identify suitability of the client's one-off solution(s) for multi-unit production. Identify and justify necessary design adaptations to the one-off solution(s) to ensure it is suitable for multi-unit production. • Identify key factors and justify the prioritisation of key factors, explaining their implications and interactions, in developing a brief for the multi-unit production of a client's one-off solution(s).
• Identify a suitable mode of multi-unit production and describe the process stages. • Estimate resource requirements & their availability for the multi-unit production of a client's one-off solution(s). • Estimate the benefits and costs for the client.	• Identify and explain a suitable mode of multi-unit production and explain the process stages and feedback requirements. • Estimate and explain resource requirements and their availability for the multi-unit production of a client's one-off solution(s). • Estimate and explain the benefits and costs for the client and other key stakeholders.	• Identify and justify a suitable mode of multi-unit production and justify the process stages. Discuss the process stages in relation to feedback requirements and known and potential variables that require accurate management. • Estimate and justify resource requirements and discuss their availability for the multi-unit production of a client's one-off solution(s). • Estimate & discuss benefits & costs for the client, other key stakeholders and wider-community stakeholders. Predict process viability and critical factors for project success, & discuss means to minimise or maximise estimated impacts.

Explanatory Notes

1 This achievement standard is derived from *Technology in the New Zealand Curriculum*, Learning Media, Ministry of Education, 1995, TC Level 8; and *Hangarau i roto i te Marautanga o Aotearoa,* Te Pou Taki Kōrero, Te Tāhuhu o te Mātauranga, 1999.

2 Appropriate reference information is available in *Safety and Technology Education: A Guidance Manual for New Zealand Schools,* Learning Media, Ministry of Education, 1998; and the *Health and Safety Code of Practice for State Primary, Composite and Secondary Schools,* Learning Media, Ministry of Education, 1993.

3 The *client's one-off solution* may be a product or system that the client wishes to take into multi-unit production. The client cannot be the student. However, if the client is representing a group, eg sports team manager, the student may be a non-leading member of this group, eg team member.

4 Brief development entails:

- exploration and critical evaluation of the client's one-off solution(s) to identify its suitability for multi-unit production
- the development of an initial brief that identifies the constraints and opportunities on the mode of production and the processes needed to develop it!! identifying and accessing skills and knowledge that will be needed to refine the brief and fully investigate the identified opportunities and constraints with consideration of key and wider community stakeholder perspectives
- ongoing brief refinement and/or modification is based on the student's developing understanding of the social and physical environment in which practice is undertaken, and in particular on feedback from key and wider community stakeholders. The student should develop an understanding of the mode of production and the processes proposed for the multi-unit production of the client's one-off solution(s)
- development of a final brief that will provide specifications for the student, teacher, and key and wider community stakeholders, which includes a means of evaluating the proposal for multi-unit production of the client's one-off solution(s) as being fit for purpose.

5 *Modes of multi-unit production* includes batch production, continuous production, and semi-continuous production.

6 A *suitable mode of production* is one where the characteristics of the process match the requirements of the one-off solution and the social and physical environment where the production process will be sited.

7 Examples of:

- *Process stages* may include such things as storage, transport, delay, inspection, transformation operation, production management.
- *Variables* may include such things as temperature, volume, length, quantity of output, labour availability, protocols including cultural and professional.

8 *Resource requirements* are the quantities of the major resources (eg materials, energy, labour) required for the process to operate in an ongoing manner.

9 *Estimated benefits* refer to likely positive impacts from the production, distribution and/or sales of the units produced in terms of economic, social and environmental considerations. Examples of considerations include: economic – increased personal revenue, increased revenue in local/national economy; social – increased employment opportunities, enhanced quality of life due to product, increased cultural understandings through product line; environmental – impact of 'green' production, reducing waste and decreasing energy consumption.

Note: It is expected that the estimates will be approximate, but realistic.

10 *Estimated costs* refer to likely negative impacts from the production, distribution and/or sales of the units produced in terms of economic, social and environmental considerations. Examples of considerations include: economic – obtaining materials, equipment purchase and maintenance, energy and labour; social – rezoning of land, shift work impacts on family life, impact of new product on existing/competing market; environmental – noise, pollution, erosion, depletion of natural resources.

Note: It is expected that the estimates will be approximate, but realistic.

11 *Viability* refers to such things as the sustainability of the production process for its estimated life cycle in terms of its potential social and environmental impact, likely future demands and availability of resources for the maintenance of the production process.

12 The *client* is a key stakeholder. Other key stakeholders are those who are directly implicated in the development work, or who would be directly impacted by the implementation of the multi-unit production. Wider-community stakeholders are those who are or may be indirectly implicated in the development work, or who are or may be indirectly impacted by the implementation of the multi-unit production.

Replacement information

This achievement standard replaced AS90627.

Quality Assurance

- Providers and Industry Training Organisations must be accredited by the Qualifications Authority before they can register credits from assessment against achievement standards.
- Accredited providers and Industry Training Organisations assessing against achievement standards must engage with the moderation system that applies to those achievement standards.

Accreditation and Moderation Action Plan (AMAP) reference 0226

Appendix F: PPTA ICT Taskforce Sample Achievement Standards

F1 Sample Achievement Standard 1

Title	Demonstrate knowledge of computer systems		
NQF level 3	**Credits** 4	**Assessment**	External

This achievement standard requires students to demonstrate knowledge of computer systems and to compare past computer systems with contemporary computer systems.

