DESIGN TECHNOLOGY LEADERSHIP:

Leadership Strategies that Enable High Quality Outcomes from Innovative, Entrepreneurial and Engaging Design Technology Programmes

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None of this would have been possible without my staff who covered for my absence, especially those senior staff members who stepped up to cover the chain reaction of higher duties. You have my deepest thanks.

A special thank you to Moira Patterson and Vicki Compton from the University of Auckland whose encouragement of our school's journey in implementing Design Technology has been profound.

I also acknowledge the inspiration and encouragement I received from the late Sir Paul Callaghan, one of New Zealand's most eminent scientists. Sir Paul's vision of a high-tech New Zealand incorporating technology and science into an entrepreneurial mind-set that would enable New Zealand's economy to compete globally, has been responsible for our fascinating learning ventures.

Appreciation is also extended to the academic educators and the school leaders – principals, heads of department and their staff – who hosted me, giving so freely of their time, opening up their centres of learning, and patiently answering my myriad questions. I have listed your organisations as an appendix, to acknowledge your outstanding support. You have helped me appreciate that there are kindred spirits world-wide who share my passion and vision for Design Technology and the best for students.

I think it is important to also acknowledge that by quoting all the wonderful Technology experiences I saw while overseas, it does not mean that we in New Zealand are not achieving innovatively and to the highest levels. I have it on good authority that there are examples of technological excellence throughout New Zealand, not the least of which I believe is my own school's example. However, NZ case studies lie outside the scope of this study. Similarly, the overseas examples are not alone in experiencing barriers to achieving good technological outcomes either. Educationally speaking, we are all in this together.

CONTENTS PAGE

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EXECUTIVE SUMMARY

In an exponentially-changing, technologically-driven future, New Zealand must confront the imperative to produce future citizens who can compete for jobs and businesses within an increasingly competitive global economy. If New Zealand is to retain our standard of living, then it is arguable that keeping on doing what we already do in education will not suffice as other countries improve. My contention is that if we want to *better* our standard of living, we need to do something different – we should be focussing on more than literacy and numeracy; we should be putting our energies into developing applied science and maths, as well as Design Technology and entrepreneurial thinking. These lie at the core of economic growth.

This study set out to establish what it is that school leaders do to produce high quality outcomes in Design Technology and entrepreneurship education. I wanted to ascertain whether I could do any better to lead this curriculum area in my own school but also whether I could learn anything my principal colleagues might find useful. As a framework, I chose to use the leadership dimensions in the Best Evidence Synthesis on Leadership[1] as these are argued to have the most impact on student outcomes. The five most influential dimensions on leadership are said to be:

- *Establishing Goals and Expectations*
- *Resourcing Strategically*
- *Planning, Coordinating and Evaluating Teaching & the Curriculum*
- *Promoting and Participating in Teacher Learning & Development*
- *Ensuring an Orderly & Supportive Environment*

In my study, I found outstanding examples of subject leadership in the schools and institutions in the first three Dimensions: *Establishing Goals and Expectations, Resourcing Strategically and Planning, Coordinating and Evaluating Teaching & the Curriculum*.

The fourth Leadership Dimension, *Promoting & Participating in Teacher Learning & Development*, did not feature as an exemplar of Design Technology (DT) leadership and proved significant for being the biggest issue facing school and academic leadership, not only in the schools visited but reportedly also further afield. This has been included in the section labelled as *Issues Confronting Design Technology Outcomes.*

The fifth Dimension, *Ensuring an Orderly & Supportive Environment*, was certainly present in the schools and institutions visited. I found well-organised, resource-rich institutions, well-supported by school leadership. Examples of this aspect to the Dimension have been included in the section: *Resourcing Strategically*. However, aspects of the fifth Leadership Dimension that refer to student behaviour and engagement are not explicit features in this report, simply because they did not reveal themselves as issues for these schools. It is possible that my interviews did not sufficiently probe this aspect of the Dimension, or the schools visited may have considered this to be outside the brief, however, I gained a very strong impression that in high-quality Design Technology environments, problems of behaviour and engagement were not major factors – rather, that there were high levels of behaviour and engagement present.

[1] Robinson, V., Hohepa, M, and Lloyd, C., *School Leadership and Student Outcomes: Identifying What Works and Why :the Best Evidence Synthesis,* New Zealand Ministry of Education, 2009, p.39.

What was particularly significant was that, while Dimensions 1,2,3 and 5 have powerful presences, and the fourth was relatively absent, it was the sixth Leadership Dimension, *Creating Educationally Powerful Connections*, which proved to be an outstanding indicator of the depth of innovation, entrepreneurship and quality outcomes in successful Design Technology programmes in the schools visited and from the academics interviewed.

I also contend that another dimension that educational leaders must manage in order to promote high-quality Design & Technology outcomes is to confront and overcome barriers to learning. Another dimension has been added with examples and suggested solutions. To overcome these obstacles, it is not only educational leaders but also political leaders who must act, if Design Technology is to take its place at the forefront of any nation's secure fiscal future.

DEFINITION OF 'TECHNOLOGY'

I use the term Design Technology (DT) to distinguish it from an assumption that many people make that Technology automatically refers to ICT (although I acknowledge ICT has a place in the Technology curriculum). Nor do I use the terminology, 'design *and* technology,' so often referred to in the UK, as this infers that design and technology are in some way separate entities, which I think is illogical. Nor am I referring to a 'technicraft' view of technology which implies that we have not moved on from the good old days of 'manual' classes in cooking, woodwork, etc. Nor do I automatically associate DT with science and engineering in the purist sense, though I see the common sense of the links to *applications* of these disciplines.

I define Design Technology as a robust implementation of the NZ Technology curriculum which itself defines Technology as "*intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities*" which has at its heart "*adaptation and innovation*" resulting from "*thinking and practices that are informed, critical and creative*." [2]

I believe the Technology curriculum can be delivered through any authentic context – be it an integrated or a compartmentalised approach normally associated with "subjects" (such as food technology, hard/resistant materials, electronics, control systems, etc.). I believe that contexts are just the vehicles for the more important development of technological literacy and Key Competencies, involving a holistic view which incorporates entrepreneurship, creativity, problem-solving, investigation (inquiry), and innovation.

PURPOSE

The purpose of this study was to find out from world-leading Technology Education academics and from visiting schools with strengths in Design Technology in the UK and Europe, the leadership strategies associated with producing high-quality outcomes in Design Technology. My intention

[2] New Zealand Ministry of Education, New Zealand Curriculum, Technology Learning Area, 2007.

was two-fold: to not only bring any ideas back that would be of benefit to my school but also to compel principal colleagues and, if it is in my power, others of influence in the educational sector, of the national imperative to do better in this subject.

RATIONALE

It is my contention that educational leadership in New Zealand should be doing more to raise the profile of Technology as a curriculum subject worthy of higher prominence.

