Essential Learning
Prep to Year 10
Design, Technology and Innovation
Curriculum Area

A discussion paper prepared in September 2004
for the Victorian Curriculum and Assessment Authority
as theoretical background for development of the
Victorian Essential Learning Standards

Victoria
The Place To Be

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Acknowledgments

The VCAA acknowledges the following Design, Technology and Innovation writer:

Dr Grace Lynch, Lynch & Associates

The VCAA also acknowledges the following discussion group participants who provided advice that helped shape the Victorian Essential Learning Standards in the Design, Creativity and Technology learning domain:

Kate Baulch, Technology Education Association of Victoria,

Dr Damon Cartledge, La Trobe University

Joss Evans, INNOVIC

Cheryl Holdsworth, Vermont Primary School

Beverley Jane, Monash University

Wendy Jobling, Syndal South Secondary College

Rob Kayler-Thomson, The Geelong College

Frances Lamb, Victorian Qualification Authority

Roger La Salle, INNOVIC

Gail Major, Mount Waverley Secondary College

Contents

Introduction

In the Blueprint[1] document, the first Flagship Strategy of Student Learning, outlines the need to achieve the vision of students to be active, lifelong learners by ensuring that schools are places where students develop:

- a positive attitude towards learning
- fundamental skills in literacy, numeracy and self-expression, which will enable them to be successful across all areas of learning
- high-level personal communication and social competencies for working independently and within groups
- experience in innovation, creativity and problem solving
- confidence to deal with technological and cultural change
- skills sets in the wider community and changing workplace
- ability to assess information and reflect on it.

While all of the above points are pertinent to a Design, Technology and Innovation curriculum, the points referring to 'innovation, creativity, problem solving' and 'technological change' are of particular importance. The Curriculum Victoria: Foundations for the Future report[2] signalled the importance of this area of essential learning by finding that four key elements of a 'best practice' curriculum are:

- equity and inclusiveness
- the encouragement of innovation and creativity
- clarity and focus in content specification
- assessment for learning.

The *Victorian Curriculum Reform 2004 Consultation Paper: A Framework of 'Essential Learning'* found that 'the new approach emphasises that students need to leave schooling with a broad range of high-level skills which they can apply creatively to the real world.'[3] The report goes on to state that the curriculum must recognise that the structure and meaning of work has changed significantly since the 1970s: students are no longer preparing for one career in life, information and communications

---

[1] Department of Education and Training (2004). *Blueprint for Government Schools: Future Directions for Education in the Victorian Government School System*, Victorian Government.

[2] Victorian Curriculum and Assessment Authority (2004). *Curriculum Victoria: Foundations for the Future,* East Melbourne

[3] Victorian Curriculum and Assessment Authority (2004). *Victorian Curriculum Reform 2004 Consultation Paper: A Framework of Essential Learning,* East Melbourne

technology (ICT) is pervasive and the economy is increasingly based on service or ‘knowledge’ industries.

The State of Design: Future Directions[4] report stated that *design is pervasive – it is part of everything that we do and make – and as such, a key focus for design education is to embed design awareness and the development of design skills into all levels of the school curriculum. This requires explicit teaching of the skills, flexible processes and practical applications of design and technology.*

The above policy statements establish a basis for including Design, Technology and Innovation in a framework of essential learning.

In an attempt to provide innovative teaching and learning experiences, many Victorian schools have moved towards an integrated curriculum model, which is consistent with the approach promulgated by a new framework of essential learning. This is very successfully seen in the integrated work carried out in many primary schools, and in some thematic projects carried out at the secondary level. Essentially, an integrated curriculum is one that transcends the boundaries imposed by traditional subject groupings. It allows students to move across disciplines as they learn about their world. Integrated curriculum does not do away with the distinction between the subjects or learning areas – these remain important for the purposes of balance and organisation.[5] When the curriculum has an integrated focus, students are able to achieve the outcomes from several different learning areas through carefully planned learning activities. By placing Design, Technology and Innovation in the cross-curricular pillar (strand), it is implied that activities in these areas would form the basis of units that integrate knowledge, skills and behaviours from several domains. It is recognised that ‘a greater effort is required to develop design awareness and skills in school students.’[6]

What should students know, understand and be able to do?

Social and economic progress in Australia, not only in Victoria, will increasingly depend on active people with the capacity to solve problems, to create and to generate new and better ways of doing things. At all levels, our society will require creative individuals able to communicate well, think originally and critically, adapt to change, work cooperatively, and remain motivated when faced with difficult situations.[7] This can occur through the inclusion of Design, Technology and Innovation as a core element of the school curriculum

Victoria’s future as a leading innovation economy depends upon its ability to educate not only designers, but also the users and purchasers of design products and services.