Achievement Criteria

Achievement	Achievement with merit	Achievement with Excellence
Demonstrate knowledge of contemporary and past computer systems and the underlying technologies	Demonstrate knowledge of contemporary computer systems and the underlying technologies and compare with past systems	Demonstrate knowledge of contemporary and past computer systems and the underlying technologies and provide a detailed analysis of trends

Explanatory Notes

1. For the purposes of this standard a ‘computer system’ consists of the main hardware components of a personal computer system and interaction between the components; operating system software and applications software and their interaction; and the relationships between hardware, software, data, and information.
2. Demonstrating knowledge of computer systems includes providing details of:
   a. *Hardware* – includes but is not limited to – memory, central processing unit (CPU), motherboard, storage devices, monitor, keyboard, and mouse.
   b. *Software* – includes operating system software and applications software and their interaction
   c. *Data flow* between hardware components and the interactions that occur
3. *Contemporary* computer systems may include, but are not limited to computer systems that are currently in use by one or more rganizations in New Zealand in the current year such as personal computer systems, or portable computer systems (which may include handheld devices).
4. *Past* computer systems should include but are not limited to personal desktop computers. For the purposes of this standard the term *past* refers to 10 or more years prior to the current year.

5. For the purposes of this standard

   - *Underlying technologies* means the construction of the component and the way in which the component functions
   - *Compare* means a comparison of past and contemporary systems, which should include background detail and possible reasons for differences.
   - *Analysis of components* means to discuss the rationale for components in a PC system
   - *A detailed analysis of trends* means discussing changes in computer systems from past to contemporary systems and projecting possible future changes.

Assessment details:
This standard could be assessed as an externally submitted project or an external examination.

F2 Sample Achievement Standard 2

Title		Develop a computer program to solve a problem			
NQF level	3	**Credits**	6	**Assessment**	Internal

This achievement standard requires the use of a software development process to create a computer program to solve a problem.

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
A program is produced using a software development process that meets the essential requirements of the problem	A program is produced using a software development process that meets the essential requirements of the problem and shows evidence of good programming technique.	A program is produced using a software development process that meets the essential requirements of the problem and shows substantial evidence of good programming technique and justification of the techniques used.

Explanatory Notes

1. For the purpose of this standard *a software development process* consists of:
    - Design of system to fit requirements
    - Development and testing of system
    - Implementation of system

2. The choice of problem must allow the candidate to demonstrate the following programming skills in one program:
    - arrays and/or records
    - different data types
    - selection
    - iteration
    - procedures and/or functions
    - searching techniques
    - storing and retrieving data externally to the program

3. *The essential requirements* include evidence of correct output for valid inputs, some commenting on the code and demonstration of all of the above programming skills.

4. Design should include but is not limited to appropriate sketches or diagrams of structure and processes (e.g. form layout, flow charts) and identification of inputs and outputs.

5. *Good programming technique* includes:
- an effective user interface
- systematic indentation of program code (required for merit)
- use of appropriate variable names (required for merit)
- appropriate commenting of the program code (required for merit)
- data validation (required for merit)
- internal error trapping (required for excellence)
- use of appropriate procedures and/or functions (required for excellence)

6. Any appropriate (procedural or object oriented) standalone programming language may be used. Examples include (but are not limited to) Visual Basic, C#, Pascal, Java.

7. *Justification* will explain why particular programming techniques have been used for particular tasks within the program.

8. Implementation must include instructions for installation and documentation for the user.

Appendix G: NZCS Sample Achievement Standard

Title		Debug a known program			
NQF level	1	**Credits**	3	**Assessment**	Internal

This achievement standard requires the student to correct logic errors (bugs) in a piece of code that is known to them, under controlled conditions.

Achievement Criteria

Achievement	**Achievement with Merit**	**Achievement with Excellence**
At least 80% of the bugs are removed from the sample program within the time limit.	All existing bugs are removed from the sample code within the time limit and all corrections are documented in the code according to recognized standards	All existing bugs are removed from the sample code within the 75% of the time limit and all corrections are documented in the code according to recognized standards.

Explanatory Notes

1. This assessment will be run as an online test of one hour or more, depending on the situation. Students should be supplied with softcopy of a standard block of syntactically correct code (i.e. code which will compile and run) in a language which they are familiar with. Ideally, this code (with no bugs) could be given to them a week or more before the test, perhaps as part of an assignment to enhance the code. The code will come with a program specification which details how the program should behave.

2. For the test, the examiner will insert a number of bugs into the code (up to 10), which are representative of the typical mistakes beginning programmers make in loop conditions, if statements, missing lines, incorrect sequence, typing errors in literals, ….

3. For the exam, students will have a copy of the specification and a fresh copy of the code plus a list of the symptoms of the bugs that have been introduced, so they know exactly how many bugs to find and correct. Student may make reference to their class notes and/or online help. Use of a debugging tool is permitted, if available.

4. In moderating such a test, it is advisable to have someone who did not insert the bugs actually attempt the debugging session, so a reasonable time limit can be set.

5. If during the test, a student corrupts the code so much that it will not compile, the supervisor may give assistance to correct the problem, but the student is then restricted to the *achieved level.*

Note: Similar standards could be written for NQF level 2 and 3. At NQF level 2, the bugs would not be identified, but students would be given sample data which would enable them to detect the problems. At NQF level 3, the standard could be called "Testing and debugging". Here, students would need to devise suitable test data in order to test the code (although, very good students may discover the bugs by reading the code alone).

Appendix H: CSTA Report Copyright Page

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