There is, firstly, a global fiscal necessity for this. If we keep doing what we have always done, we will be a country persistently relying on agriculture, with a brain drain of our best and brightest overseas, and an economy teetering between, at best, adequate and, at worst, stagnating. If we do not deliberately pursue entrepreneurship and Design Technology more vigorously, our country is at risk of missing a golden opportunity to vitalise our economy. Other countries are forging ahead. Two simple examples illustrate this point: the huge investment in Technology education by the Singapore Government, and the promotion overseas of tertiary education in Technology. For example, Delft Technology University is one of three such universities in Holland, and Aalto University in Finland which has entered into a partnership with Stanford University to build a leading entrepreneurial university called the Centre for Entrepreneurship that will focus on innovations, ventures and workplaces aimed at increasing European competitiveness. While NZ cannot match these big budget projects, my point is that we can do a lot more than we are currently doing.

The late Sir Paul Callaghan, one of our country's most influential scientists and High Tech business leaders, believed that Technology has the highly lucrative potential to "transform this country into the creative innovation dynamo of the Pacific Rim" and that Technology combined with Science is the key to transforming our economy.[3] His contention was that just ten NZ innovative technology companies currently add $4 billion p.a. to NZ's GDP therefore if NZ could create 100 new companies producing innovative high-tech environmentally-friendly products, then New Zealand's economy could match Australia's! My theory is if we could add one or more such companies to the list, the result would see New Zealand outstripping Australia's economy - as a Kiwi, I rather relish this prospect!

Another important consideration for why Technology should be receiving higher prominence as a subject arises from that all-consuming need in today's society to bring about improvements in the 'under-achieving tail' of students. The underachieving students are generally those students who are disengaged from the school system, and an all-too high proportion is our Maori and Pasifika students. I believe that placing a vigorous systemic emphasis on Technology has the capability of re-engaging those students because this subject is relevant to their lives and it involves practical and authentic learning. Once students are engaged at school, the need for literacy and numeracy success becomes relevant to them. Rather than a monotonous concentration on literacy and numeracy, we should also be pouring resources into technological literacy and the benefits will follow.

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[3] Callaghan, Paul, Sir 'High Tech is High Dollars' in Education Review Postgrad & Research, 2010, p4

That New Zealand is a long way from achieving success in the Technology curriculum as things stand is demonstrated by NEMP which, in its 2008 Technology Report, found that Technology education in the primary and intermediate sector needs to do better. Their findings show a slight decrease in performance overall between 2004 and 2008 achievement results for Year 4 students and no difference between 2004 and 2008 for Year 8 students. NEMP's 2008 Report results were mediocre, ranging from 27% to 38% of students giving strong or correct responses. This is despite NEMP's findings that Technology is the second most popular subject for NZ students.[4]

The Education Review Office (ERO) found in its Technology Report (2005) that top of their list of recommended improvements was increasing teacher confidence and competence in teaching Technology and in using Technology equipment and resources, as well as in using student-centred teacher strategies rather than being prescriptive and teacher-directed.[5] This situation is not likely to improve in the face of the Ministry's cuts to professional development particularly as they affect Technology.

ERO, in its 2011 report *Enterprise in the New Zealand Curriculum*[6] stresses that enterprise activity can be the most challenging, effective and rewarding learning in a student's time at school but there was a pressing need for a shift in teaching practice if we are to adopt an enterprise approach in our curriculum.

So, given this is where we are currently at, and having, I believe, made a case for why we need to do a lot better, what are the ways that we can deliver the best outcomes in the Technology curriculum?

BACKGROUND

My school's journey in growing our expertise in the Technology curriculum has been huge. In 2008, Green Bay School conducted a routine curriculum review of our Technology programme. The review identified barriers to learning that included: lack of teacher confidence to teach the subject well, a lack of facilities and an absence of tools and materials, and low student technological achievement. The Review coincided with the timing of stakeholder consultation over reviewing the school's 5YA Property Plan. Subsequently, a multi-purpose Technology Room was built in 2009. As this represented a sizeable investment of public and local funds, we resolved to develop our Technology programme to its utmost.

As this juncture, we were given inspiration by reading Sir Paul Callaghan's theories and this led to the vision that the Technology curriculum, along with our specialist Science programme, should have a prominent place in the school. The New Zealand Curriculum encourages schools to develop a local curriculum to meet the needs of their students, which has been a boon in allowing our school to be flexible and give more weight to DT and Science. In DT curriculum planning, we can choose which DT strands we will integrate or whether some will be 'stand-alone' approaches.

[4] *NEMP Technology Report* 2008, Summary, retrieved from http://nemp.otago.ac.nz/technology/2008/index.htm
[5] ERO, *The Quality of Teaching in Years 4 and 8: Technology Report,* (April 2005)
[6] ERO, *Enterprise in the New Zealand Curriculum,* (August, 2011) Overview & Discussion.

It was a struggle to obtain professional development to support our journey as coincidentally with the building of the Tech Room, this was the time when cuts to government-funded professional development meant the facilitator service was disbanded and we could not access Technology facilitators, even if we were prepared to pay. After fruitless endeavours, we literally threw ourselves on the mercy of the University of Auckland who were sympathetic to a school striving to lead in Science and Technology. Through this initially tentative connection, we were able to grow our middle curriculum leadership capacity, and eventually this valuable connection brought us to the attention of a government-funded research project which has provided invaluable professional development support from Dr Vicki Compton, a leading international figure in Technology education, and senior lecturer, Moira Patterson from the University of Auckland. Our school's involvement in their interventionist research project on the development of technological literacy has been an additional impetus. With the project leaders' support, and the evidence of data collected from the research project, our growth in confidence and buy-in from the teaching staff has seen an escalation in the integration of DT into our inquiry learning programme and improved learning outcomes for students. Hence my search to establish whether there is more we should be doing to be the best.

STUDY ACTIVITIES UNDERTAKEN

Finding the people and places to visit in order to put an itinerary together proved a big challenge. My original idea had been to contact the leading technological educational academics and ask for recommendations of schools of excellence to visit. Initially, this was not as successful a strategy as I hoped. Ultimately, I used a variety of methods to assemble an itinerary:

- An approach to DATA (Design and Technology Association, UK) who put out a request for help on my behalf; this produced one positive lead
- Personal friends, or their friends, living in the UK, made enquiries that led to positive recommendations
- Internet research combined with a close scrutiny of school websites meant interminable hours but produced positive leads; I particularly looked for schools' references to Technology, not just under subject specific headings but also in references to extra-curricular activities, school vision, innovative programme descriptions, school pride in technologically-oriented successes, or featured in photos. It was much more difficult to establish primary school leads this way as primary schools unfailingly only demonstrated intent to deliver a broad curriculum.
- Cross-checking schools' Ofsted reports (UK schools only), the equivalent to NZ's ERO, provided another source of useful information. With the worthy exception of two schools, I was able to select Grade 1 'Outstanding' category schools based (rightly or wrongly) on the assumption that schools rated as outstanding in teaching & learning more broadly would most probably be doing a good job with teaching Technology. I had no other practicable, reliable way of establishing a school's credentials.
- Contacting the schools direct eliminated some from the list (not suitable, not interested or not available) but also resulted in principals' recommendations of other schools well-known

in their district for Technology. Most contacts were made via email but a few phone calls were necessary to get a positive response.

- Choices of schools were also made on the basis of ensuring a range: three schools were primary schools (2xYr0-6 and 1x3yrs-Yr6); two were middle schools (Yr 5-8 and Yr7-9). Eleven schools were specialist Technology Colleges (Yr 7-10 and Yr 7-13). The Welsh school was Yr7-19yrs. All UK schools were state schools; 8 were Academy Schools. Seven in UK & Europe were religious character state schools. Two of the European schools were state-funded Montessori schools. There was a mix of urban and rural. One school was a boys school (yr7-5th form) (co-ed at 6th form). Schools ranged in their socio-economic clientele. Sizes of schools ranged from 120 pupils to schools of up to 2,200.