---

[4] Victorian Government (2004). *The State of Design – Future Directions.*

[5] Murdoch & Hornsby (1997). *Planning Classroom Connections: Whole School Planning for Integrated Curriculum*, p. 1. Eleanor Curtain Publishing.

[6] Ibid.

[7] . Department of Education, Science and Training (2003). *Australia’s Teachers: Australia’s Future, Advancing Innovation, Science Technology and Mathematics. An Agenda for Action*, p. 5. Commonwealth of Australia, Canberra.

Strengthening the teaching of Design and Technology, and its concepts and principles into all levels of education will better equip Victorians with the flexibility, creativity and adaptability to respond to the opportunities and challenges of a rapidly changing technological society.[8] Providing opportunities to study Design and Technology in schools from Prep to Year 10 encourages students to undertake and continue studies in areas related to design and technology in the post-compulsory years of schooling and links to pathways in education and training.

It is clear that design education has been seen as important for the State Government of Victoria as evidenced by several recent government initiatives (some of which are still under development) such as:

- Centres of excellence – Lab.3000 innovation in digital design (2003)
- Certificate IV in Applied Design for Industry – Victorian Qualifications Authority (VQA)
- Design provision in Vocational Education and Training (VET)in Victoria
- Design in Schools (Years 9–12)
- Designed to Inspire (Melbourne Museum)
- Professional Development Learning by Design (Secondary and TAFE)
- Victorian Qualification Framework for Design – Stage 2 (VQA)

In order to be successful in these Later years and post-compulsory education initiatives, Design and Technology education needs to be strengthened across the Prep – Year 10 curricula.

The basis of essential learning in the Technology component of Design, Technology and Innovation is the development of technological literacy or capability – the ability to use, manage, assess and understand technology. It relates to the processes and knowledge that people use to extend human abilities and satisfy needs and wants. The encouragement of innovation through mastery of deep knowledge and pedagogy is based on students thinking their way through open-ended problems.[9] It is a fact that technology will keep evolving. Design, ideas and innovation are extremely important to the evolution that is taking place.

Definitions

Different countries and states use different terms to describe technology education, for example, ‘technics, design and technology’, ‘technology education’, and ‘technological education’. ‘Regardless of the term used, the universal goal is to help students become

[8] Victorian Government (2004). *The State of Design – Future Directions.*

[9] Victorian Curriculum and Assessment Authority (2004). *Victorian Curriculum Reform 2004 Consultation Paper,* East Melbourne.

technologically literate.'[10] Technological literacy should be seen in terms of experiential, practical and applied knowledge as well as theoretical understanding.

Design can be seen as a vital step in transforming ideas into creative, practical and commercial realities. Design optimises the value of products and systems and is therefore an important key to economic, social and cultural development.[11] Other, very narrow, definitions of design from the Concise Oxford Dictionary include: a mental plan; a scheme of attack; an end in view; an adaptation of means to ends; a preliminary sketch for picture; and an invention. Design also involves planning and organising production, and evaluating products in a real context.

To be **innovative** is to do something different, to explore new territory or to take a risk.[12] Technology has also been defined as 'human innovation in action'.[13] The critical element of being innovative is newness. Creativity is frequently linked with innovation. Creativity has been defined as 'the application of knowledge and skills in new ways to achieve a valued goal'.[14] Innovation can often be seen as an outcome of the broad exploration of ideas, materials and technical processes that can occur during the design and technology process.

Technology refers to the equipment and processes used to enhance, maintain and modify the environment and resources in order to support human endeavour. It involves the purposeful application of knowledge, skills, equipment, materials, energy and data to create useful products.[15] Technological literacy has been defined by the Australian Academy of Technological Sciences and Engineering as: 'the synthesis of knowledge, ideas and skills in the solution of identified problems and the development of innovative capabilities. In its focus on synthesis, design and invention, it embraces creativity across the full spectrum of a student's learning. In a real sense, this synthesis places technology education as a significant integrating force within schooling. It is learning through practice. It is often practised through group or team activities and with the objective of finding solutions that are culturally and environmentally informed. It is about "design, build and appraise" … about matching materials to purpose … about studying, disassembling the working elements of equipment and

---

[10] Raisen, A. (2003). An analysis of the technology education curriculum of six countries, *Journal of Technology Education*, 15(1), p. 31, Fall.

[11] Fleming, D. (2004). *Lab.3000 – innovation in digital design Business Plan*, RMIT University.

[12] Lynch, G. (2001). Towards innovation, *Executive Excellence*, 18(8), August, Australia.

[13] Raisen, A. (2003). An analysis of the technology education curriculum of six countries, *Journal of Technology Education*, 15(1), p. 39, Fall.

[14] Department of Education, Science and Training (2003). *Australia's Teachers: Australia's Future, Advancing Innovation, Science Technology and Mathematics. Main Report,* p. 22. Commonwealth of Australia, Canberra.

[15] Victorian Curriculum and Assessment Authority (2000). *Technology: Curriculum and Standards Framework II*, East Melbourne.

systems…it is about "making and doing".'[16] Technology is also about evaluating and modifying practical outcomes.

From all of these definitions it is clear that design, technology and innovation [creativity] are intrinsically linked. The current world of work and global economies demand that workers become innovative lifelong learners who are able to use a wide range of information and communication technologies. Education providers have to be able to support enterprises by developing 'designerly' ways of thinking and nurturing creativity in their students. A paper from the Design and Technology Association (DATA) 2003 International Research conference supports these ideas, pointing to a possible direction for education in the future:

> Design and technology prepares pupils to participate in tomorrow's rapidly changing technologies. They learn to think and intervene **creatively** to improve quality of life. The subject calls for pupils to become **autonomous** and creative **problem solvers**, as individuals and **members of a team**. They must look for needs, wants and opportunities and respond to them by developing a range of ideas and making products and systems. They combine **practical skills** with an understanding of aesthetics, social and environmental issues, function and industrial practices. As they do so, they reflect on and evaluate present and past design and technology, its uses and effects. Through design and technology, all pupils can become **discriminating and informed users** of products, and become innovators.[17]

Scope of the domain

Central to design is the design and technology process. The implications for this in teaching and learning allow for open-ended, hands-on tasks within safety guidelines that provide interdisciplinary collaboration and self-monitoring of process and product. Other processes unique to learning in design and technology are:

- the development and management of design processes
- the application of design skills and knowledge to a complete and holistic task
- the production of a real/physical solution within a relevant context (a product or model)
- the knowledge and use of a wide range of tools and equipment
- an understanding of safety
- an experiential understanding
- the application of materials.

---

[16] Department of Education, Science and Training (2003). *Australia's Teachers: Australia's Future, Advancing Innovation, Science Technology and Mathematics. Main Report,* p. 26. Commonwealth of Australia, Canberra.

[17] Martin, M. (2003). *Valuing Progression in Design and Technology Education*. DATA International Research Conference Proceedings, p. 80.

The teaching and learning model of Design, Technology and Innovation is project based. Projects provide a real and relevant context where students have the opportunity to design, make and evaluate real solutions or products using design and technology processes[18] in an holistic way. It takes a task from inception to completion within the constraints of time, cost and resources. It requires students to:

- deconstruct the complexity of tasks and the values inherent in the concept of improvement
- be creative, conceiving ideas and planning that which does not yet exist
- model their concepts of the future
- make informed judgments
- manage both complexity and uncertainty in their projects
- deal with multi-dimensional and value-laden tasks.[19]

Development of design and technological and innovation capability includes the ability to use, manage, assess and understand design and technology and their relationship to innovation. In more detail, this means being able to:

- pose problems and be active in identifying areas for improvement
- develop and use design and technology processes
- understand and apply design skills and knowledge
- use technological tools to realise the design
- understand how design and technology lead to innovation
- assess the outcomes of design and technology processes and products in relation to environmental, social and economic factors.

Design and technology process skills – interpreting, generating, collaborating, reflecting, representing and evaluating – can apply across all areas of the curriculum. However, within design and technology tasks, the design and technology process is used in a strategic and holistic way to create real solutions in relevant contexts. This is consistent with problem solving; collecting, analysing and ***organising information;***

---

[18] It should be noted that 'design and technology process' has been used in this paper as the preferred terminology of the Technology Educators Association of Victoria (TEAV). There needs to be an in-depth discussion on the appropriate terminology of the design, design and technology, or technology process used to describe the methodology of the Design, technology and innovation/ creativity curriculum area in Stage Two. This discussion is outside the scope of this paper but is raised again in 'Issues for consideration' at the end of this paper.

[19] Wilson, V. & Harris, M. (2004). Creating change? A review of the impact of design and technology in schools in England, *Journal of Technology Education*, 15(2), Spring.

planning and organising activities; using technology; communicating ideas and information; collaborating or working in teams; and learning to learn.

The principal objectives of technology education found in a study of technology education across six countries[20], could apply to a Design, Technology and Innovation curriculum. These are:

- understanding the role of science and technology in society
- balance between technology and the environment
- development of technological literacy (both theoretical and practical)
- development of skills such as planning, making, evaluating, social/moral/ethical thinking, innovativeness, awareness, flexibility, and entrepreneurship
- systems and structures of technology
- professions in technology and industry
- safety practices
- ergonomics, design and construction techniques
- role and history of technological development
- problem-solving strategies.