For schools in Holland, I was completely in the hands of my host at Delft University, Marc de Vries[7], who organised school visits and itinerary. My contacts at Auckland University paved the way for me with Marc which is fortuitous as he is considered to be one of the world's foremost Technology educators. The recommendations for schools in Germany came about via one of my teachers who is German and has a friend in the Technology Advisory who, in turn, organised a contact at Potsdam University. This contact then organised all my visits to leading academics, school visits and my itinerary and provided patient translation services. An unexpected bonus visit to a school in Denmark came about through friends in the area. I had also hoped to visit schools in Singapore but, despite seeking the involvement of a NZ advisory agency, after a protracted fruitless effort to make contact, I had to abandon this idea.

In visiting the schools, I provided my research question and some guidance notes in advance. My hosts dictated the time of arrival and length of visit, and what they wished to show me. This usually included a tour of the school and an opportunity to talk to Head Teachers, Heads of Departments or curriculum leaders, and in some cases, groups of student leaders. One school convened a panel of education leaders from local schools and the local education agencies as a think tank to advise me. Issues arose with my visit coming at the end of the UK school year and the start of the European school year, meaning normal programmes were not always operating, but this was offset by staff release time being easier. It was a privilege to have fellow educators so generously open their schools to someone from the other side of the world.

FINDINGS

Not surprisingly, considering the complex world of school leadership, there are a variety of strategies that school leaders have found to be effective in promoting high-quality outcomes in Design Technology. These are as follows:

I Establishing Goals & Expectations

1. **Setting the Vision**:

[7] Marc de Vries, Professor of Reformational Philosophy, Delft Technology University; editor in chief of The International Journal for Technology and Design Education

Research into school leadership has demonstrated that one of the five leadership dimensions that has the most impact on student outcomes is establishing "*the importance of goals by communicating how they are linked to pedagogical, philosophical and moral purposes*."[8] In view of my own beliefs, I was interested to find out if school leaders elsewhere communicated any vision for Design Technology.

I found a variable approach. Some school leaders had not given it any specific thought. Many school leaders just assumed it to be incorporated into their school's more global aspirations for excellence or, as Thomas Estley Community College, Leicester, has done, incorporated it into a vision of "Modelling tomorrow's global citizens." For the panel of educators who met with me at St Peters Collegiate in Wolverhampton[9], their vision is that DT must be considered "an academic course." For Rod Welsh, Head of St Edwards Royal Free School, vision was about children from Year 5 deserving the opportunity to benefit from specialist teaching (across the curriculum). The vision of Ravens Wood School in Bromley, Kent, is to be nationally and internationally renowned - in all areas (including DT). Schools like theirs that are specialist Technological colleges or Technasiums have, obviously, a stated up-front belief that Technology will have pride of place in their curriculum.

Not many school leaders automatically associated a vision for DT with any economic imperative. Rhys Evans, Head of Department at Ysgol Dinas Brân in Wales, has made such a link. He refers to how Britain used to lead the world in engineering, for instance in pneumatics. The absence of pneumatics businesses in Britain today has contributed to drive his belief in the need to address this trend through quality Technology education. Tim Moralee, Head at Thomas Estley College, mourns that "Britain was once the engineering capital of the world. Now they are crying out for engineers."

There were instances where a school Principal's admission that they had not considered a specific vision for their Technology Department was at odds with the passion and vision of their Head of Department. There were also some examples where Heads of Departments were frustrated because they felt Design & Technology as a subject was being eroded for a multiplicity of reasons, including 'politicians and principals just not getting its importance'. This sentiment was mirrored at the PATT Technology Conference, where academics from all around the world shared with me their belief that a lack of futures-focussed vision by principals (and politicians) was part of the problem of devaluing D&T curricula. I also encountered instances where principals held the inspirational view of the importance of Technology because it exemplified a broader vital concept, such as Creativity, while their Head of Department saw the goal was merely 'to simplify and focus on quality and make the subject more efficient in monitoring pupil progress in D&T.' These range of examples impressed on me the need for Principals to ensure alignment of the vision through the school.

[8] Robinson, V., Hohepa, M, and Lloyd, C., *School Leadership and Student Outcomes: Identifying What Works and Why :the Best Evidence Synthesis,* New Zealand Ministry of Education, 2009, p.39.
[9] David Chapman (St Peters Collegiate); Lakshmi Devi (St. Edmunds Catholic School); Neil Kells (Moreton School); Phil Clayton (RAF Museum Education Officer); Amanda Waldron (St. Andrews Primary School).

I met many kindred spirits during my trip who did ‘get it’. Nicki Robertson, Director of Science and Technology and her Head of D&T, Vicki, at Rivington & Blackrod High School, Bolton, have developed a vision for their department as “*Creating Tomorrow’s Entrepreneurs Today*.” This impressive quote features on the wall as you go into the Department, unreservedly stating up-front