Wilson and Harris's study of design and technology education in England identified three main concepts that could be seen to be essential elements of Design, Technology and Innovation: resources, activities and human linkages. Students develop capabilities only when an interrelationship occurs between these three concepts.[21]

The concepts in more depth are:

- What resources (human, physical, financial, or technical) are required for the activity?
- How is the activity handled (processes, techniques, methods)?
- How and why are people linked to processes and resources?

---

[20] Raisen, A. (2003). An analysis of the technology education curriculum of six countries, *Journal of Technology Education*, 15(1), p. 45, Fall.

[21] Wilson, V. & Harris, M. (2004). Creating change? A review of the impact of design and technology in schools in England, *Journal of Technology Education*, 15(2), Spring.

Core concepts, skills and behaviours

Design, Technology and Innovation has a core body of knowledge. While the design process is central to it, there is technological knowledge that is unique to the area.[22] This technological knowledge is critical for students in an ever-changing technological world.

Design knowledge is essential in order to be able to teach design effectively. Initiatives such as the Design Education and Training Professional Development project identified that many current design and technology teachers lack background knowledge of design. This includes design principles and elements, processes, history and contemporary issues, as well as strategies for developing creative skills. All of this needs to be explicitly taught and made quite clear in the outcomes to be developed.[23]

Students need to embed the *design process skills* ***in everything that they do. These skills are:***

- **interpreting** situations, needs, possibilities and procedures
- **generating** alternatives, innovations or solutions
- **collaborating** with others
- **reflecting** on situations, procedures, needs and opportunities
- **representing** ideas or suggestions
- **evaluating** merits and disadvantages.[24]

The Australian Council of Deans of Science[25] has argued for a combination of 'content knowledge, technical skills, planning, teamwork, problem solving and creativity as the ingredients of innovation. It is the application of creative ideas that is important for innovation.'

Design, Technology and Innovation should create students who:

- explore
- take risks
- care about…(many diverse issues)
- are confident

[22] Baulch, K. (2004). *Design and Technology – some considerations*. (Not Published)

[23] Ibid.

[24] Australian National Training Authority (2002). *Innov@tion–ideas that work,* ANTA, Brisbane.

[25] Department of Education, Science and Training (2003). *Australia's Teachers: Australia's Future, Advancing Innovation, Science Technology and Mathematics. Main Report*, p. 23. Commonwealth of Australia, Canberra.

- can communicate in 2D and 3D
- enjoy open-ended situations
- can develop a 'process' to solve problems
- are tactile
- ask questions
- can challenge
- want to be challenged
- are social; they can be part of a dynamic team
- are curious
- can see the big picture
- are good with detail
- are not precious
- interact with objects
- understand materials
- are not afraid to be different
- enjoy difference
- can think again
- turn mistakes into progress
- communicate in many different ways.[26]

In the Tasmanian Essential Learnings Framework,[27] designing and evaluating technological solutions is situated in the World Futures foundation and involves students understanding how to design, make and critically evaluate products and processes in response to human needs and challenges. This includes:

- devising creative ways of generating and applying ideas
- developing and producing appropriate technological solutions using problem-solving systems and strategies
- using the arts, mathematics and science in design, production and evaluation

[26] Technology Educators Association of Victoria (2004). *Discussion notes* (adaptation – not published).

[27] Department of Education (2004). *Essential Learnings Framework*, Tasmania. See http://www.education.tas.gov.au/ocll/outcomeschart.pdf.

- modifying ideas in the face of adversity and consider alternatives, dealing with uncertainty in an informed way
- evaluating proposed and established technological and scientific solutions for their economic, social, environmental, aesthetic and ethical impact.

In the South Australian Design and Technology area of the Curriculum, Standards and Accountability Framework, connections to the Mayer Key Competencies are provided throughout the strands of critiquing, designing and making.[28] The three strands are interdependent and none of them is predominant. Read alongside each other, they do not constitute a sequential process. They interrelate to support rich understandings. The three strands should be woven into a dynamic and holistic learning experience for students.

Interstate curriculum documents may inform the knowledge, skills and behaviours of the Design, Technology and Innovation domain, along with the following profiles for the Early, Middle and Later years.

Early years (Prep–Year 4): Core concepts, skills and behaviours

Early childhood programs already feature many technological materials, such as blocks, collage and construction kits, and many young children use materials as tools for thinking.[29] Research has shown that teaching experiences that focus children's learning around 'designerly' thinking also accelerate learning outcomes across the curriculum.[30] Students in the Early years play with materials in a focused manner in technology education, which fosters their development of design and technical skills and language. For example, in focused design and technology learning experiences for children in the Early years involving a bag, the children developed:

- a personal perspective – why is the bag special to you?
- a perspective of other individuals and groups – what might be in the bag?
- a historical perspective – what sort of bags did their grandparents use?
- an environmental perspective – by drawing flowcharts to map the life cycle of plastic bags
- a producer perspective – who made the bag and who benefits?[31]

[28] Department of Children's Services (2004). South Australian Curriculum, Standards and Accountability Framework, *Design and Technology*, www.sacsa.sa.edu.au

[29] Fleer, M., Jane, B. & Robbins, J. (2004). *Designerly thinking: Locating technology education within the early childhood curriculum*. New Zealand Council for Educational Research, Early Childhood Folio.