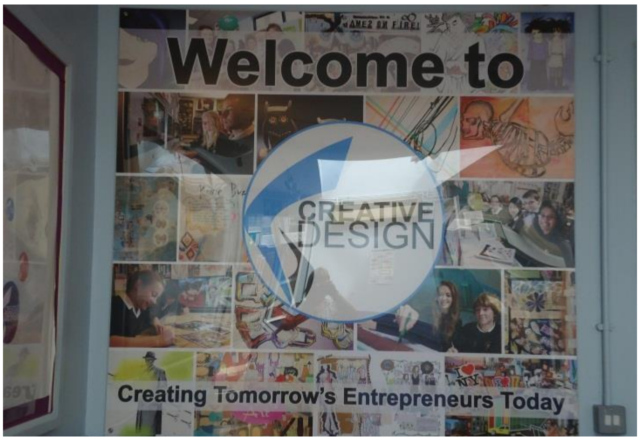


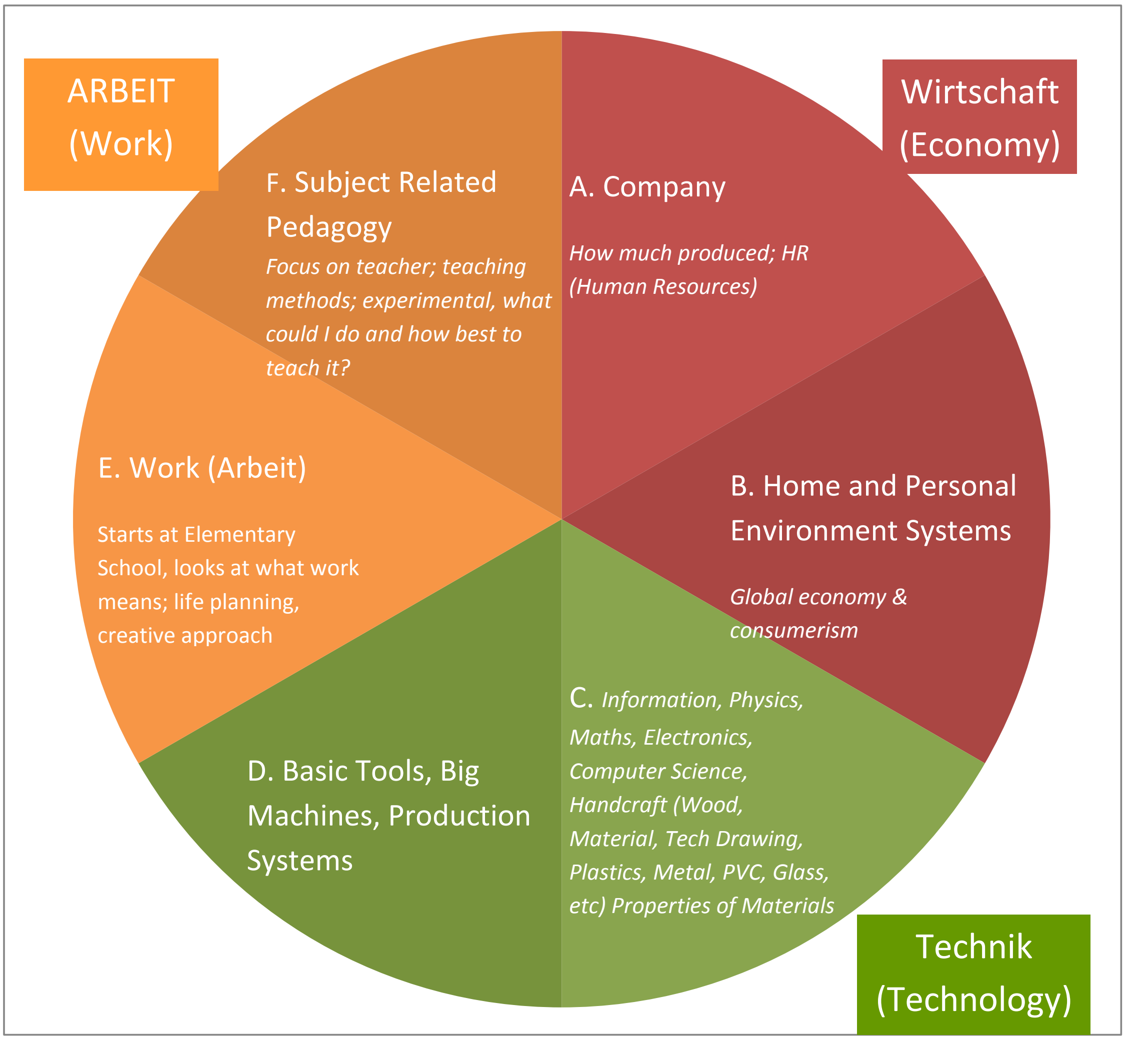
Figure 1 Rivington & Blackrod's DT Vision

what they aspire to achieve. They back it up with a belief that learning will involve a real problem, backed up by research, which pupils then try to solve by designing and developing a purposeful product. For Maaike van der Voort of the Christelijh Lyceum in Delft, the vision is all about promoting Technology because of a belief about the future and creating curious, independent students. Students and their school need to be the best because the Technasium movement in Holland is in its infancy and needs to be proven, an acknowledgement I took to mean that it is also a useful marketing strategy. Jan de Jong, the founding Principal of Melanchthon Bergschenhoek, a Technasium in Holland, shared that his vision right from when the school was first built was that “Technology was the way to go”… “to achieve what education should be like.” The eager consensus from staff gathered around us in the staffroom was that “the Principal’s role is to ‘future-gaze’ – be quicker-thinking in their vision than the staff, to be thinking ahead of everyone.” Both the ex-principal and their new Principal, Gesinus Hospes, are dedicated believers in the power of the Technology curriculum.

One of the best examples of alignment of the vision was in Potsdam, Germany. Each state in Germany has its own Technology curriculum. Brandenburg State defines its vision as “Wirtschaft – Arbeit – Technik” (Economy – Work – Technology). The following diagram may owe something to translation difficulties, but it is the essence of the Potsdam University Technology teacher training programme and what is taught in schools mirrors it.

Diagram A: Brandenburg Technology Curriculum

Teacher Training Model, Potsdam University, Brandenburg, Germany



This vision was replicated in the schools I visited, even to the point of featuring on the walls of Technology suites and appearing as headings in teacher planning. This vision was a broader view of Technology than I had considered. Brandenburg's Technology curriculum demonstrates clear links to the German economy and people's career and lifestyle choices.

Figure 2 Brandenburg's DT Vision, Ernst-Haeckel- Gymnasieum, Werder

2. **Laying a Foundation of Pedagogy**:

The trip made me reflect that it is important for school leaders to establish expectations of teaching and learning by laying down pedagogical foundations. A number of schools stood out to me because they had established a pedagogical basis to their implementation of the DT curriculum.

Ysgol Dinas Brân discovered, in research conducted by Barber in their school and others (1994), that up to 70% of secondary school pupils counted the minutes to the end of lessons and 30-40% thought that school was boring and would rather not go to school at all. To address the problem, Dinas Brân has come up with various pedagogical approaches.

To improve Creativity, they are influenced by Dr Mihly Csikszentmihalyi who is known for his seminal work *Flow: the Psychology of Optimal Experience (1990)*[10] in which he says that people are happiest when they are in a state of complete absorption with the activity or situation at hand, so involved that nothing else seems to matter, not time, food, or ego. Such activities are intrinsically rewarding. To achieve *flow*, several conditions must be met:

- Clear set of goals and progress – adds direction and structure to a task
- Clear and immediate feedback – helps negotiate changing demands and allows time for adjustment of performance
- A balance must be struck between the *perceived* challenge of the task and the *perceived* skills – too easy or too difficult and flow cannot occur. The person must have confidence that they are capable to do the task.
    - Challenge low/ Skill level low = apathy, lack of interest
    - Challenge low/ Skill level high = boredom
    - Challenge high /Skill level exceeded = distress, anxiety

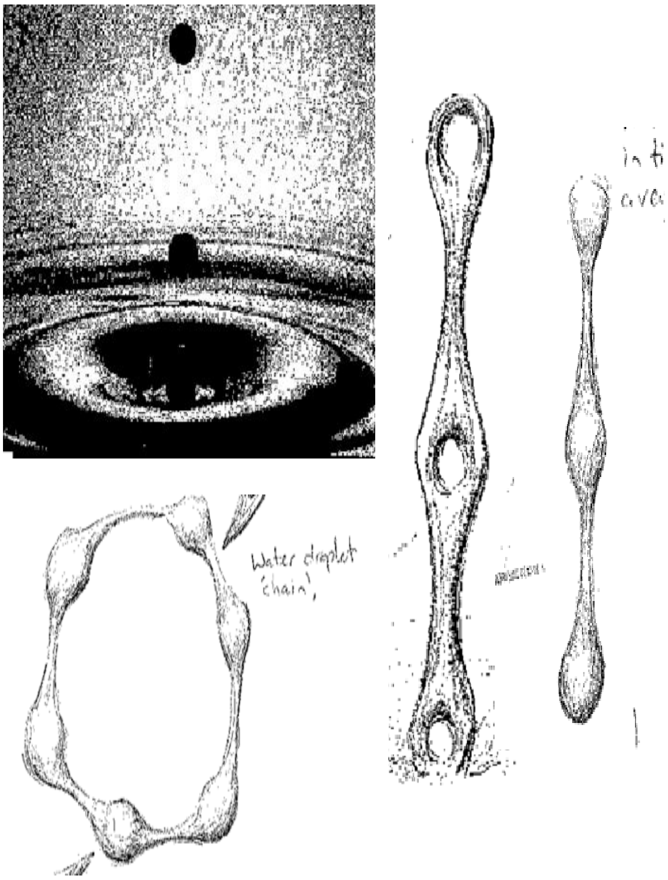
Dinas Brân also uses Assessment for Learning, which is a familiar approach to most New Zealand schools. Following on from Csikszentmihalyi's insistence on clear goals, progress and immediate feedback as being conditions for *flow,* AfL makes good sense. AfL is a strategy that promotes engagement and self-motivation in pupils.