[30] Ibid.

[31] Ibid, p. 3.

In these Early grades, students begin to understand that people use creative and inventive thinking to help them meet human needs and wants. In addition, students should begin to see the different processes and techniques that could be used.[32] In the Early years, the student inquires into and questions their world, offering ideas and suggestions. They wonder about and explore concepts and possibilities, give reasons for changes in their thinking, and respect and accept that others have different opinions. They verbalise their thought processes. If this conceptualisation and development of knowledge and skills occurs in the Early years, it may be assumed that they are expanded upon with older children as well as new concepts, knowledge and skills being introduced. [33]

Design, Technology and Innovation thinking and its culture of reflection can be grouped under three general headings. These are materials/systems; design and technology processes;[34] and impact on society, environment and the future. These categories could form the basis of a three dimensions in a Design, Technology and Innovation domain.

Materials/Systems

- Materials have specific characteristics that enable them to be useful in the production of functional products.
- Materials can be manipulated to make functional products.
- Technical systems have an input, process and output, and can be controlled.
- Technical systems have components that interact with each other.
- Technical systems contain suitable materials and serve a function.
- Functional products require materials to be arranged in specific manners that support functionality.
- Functional products sometimes utilise specialised materials and processes to combine them.
- Some structures have moving components and integrated systems to achieve functionality.
- Tools and machines are made by people in order to serve a human need.
- Each tool and machine has its individual character and can serve a range of purposes.

[32] International Technology Education Association (2000). *Standards for Technological Literacy*: *Content for the Study of Technology*.

[33] Webster, A. (2004). *Discussion notes*, Victorian Curriculum and Assessment Authority Design, Technology and Innovation Think Tank (not published).

[34] See footnote 19 regarding terminology.

Design and technology processes

The student:

- Poses questions and identifies problems, needs and opportunities.
- Interprets and contributes to the content of design briefs.
- Able to describe ideas and concepts about design, materials and systems in simple terms and how these can be combined in innovative ways to create solutions.
- Makes simple drawings and plans, and uses annotated drawings, labelled diagrams and flow charts of ideas to represent possible solutions.
- Makes products safely, using basic tools and equipment in response to design briefs.
- Describes features of products s/he made and compares these with original intentions.

Impact on society, the environment and the future

The student:

- When products are made, waste is created that must be disposed of in some way.
- Making products requires the use of energy.
- Some materials can be harmful when used in the construction of functional products.
- Each tool and machine has an individual means of manipulation and operation.
- Using tools and machines can be dangerous.
- Each tool and machine must be used in accordance with safety guidelines.
- Products are changed and improved as our knowledge of materials, systems and processes increase.

Middle years (Years 5–8): Core concepts, skills and behaviours

In the Middle years of their schooling, students continue to benefit from an integrated approach to learning, especially in the earlier part of the Middle years.[35] By the end of the Middle years students should be proficient in their use of a range of equipment and tools, including computers, to effectively solve problems. Students in these years need to learn how creativity and lateral thinking is central to the development of products

[35] Victorian Curriculum and Assessment Authority (2000). *Technology: Curriculum and Standards Framework II*, East Melbourne.

and systems. The development of an innovation is closely related to addressing a need or want.[36] In the Middle years, the student investigates through questioning, and recognises the complexity of concepts and opinions. They seek creative, innovative alternatives and evaluate their decisions. Students develop greater spatial awareness and can represent their ideas using two- and three-dimensional hand and computer-assisted drawing techniques. They trial and make products based on their design concepts. They justify changes in the direction of their thinking and recognise the right of others to perceive things differently. They begin to develop an understanding of the creative problem-solving process.

Materials/Systems

- Knowledge and understanding of materials, including origins, properties and characteristics, how they are manufactured/processed, what they can be used for, the consequences of their use.
- Understanding and use of a variety of ways to manipulate a broad range of materials.
- Mechanisms that create movement, and their possible application.
- Explanation of some of the social and environmental implications of using particular materials in products.

Design and technology processes

- Ability to develop problem-solving skills within real contexts.
- Prepare designs for products, organise and undertake a range of production processes, and evaluate their finished product against the design specifications.
- Creates simple products to meet requirements specified by teacher or in a design brief.
- Develops design skills in drawing and communicating ideas.
- Understands and manipulates design elements.
- Undertakes design and technology projects individually and in teams.
- Uses past experience to find solutions.
- Chooses appropriate materials, tools and skills to realise a product from a design brief.
- Able to think conceptually and analytically.
- Makes appropriate decisions about designs, materials, equipment, processes and the management of time and resources.

[36] International Technology Education Association (2000).*Standards for Technological Literacy: Content for the Study of Technology*.

- Describes how well products and processes comply with requirements and intentions, and how these could be improved.

Impact on society, the environment and the future

- Knowledge and understanding of the impact of technology on the development of products (both historical and current).
- The impact of design and technology on society and culture.
- The relationship between technology and the environment, and the impact they have on one another.
- Knowledge and understanding of developments in design and technology, including how and why these have come about.
- Knowledge of safe work practices when implementing designs.

Later years (Years 9 and 10): Core concepts, skills and behaviours

Responding to the needs of students in the Later years is not simply in preparation for post-compulsory schooling but to encourage them to take greater responsibility for their own learning in a social and community context. In the Later years, students start to specialise in specific areas of the curriculum. In these years, students should be addressing problems associated with other people, as opposed to those associated with only themselves.[37] They continue to pose problems and develop problem-solving skills that are transferable to other learning situations by working with a variety of design briefs and within a range of contexts. Students need to be actively engaged in their learning as these are the years when motivation for schooling can decrease. Development of social and personal skills is encouraged through teamwork in Design, Technology and Innovation activities. Students need to continue developing higher-order thinking skills such as questioning, investigating and researching.[38] In the Later years, students develop questioning techniques that probe into and elicit information from varying sources. They monitor and evaluate their own and others' thinking. They become discerning and discriminate thinkers, able to address controversial and complex issues. Through creative processes, and by applying evaluative criteria, they are able to examine and respect a range of perspectives and accommodate diversity.

Because design and technology are widely applied across society, students should use a range of equipment and resources within safety guidelines in order to create their products. Some examples are:

- a computer for designing and processing data
- a saw and other tools for separating and shaping wood, metal and plastic

---

[37] Victorian Curriculum and Assessment Authority (2000). *Technology: Curriculum and Standards Framework II*, East Melbourne.

[38] International Technology Education Association (2000).*Standards for Technological Literacy: Content for the Study of Technology*.

- a sewing machine and overlocker for constructing garments
- a food processor or blender for mixing ingredients.[39]

Materials/Systems

- Knowledge and skills necessary for using a variety of equipment and resources.
- Understanding of the principles for safely using materials and operating equipment.
- Knowledge of materials, systems, structures and how they are made.
- Use and consequences of using different materials.

Design and technology processes

- Capacity to model, disassemble materials and products, and communicate ideas (verbally, 2D drawing, 3D modelling)
- Develop a systematic and creative approach for generating innovative technological solutions, including time and resource management
- Organise and manage stages in the design and technology process
- Develop the flexibility to modify and adapt the design and technology process to suit different situations
- Develop higher-order cognitive skills, such as divergent, analytical, critical, reflective and evaluative thinking
- Establish capabilities in problem solving, innovating and conceptual technological understanding, beyond operational know-how
- Work collaboratively within teams
- Develop willingness to change and experiment
- Make informed judgments
- Manage both complexity and uncertainty in projects
- Deal with multi-dimensional and value-laden tasks
- Develop communication skills, including representing ideas, and technical language and terminology
- Ability to define problems
- Work safely

[39] Victorian Curriculum and Assessment Authority (2000). *Technology: Curriculum and Standards Framework II*, East Melbourne.

- Learn how to assimilate specialised knowledge from curriculum domains.

Impact on society, the environment and the future

- Ability to explore and assess the past and potential consequences of using technology
- Knowledge of the impact of design and technology on society and each other
- Critically assess the short- and long-term impact of technologies and innovations on work, lifestyle, society and the environment
- Assess how large-scale societal problems can utilise knowledge and technologies for possible solutions
- Model their concepts of the future
- Understand the legal aspects – for example, intellectual property, ownership, commercialisation process and liability – associated with developing a product
- History of design – responding to design, approaches, stages, initiatives e.g. Bauhaus
- Recognising limits/social responsibilities.

What is the relationship of this domain to others in the framework?

Design conceives and defines all the means we employ to satisfy our many and increasingly intricate needs. It covers our cities, factories, hospitals, schools and houses, together with all those products we use within them. It embraces complex systems that provide us with energy and materials. It spans the ways in which we transport ourselves on land, sea and in the air. It stretches over our other means of communication, whether by speech, writing or illustration. It includes the instruments we use to discover more about our universe and ourselves. It extends to the artefacts that we have developed to help us express our thoughts and emotions in the fields of literature, art, music and drama.