Dinas Brân's D&T Department also learnt from Bill Nicholl of Cambridge University who is a lecturer in D&T education. Titles of Nicholl's research give some hints at his cautionary tales on the perils confronting design: '*Oh yeah, yeah you gets a lot of love hearts. The Year 9's are notorious for love hearts. Everything is love hearts' Fixation in Pupils' Design and Technology Work (11-16 years).*' Also *'If I was going to design a chair, the last thing I would look at is a chair.' Product analysis and the causes of fixation in students' design work 11-16 years.'*[11] He challenges us to consider whether student work truly is original, seeing it as permeated with clichéd images such as Playboy bunnies, hearts, cartoons, football insignia, etc. He refers to this as "Design Fixation" a term coined by Janson & Smith (1991) "as a blind adherence to a set of ideas or

[10] Csikszentmihihalyi, M. (1990) *Flow: The Psychology of Optimal Experience,* New York: Harper & Row.

[11] Cited in Bill Nicholl's profile page, http://www.educ.cam.uk/people/staff/nicholl

Figure 3 Dinas Bran water droplet inspiration concepts limiting the output of conceptual design."[12] Nicholl says teachers are the gatekeepers and solution to the problem. Instead of developing procedural knowledge and using a rigid, structured linear design process, Nicholl suggests some ways teachers can overcome this by using 'Metaphor' (narrative) and 'Analogy' (bio-mimicry; transformation). For example, a notable fashion designer used inspiration from an old perfume bottle to design an evening gown; jewellery can be inspired by a photo of a water droplet; forms inherent in organic designs such as the curve of petals can inspire picture frame designs. HOD Evans believes that using abstract forms creates ideas that are more open to originality and he abhors the use of looking at existing products.



Evans advocates beginning by looking at just about everything else but similar existing products if you want pupils to be creative. He advocates what he calls a "'no naming' rule'. The students are not allowed to name or associate their sketches with anything existing or familiar." Evans believes setting students "the task of analysing existing products as an early part of their research activities is a mistake because it leads to copying and predictable outcomes as pupils search for the 'right' answer. Instead, the teacher should encourage pupils to take risks and realise 'ideas are free' and everyone can and should be different and everyone can still have their right answer. Product analysis is for later in the process when you have a range of ideas and you wish to check how original you have been. These strategies are designed to break pupils out of fixated thinking because naming something brings strong associations with it."[13]

Evans' department, like many other schools, makes use of a wide range of Thinking Skills. Evans includes the strategy of Ockham's Razor which can be applied to reduce the components in a design to the bare minimum required, to give a simplistic but striking effect. He uses abstract drawing exercises such as 'taking a line for a walk' and 'drawing without looking'. He also utilises De Bono's Hats and KWHS tools at the planning design project stage, and PMI (Pluses Minuses & Interests) and OPV (Other People's Views) as evaluation tools.

[12] Nicholls, B. *'Unlocking the creative gates: Who's got the keys?'* retrieved from http://www.asee.org/documents/conferences/international/2009/Nicholl/pdf.
[13] Evans, R., Interview

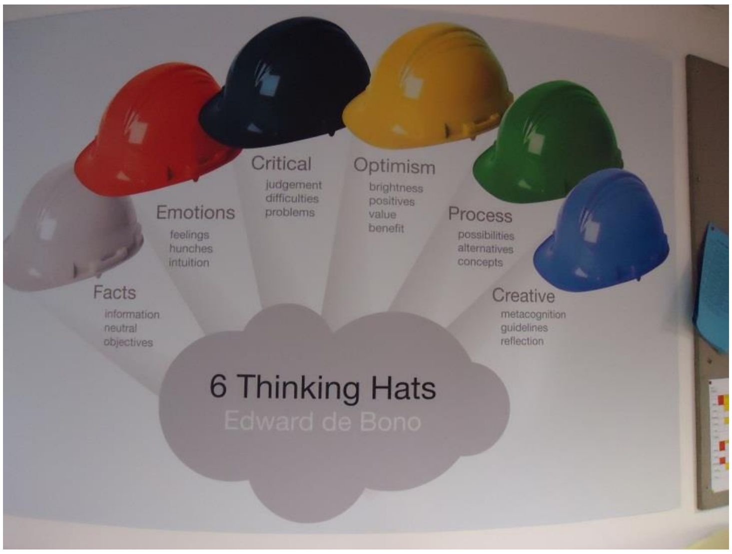


Figure 4 Thinking Skills St Peters Collegiate

A number of Heads referred to Sir Ken Robinson as being an inspiration for the importance of Creativity in their schools. Sarah Longville of The Marches School in Oswestry credited the thinking behind their pedagogy on theories espoused in literature such as: *Creativity: Impetus for Growing Creative Minds* and *High Performers: the Secrets of Successful Schools* (Alistair Smith) and *Accelerated Learning* (Mark Lovatt, Alistair Smith, & Derek Wise).

Figure 5 Ecology of Learning, The Marches School

Rivington & Blackrod High School made an important discovery of a barrier to Creativity which they took steps to address. Their programme used to be more of a 'design and make' basis but the problem with this approach was that pupils would only design what they thought they could make and this limited the scope of their thinking. Pupils thought their 'making' capability might not be good enough. This illustrates one of the constraints of *flow* that Csikszentmihalyi referred to – the pupils' *perceptions* of their making skill evidently created the 'Challenge high /Skill Level Exceeded' that Csikszentmihalyi believes leads to distress and anxiety. Rivington's answer was to

Figure 6 Thinking Skills, The Marches School

design their programme to counteract this trend. Instead of designs always leading to making, they allowed for variations. Some processes lead to a model or prototype; some to making an existing product better, which is then made and marketed (they can use the school's Rivi Studio radio station); a first exam encompassed a familiarity with, and design in, the style of a design era; a second exam in two parts, contained a three hour Innovation Challenge involving a problem which pupils solved following a process; and another three hour exam covered modelling, but not marketing, a product.

Some schools made effective use of models of Personal, Learning & Thinking skills which were used schoolwide. Examples of these were found at Blackrod & Rivington High School in Bolton and Thomas Estley College in Broughton, South Leicestshire. Each area was defined as to what it meant for this school and definitions and features of each were shared with students. Thomas Estley College used bright coloured cartoon figures to illustrate each area.