Design and Technology carries its own conceptual and procedural body of knowledge. Central to Design is the design process and the capacity to carry out Design and Technology activities. The implications for this in teaching and learning allow for open-ended, hands-on tasks that provide interdisciplinary collaboration and self-monitoring of process and product.

> *Design is an integral part of our everyday lives, informing the architecture and landscape of our cities, as well as the style and function of our products and services. It is a key aspect of industry success, providing the innovations with which our products and services stand out in an increasingly competitive marketplace. Culturally, design helps shape our unique and vibrant identity, putting an international spotlight on Victoria.*[40]

The website of the upcoming [2004] International Conference on Technology Research: Learning for Innovation in Technology Education[41] states that 'an increasingly important aim of education generally is to develop learners' creative and innovative thinking abilities. The related aim of technology education is to develop in learners the capacity to solve socially significant problems for improving the quality of life. Accordingly, in technology education, the curriculum content is aimed at developing students' social, cultural and environmental responsibility, students' understanding of materials, processes, information and systems and student mastery of methods and techniques in applying these concepts to problems.' Technology education emphasises student engagement in designing, making and appraising processes as a way of developing creativity and innovation in students.

The development of an innovative culture in schools must be built upon the complex interdisciplinary understandings students attain across the range of education they experience, from the arts, humanities, social sciences, mathematics, science, design and technology.[42]

In an already crowded curriculum, the learning experiences required to develop in students a capacity and predisposition to be innovative cannot simply be added on. The learning experiences need to be integrated within and become an integral part of the curriculum.[43] The links with Design and Technology are obvious since skills needed to be innovative are creativity, imagination, original thinking and problem solving to name just a few.

There are innumerable ways that Design, Technology and Innovation can be linked with the other domains in the Framework of Essential Learning. A few examples are:

Science

Developing an understanding and applying knowledge of materials (e.g. properties), structures and systems. Biological science provides understanding of plants, animals and ecosystems that inform understanding in agricultural and horticultural applications.

---

[40] Victorian Government (2004). *The State of Design – Future Directions*, p. 4.

[41] http://www.gu.edu.au/text/centre/clr/terc2004 .

[42] Department of Education, Science and Training (2003). *Australia's Teachers: Australia's Future, Advancing Innovation, Science Technology and Mathematics. An Agenda for Action*. Commonwealth of Australia, Canberra.

[43] Ibid.

Visual Art

Understanding the elements and principles of design/aesthetics and styling links Design, Technology and Innovation with Visual Art.

Humanities

Comprehending the social/cultural, environmental and economic impacts of products (including, for example, the creating of wealth, enriching and enhancing daily lives, creating waste, using natural resources, sustainability, ethical issues, and cultural meanings) provides links across the Humanities.

Language

Development of design, technical and innovation language provides a direct relationship with the Language discipline.

Mathematics

Spatial skills are very strongly emphasised when students work with design briefs involving 3D projects. Aspects of geometry such as symmetry, congruence, ratio and rigidity of shapes may be incorporated in design and production of products. Cartesian coordinates are used in many Computer-aided design/Computer-aided manufacture (CAD/CAM) applications.

In the **Thinking** domain, strong links exist with creativity. Through the design and technology process, students are involved in seeking innovative alternatives and applying imagination to possibilities. In addition, students are involved in the reasoning and inquiry dimension in transforming and transferring understanding. Likewise, students are involved in developing and applying evaluative criteria to their own products and those made by others.

Presenting in the **Communication** domain is also significant in Design, Technology and Innovation in that appropriate means of conveying ideas and meaning must be selected.

Selecting and accessing information via the Internet, presenting and using **Information and Communications Technology** (ICT) are all utilised in Design, Technology and Innovation. Data logging, use of CAD/CAM and simulation and programming control technology software can also be applied in this domain. Students can also use digital photography combined with project management tools to manage and record production.

The **Personal and Social Development** domain [**Interpersonal Development** and **Personal Learning** domains], in which students develop knowledge, skills and behaviours while working in teams, sharing resources and acting responsibly, has its counterparts in Design, Technology and Innovation. Students develop self-esteem and personal satisfaction through the completion of products they have designed and developed. The ‘hands-on’ nature of experience, working with tools, equipment and materials, is highly satisfying and fulfilling and prepares students for future occupational or leisure pursuits.