Figure 7 Personal Learning & Thinking Skills, Blackrod & Rivington School

In Holland, Remke Klapwijh a researcher at Delft University, is conducting interventionist research with schools entitled "Kleuterprojecten 'Nieuwsgieng? Graag!'" (Creativity and Curiosity). This is intended to demonstrate to these schools best practice in Creativity and Technology from around the world. Influenced by Regio Emilio pedagogy, they teach children even as young as 4 years old, to act and think of themselves as Researchers. Many of the teaching techniques described to me were what New Zealand teachers would consider routine teaching approaches. Teaching topics were related to the child and aimed for authenticity. For example, a cold winter last year formed the basis of a unit of work that covered the weather phenomena, the child's experiences, a story book about cold weather, discussion of the type of clothing suited to winter and summer, the involvement of dance, drama, art, etc. From this they look for possible problems to investigate, such as how to stop someone from slipping on icy surfaces. They work on the solutions with the help of a TU (Technology University) student of industrial design who works with the class in great detail.

The adults set an open 'assignment' for all students and expose them all to the same know-how, for example, it might be electronic skills to design an alarm. A Nicholl technique would be to give pupils a sheet of pictures of different solutions, such as an alarm for when a bath is filled, an alarm for when a baby is crying, a house alarm, etc. so the pupils appreciate that there are multiple potential designs. The skills-building might be done before or during the unit, depending on the context and pupils' needs. They sometimes teach different children different skills so each child has some different knowledge to bring to the group.

During the unit of work, teachers and students are exposed to a repertoire of techniques to stimulate divergent thinking, often adapted from actual use in the university's own design programmes, and some from Bill Nicholl's influence. These include *brain writing, brain drawing, guided fantasy and art such as quick collage or painting. Brainwriting* (also known as 6-3-5 Brainwriting) is a group creativity technique used in marketing, advertising, design, writing and product development originally developed by Professor Bernd Rohrbach in 1968. Based on the concept of Brainstorming, the aim of 6-3-5 Brainwriting is to generate 108 new ideas in half an hour. In a similar way to brainstorming, it is not the quality of ideas that matters but the quantity. The technique involves 6 participants who sit in a group and are supervised by a moderator. Each participant thinks up 3 ideas every 5 minutes. The ideas are written down on a worksheet and passed on to the next participant. The participant reads the ideas and uses them as inspiration for more ideas. Participants are encouraged to draw on others' ideas for inspiration, thus stimulating the creative process. After 6 rounds in 30 minutes the group has thought up a total of 108 ideas.

Another creativity technique is *brain drawing. Brain drawing* is a method of drawing and teaching that was revolutionary when Betty Edwards published *Drawing on the Right Side of the Brain* in 1979. Underlying the method is the notion that the brain has two ways of perceiving and processing reality — one verbal and analytic, the other visual and perceptual. Edwards' method advocates suppressing the former in favor of the latter. It focuses on disregarding preconceived notions of what the drawn object should look like, and on individually "seeing" edges or lines, spaces, relationships, and lights and shadows, later combining them and seeing them as a whole. Her works are accompanied with special drawing tools, materials, and videos. Drawing exercises include 'upside down drawing', 'blind contour' and 'modified contour' drawing, negative space drawing, portrait drawing, hatching and cross-hatching and perspective

Guided fantasy is a technique sometimes called Guided Visualisations or Guided Imagery. It is an opportunity for the subconscious to slip ideas through to the conscious mind. It works by [in a school setting] the teacher getting the pupils to be comfortable, sitting still or lying down. The teacher paces their aural text to the listeners' state of relaxation, trying to be slow and gently expressive. The teacher can use a pre-prepared script or make one up. The teacher gets the pupils to close their eyes and visualise something. For example, "imagine yourself [sitting in a field, the grass soft and flowers all around you, perfuming the air.]" The teacher walks the pupils metaphorically through the space they find themselves in, describing using as many of the senses as can be loaded in to the experience. The method can reward participants with significant 'ah-ha' moments even on deep problems, although it can sometimes work one day and not the next. Persisting leads to insights and ideas that will not come through any other method.

Use of art can be useful techniques for inspiration. Quick collage or painting are two examples. Divide a sheet of paper in 4, fill it with associated words and drawings, pass to the next person who adds to it; then use clustering techniques, such as colour coded dots, to cluster the ideas together. The key difficulty for teachers is how to avoid shallow designs by the pupils.

Another pedagogical approach schools found useful is Discovery Learning. Maaike van der Voort from Delft is an advocate of Discovery Learning. This is a pedagogy familiar to New Zealand schools so I won't elaborate on it. Discovery Learning is an approach encouraged from the Dutch Technik professional development. Maaike does do some direct instruction for skills, sometimes at the start of a lesson or as needed. If students get stuck, she says, 'It's your problem, how do you think you might solve it?' This is to build independence and problem-solving.

II Resourcing Strategically

3. Funding

School leaders everywhere face an on-going challenge in the face of cuts or constraints brought about by what is apparently a common reaction of governments generated by today's international fiscal climate. Many school leaders in the schools visited perceive that DT is one of the more expensive school subjects to run. Principals of UK Technology Colleges advise that the government funding for specialist schools has been axed leaving them with the challenge of how to maintain Technology programmes. Lutterworth High School, for example, has lost a million pounds in funding since specialist funding was axed last year.

Some schools are cutting back on the range of DT programmes on offer, particularly Resistant Materials which is considered one of the most expensive to run. Some schools have re-structured departments; some are electing to promote alternative subjects such as psychology and accountancy that are popular with parents and relatively less expensive to run. Fortunately, some specialist schools have opted to continue to give prominence to DT without compromising curriculum delivery. The most common funding solution to achieve this has been to apply to become an 'Academy School'. This means, in essence, devolution from the Local Education Authority which frees schools from the old financial ties and other impositions; schools then have to fund their own services such as HR: payroll, accountancy, etc, and property management, which they can do either by in-house provision, buying back LEA services, or by outsourcing such as utilising a co-operative approach in conjunction with other Academies. Whichever option is elected, there is a strong belief by Principals that there are cost and autonomy benefits which, for many schools, has enabled DT funding to continue. For Nora Roberts, Head of Lutterworth High School, becoming an Academy has meant her school was entitled to apply for a capital injection of money for refurbishment which has resulted in a million pound Design Centre and refurbishment of an old Food Tech Block.

4. Timetabling

One of the ways school leaders can influence DT provision is by how they choose to timetable DT classes.

In John Betts Primary School, London, D&T shares a term with Art, half-and-half, though it is integrated where possible into other curricula and themes. Some teachers teach 1 hour per week of D&T then Art; others alternate fortnightly; some do a half term of each. Classroom Release Time for senior leaders is utilised as an opportunity for D&T. In St Edwards Royal Free Ecumenical School in Windsor, all subjects are taught in one hour blocks, with D&T for Year 7&8 students allocated 2 hours per week for 5 week units; Year 5 students have one hour sessions. Teachers do one lesson on book work and one hour lesson on practical "to pace the lessons' interest factor so that in a term they can fit in five practical 'design and make' sessions." For Resistant Materials workshops, classes are split to enable the required workshop ratio of 1:15; half the class do book work with a teacher aide and the remaining half work on practical activities in the workshop with the teacher.