Design and Technology has come to be acknowledged as a 'multidisciplinary subject with potential for cross-curricular activity.'[44] Design and Technology is a 'unitary concept … it is intended to emphasise the intimate connection between the two activities as well as imply a concept which is broader than either design or technology individually and the whole of which we believe is educationally important.'[45]

Issues for consideration

There is, however, a fear expressed by some members of the Design, Technology and Innovation Think Tank that, by integrating design, technology and innovation across the curriculum, these concepts will be diluted and not taught with the ***expertise that is*** required to develop design principles and technology skills.[46] Greater specialisation in the Later years necessitates use of more complex equipment and greater teacher expertise and familiarity with the design process. The argument still needs to be debated over whether Design, Technology and Innovation should be a separate discipline or integrated across several curriculum areas. Design and Technology is recognised as a core discipline in all other states and territories around Australia as well as overseas.[47] It would be dangerous (in terms of the breadth and depth of student learning outcomes, the engagement of a broad range of students, and possible loss of teacher expertise) to change the status of Design, Technology and Innovation from a recognised Key Learning Area or Core Discipline to an area exclusively seen as containing generic and cross-curricula skills.[48] Consideration also needs to be given to articulation to post-compulsory studies.

The notion of applying Design to other learning areas needs to be carefully considered. There are aspects of Design that could be encouraged in other learning areas, but design itself is quite complex. It is made up of many complex elements that are combined/used/implemented within a context to develop what are often complex, creative and possibly innovative results. However, this can only happen in a design environment. Design also needs to be seen in conjunction with technology.[49] The embedding of design tasks within the context of a design and technology process or project gives design purpose. It also helps to engage students and makes skills and knowledge relevant and purposeful.

The terminology of 'design process' *versus* 'technology process' *versus* 'design and technology process' needs to be decided upon in the development of standards for the domain of Design, Technology and Innovation in Stage Two of the development of a framework of essential learning.

---

[44] Wilson, V. & Harris, M. (2004). Creating change? A review of the impact of design and technology in schools in England, *Journal of Technology Education*, 15(2), Spring.

[45] Ibid.

[46] Technology Educators Association of Victoria (2004). *Discussion notes* (not published).

[47] Baulch, K. (2004). *Discussion notes*, for Victorian Curriculum and Assessment Authority Design, Technology and Innovation Think Tank (not published).

[48] Technology Educators Association of Victoria (2004). *Discussion notes* (not published).

[49] Ibid.

The ‘design process’ could be interpreted as the conceptualisation of how a problem/need or opportunity *could* be met or solved without necessarily *effecting* such resolution. This could be appropriate in some circumstances, and roughly equates to notions of the designer as conceptualiser and planner who ‘hands over’ designs to the producer/manufacturer/maker. This separation has its foundations in the Industrial Revolution, before which objects were craft-produced, meaning that the conception *and* realisation of the object were most often undertaken by an individual creator.[50]

The ‘technology process’ is described as ‘a method for solving technological problems. This process consists of four steps or phases: investigating, designing, producing and evaluating. The process can be applied sequentially, where students move directly from investigating to designing, producing and evaluating. Alternatively, students might have to return to the phases in order to solve a problem: for example, students continually evaluate during each phase and therefore will often have to return to a preceding phase.’[51] Although not identified as such, the equivalent to the technology process in *Technology – a curriculum profile for Australian schools*[52] is the designing, making, appraising process described as ‘a process through which students develop ideas and create imaginative solutions for learning tasks’. The statement continues: ‘[T]hey participate in decisions about what to do, why it should be done, how it should be done, and how what has been done might be improved.’

> *We need to be clear about what could realistically occur in other learning areas (domains). They could utilise and implement aspects of design – just as currently in Design and Technology aspects of Mathematics and Science are utilised and implemented. No one would be claiming to be teaching algebra or physics, but they would say that they are drawing upon, strengthening or teaching aspects of these. In order to effectively implement elements of design across other learning areas, the current core teaching of design needs to be strengthened.*[53]

The knowledge and competence of all teachers, not only Design and Technology teachers, need to combine a broad understanding of the knowledge society, design, technology and innovation with the sociocultural context with depth in the fields of their specialisation.[54] This has huge implications for the training and professional development of teachers.

---

[50] Fiell, C. (2001). *Design of the 20th Century*, Taschen, Köln.

[51] Victorian Curriculum and Assessment Authority (2000). *Technology: Curriculum and Standards Framework II*, East Melbourne.

[52] Curriculum Corporation (1994). *Technology – a curriculum profile for Australian schools.*

[53] Baulch, K. (2004). *Design and Technology – some considerations*. (not published)

[54] Department of Education, Science and Training (2003). *Australia’s Teachers: Australia’s Future, Advancing Innovation, Science Technology and Mathematics. Main Report*. Commonwealth of Australia, Canberra.

Conclusion

This paper has set out to establish a position for the domain of Design, Technology and Innovation. It provides a strong argument for its inclusion in a Victorian framework of essential learning. The domain of Design, Technology and Innovation will prepare students to become autonomous and creative problem solvers, as individuals and members of a team. It will provide students with a combination of practical skills and an understanding of aesthetics, social and environmental issues, function and industrial practices. The processes involved in posing questions and identifying problems, designing solutions, making and producing products and systems, and evaluating solutions are central to Design, Technology and Innovation.