At The Piggott School in Twyford, Reading, Year 7&8 do 1 Food Tech lesson, 1 Product Design/Graphics per week; the following year, they pick up the other subjects, e.g. Resistant Materials combined with Electronics. This means that by the end of Year 8, they have covered all the basics so pupils can make more informed choices if they elect to continue in D&T. DT teachers have 50 periods of teaching over 2 weeks, 5 sessions per day including 2 home class tutorials.

At The Marches School & Technology College in Shropshire, Year 7&8 have 12 hours per subject per term; a term is divided into two lots of 5 weeks with a week's break in between, which further constrains their timetable and puts pressure on teachers to finish units in 5 weeks.

In Melanchthon Bergschenhoek, Holland, every class does 2 hours per week in the Technasium for Grades 7-9 and after Grade 9 they must choose DT to stay in the Technasium pathway. The school must also decide if students are able enough to stay. This pathway provides for 80 hours per year for 6 years, the 480 hours being considered very good compared with regular Dutch schools.

5. Programming

Another leadership strategy promoting DT is how programmes are structured and what programmes are offered, the most fundamental influence being whether DT is compulsory or optional, and if compulsory, how long a school allocates it this status.

At The Piggott School, D&T is compulsory for Year 7&8, but by choice in Year 9 as part of pupils' GCSE choices. The school offers Catering, Food, Resistant Materials, Product Design, Textiles, Graphics, and Electronics. System & Control is not offered, and Bio-Technology had not been considered. (System & Control was not a notable feature in most UK schools visited and Bio-technology was only included in the curriculum by Technasium schools in Holland). The Piggott School has taken advantage of devolution to change their programme structure so that GCSE can take 3 years instead of 2. By starting one year early, it means they can slot in more diverse opportunities (e.g. students can take two languages instead of one). However, they report less pupils electing to take DT because of perceptions about academia, although Food Tech and Catering have grown in popularity, they believe because of the interest stemming from chef cooking programmes on television.

At Dinas Brân, DT is compulsory up to 14 years old. Students rotate through all the DT subjects. Their belief is that after the age of 14, pupils should be free to drop a subject if they choose. According to Rhys Evans, the school is a "national leader in the UK for success in using CAD." He believes the Welsh DT curriculum emphasis at Foundation level in "openness and creativity, influenced by Reggio Emilio" promotes DT from an early age, and inclusion of "the study of designers, architects, engineers, inventors and food" differentiates the Welsh curriculum from England's.

Thomas Estley College in Broughton Astley, Leicester, offers Textiles, Resistant Materials, Food, CAD, and Product Design. They are renowned as a leader in curriculum innovation. There is weekly provision for Year 7 pupils to focus on developing global citizenship, ICT skills and Personal, Learning and Thinking Skills (PLTS). The PLTS skill areas are: *Effective Participators*, *Independent Enquirers, Self Managers, Reflective Learners, Creative Thinkers, and Team Workers*. Four times a year the College runs Modules programmes involving 12 cross-curricula themes, and every Tuesday afternoon they run Year 9 specialisms linked to 9 vocationally-linked contexts to progress their PLTS curriculum. Included in Specialisms Afternoon for 2012-2013 are 'Engineering Challenge' and 'Building Apps & Computer Programming.' Their challenge is now how to transfer this to the rest of the school.

St Peters Collegiate School in Wolverhampton makes DT compulsory to Key Stage 4 (Yr 9-10). Year 7&8 are exposed to Food, Textiles, Product Design (60%)/Resistant Materials (20%)/Graphics (20%). At Year 9 pupils opt to do just two of these; in 2013 the school is dropping BTAC Engineering and instead offering CAD to improve the Design element of their pupils' GCSE performance. For a 50 minute period every Monday for 15 weeks, the whole school (except the 6th form) do Personal Social Health Education which, for Year 9s consists of the Jaguar Project (more information on this later); the Year 10's ready for work experience and the Year 11's do academic tracking and intervention.

Rivington & Blackrod High School in Bolton makes Technology compulsory to the end of Year 9 and thereafter it is an available option, offering Food, Textiles, Engineering, Product Design, Art & Design, CAD, Radio Production, Moving Image Technology, or combinations. DT used to be compulsory beyond Year 9 and they report that numbers pursuing DT have dropped. They have restructured so that Technology is now part of the Science Department, and as a subset of this, DT has been rebranded as 'Creative Design' which includes Art. They report that when they assess their Year 7 students "the standard of DT knowledge from contributing schools is very variable". Their P.O.W.E.R.W.A.V.E. Skills Centre offers innovative provision for 14-16 year olds vocational skills in construction and build industry such as tiling, bricklaying, etc. Set up to cater for disaffected students who need a non-traditional mode of education, it is also open for students from other schools.

Other schools offer fewer choices of programmes. This can be for a variety of reasons: lack of qualified staff in particular fields, or having "3 old dinosaurs in DT who don't work as a team." One school tried to provide, as an addition to Textiles, Food and Resistant Materials programmes, Product Design to provide GCSE studies at Year 9, to enable them to work in partnership with the nearby College who take their students from Year 10. This venture was initially unsuccessful - though the Principal has not given up on the idea. In one of the Montessori schools in Germany, Geschwister-Scholl-Grundschule, Woodwork, (plus Personal and Economy) were all that were offered because of restricted staff training and limited workshop facilities.

Ravens Wood School, in Bromley, Kent, is notable for DT being compulsory for all students up to 16 years old, however, having a small staff means their focus is narrower, settling on Graphic Products and Resistant Materials. They are building a Food Tech Room, being designed in an amphitheatre style where the teacher will model in the middle while being videoed on to a big screen and students will move to a 'break-out' section to do the practical work. Textile Tech is being offered from 2013 but will not be a GCSE subject and will cater for products of interests to boys.

In Germany, the areas of Berlin, Brandenburg, and Hamburg are similar in that Technology is a subject pupils can take for the whole of high school, according to Professor Mette, Head of Production Systems at Potsdam University. In Ernst-Haeckel-Gymnasium, a specialist Technology high school, Technology is compulsory for everyone in their school. Their school starts at Grade 5 which has compulsory technology. In the 6th and 7th grade classes there is ***no*** Technology (at a Gymnasium school). The 8th and 9th grades have Technology. From the 10th grade, pupils must choose one of the three: Informatik, Natural Science or Technology, and then they must stay with it through to grade 12.

6. Staffing

This is one of the areas of resourcing that most taxes school leaders: providing high quality teaching staff who are qualified in DT and have the right progressive up-to-date attitude and methodology. The complaint about the "the three old dinosaurs" in the section above was typical of the constraints principals were under in effecting improvements in DT, not helped by the difficulties regarding access to professional development.

HOD's in the big colleges visited, and curriculum leaders in primary schools, are of vital importance to the flourishing of DT. To perform their roles, resourcing is needed for classroom release. This can be a challenge, especially for smaller schools. At a small school like Newtown CE Primary School in Wem, Shropshire, the release provided was because the curriculum leader happened to also be the Deputy Principal and was given 1 day per fortnight for management release. Their Curriculum Leaders are not automatically released or paid for the responsibility as it is considered part of the role of every experienced teacher. In Newtown School, Subject Leaders' roles included a mini SEF (Self Evaluation Framework) of their subject that reviews the quality of subject teaching, also an annual Evaluation of their subject which they report to the Principal on teaching, planning, children's work, and test results. Rebecca Higgins, the DP and leader of D&T, also writes the DT planning for the whole school, checks teacher planning in DT, models lessons or supports teachers, provides professional development (PD), interviews students about DT to ascertain student voice, and evaluates DT curriculum delivery design. She designs the school's DT overview, basing this on skill-sets such as "Structures", "Control", "Textiles" and then listing the possibilities of topics that teachers could choose from so that teacher creativity is not constrained to one topic but also so teachers are supported with topic ideas they might not have otherwise thought of. Rebecca perceives that her role is also to promote students' awareness of the world of design.

The HOD at St Edwards Royal School gets 2 hours per week release time and 2 hours normal CRT entitlement. Her responsibilities centre on tracking and monitoring and ensuring student achievement; she plays a part in performance management of staff but this was mainly a senior management responsibility. At The Piggott School, the HOD teaches for 40 out of the 50 hours over a 2 week period. Her responsibilities include day to day running of the department, exam entries and successes, data tracking and target grades, and syllabus design and curriculum development.

In a predominance of schools, issues were forcing Heads to make staffing changes. Usually this involved – or had already involved - promoting a dynamic, often younger staff member into a position of responsibility over more experienced 'old dinosaurs,' or bringing in someone from outside who could bring in new and dynamic ideas. To recruit the right people, schools like Ravens Wood employ graduates straight out of DT fields at university and support them through an on-site Graduate Training Programme (GTP) to gain Newly Qualified Teachers (NQT) status. This is externally monitored by Ofsted. Technasium schools in Holland also make good use of university graduates. Maaike van der Voort has a degree in Research and Design and comes from an industrial engineering background; she is employed as a DT teacher while still working one day a week out in industry to 'keep her hand in.'

Heads frequently look to new staff to plug perceived gaps, such as one school requiring a new HOD with more STEM experience (Science Technology Engineering & Maths, i.e. applied sciences). Rivington & Blackrod has employed a young man for Food Tech as a non-traditional role model.

In a few cases, Heads were playing a waiting game, waiting for an HOD to retire before believing they could bring in the changes they desire. In one instance, a Principal reflected on my conversation with one of their 'dinosaurs' and observed that I had made more progress with challenging their teacher's thinking in a half hour than the Head had achieved to date; the Head reflected she needed to up-skill in knowledge of DT to conduct more effective DT-oriented learning conversations.

Induction was another aspect of staffing worthy of note. Dinas Brân sensibly advocates a 6 week training programme in practical skills for new staff. New teacher training programmes often had not prepared them for practical aspects such as use of specialist equipment, even fundamentals like sharpening the lathe.

Another interesting idea I picked up from Tony Purcell, Head at Rivington & Blackrod affects the mentoring of new staff. Included in his leadership development programme was Brent Davis's "Animals of Change" or "Creatures of Change" framework. New teachers can be thought of as "Sheep" who have a lot of potential, given time and experience. Existing staff can be divided into "Foxes" (wily old cynics); "Owls" (mature, sophisticates who make things happen) and "Donkeys" (stubborn resistors). The trick of leadership this model suggests is to develop strategies to protect the "Sheep" so they become "Owls"!

7. Resources and Facilities

Good leaders provide appropriate resources and learning environments, obviously within the constraints of funding. There was a huge range of resources and facilities observed on my travels by the very differences in size and specialism of the different schools.

7.1 Facilities:

On my trip I saw each end of the spectrum of facilities housing DT programmes.

At one end of the spectrum was John Betts Primary School which was typical of most primary schools in its reliance on using the general classroom for DT delivery but which also experienced severe constraints from inner city over-crowding. They provide portable kits of tools and materials for classes to use for DT.

Figure 8 Storage Units, John Betts School

Figure 9 Resistant Materials Storage, Lutterworth High

The other end of the spectrum featured facilities that were brand-new, modern and dazzling, spaces which, just by their design and appearance, made a statement about the importance of this subject in their school scheme. Photos are the best illustrators.

Figure 10 Entry to Design Department

Figure 11 Textile Room, Lutterworth High

Something which struck me was the inspirational quotes that appeared on the walls of many DT suites in many different places. These were certain to give students pride, inspiration, role modelling, and food for thought. While this theme was carried on to other departments in some schools, it was generally a feature that stood out as personal to DT departments.

Figure 12 Foyer Quote, Blackrod & Rivington High

Figure 13 DT Dept Computer Pod, Lutterworth High

Figure 7 Design Department, St. Peters Collegiate

Figure 14 Foyer Display, St Peters Collegiate

Figure 15 Textile Display, The Marches School

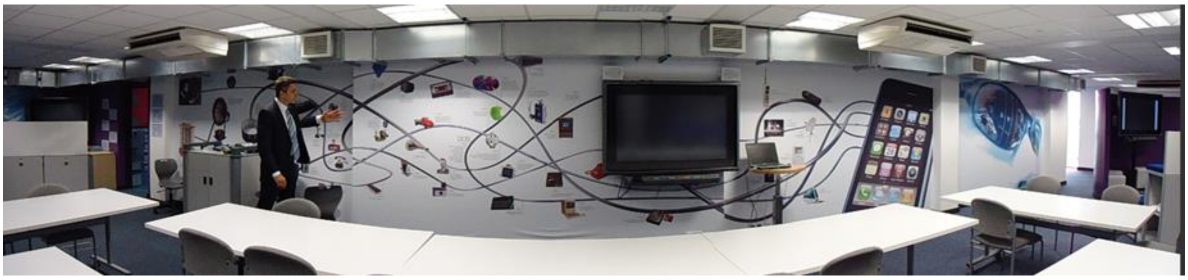


Figure 16 Design Centre, St. Peters Collegiate

Figure 17 Furnace, Lutterworth High

At the end of the day, facilities are only window-dressing. Staff at Ravens Wood, considered their facilities to be “antiquated,” yet they were amongst the most innovative schools I visited. In contrast, the A.P. Møller Skolen in Niebüll, Germany, one of the most stunningly designed and equipped schools, delivers a technicraft programme and has difficulty in conceiving of a futures-focussed curriculum because of their conservative parent body. It is not facilities that make the biggest positive impact; and it’s not necessarily a reflection on teaching - I’m sure there are quality DT teachers in these establishments; it is the *how*, the *why* and the *where to?* that makes the most difference.

7.2 Hardware and Digital Resources:

As expected, the specialist colleges have far more resources by comparison with most primary schools. The Resistant Materials teacher at Lutterworth High School proudly showed me their two heat presses; the brand-new one can print on to any surface including tea-shirts, cups, mugs, etc., a technique referred to as “Sublimation Printing”. The teacher positively glowed when he discussed the impact of new technologies on students, believing they open up a more creative world such as Walt Disney had envisaged when coining the term “*Imagineering*.”

Many of the big UK schools had 3D laser cutters, 3-D printers, routers, equipment for moulding plastics etc., even Sticka Machines (Vinyl Cutters) that print personalised student-designed stickers for a professional look (cost to one school was £300). Students now have the opportunity to design using CAD, use a 3D printer to create a model, then transmit to a laser cutter. Pupils told me how impressed they are that they can get instant gratification from testing out the accuracy of their designs and how polished and professional the final outcome appears. Schools reported their 3D printers cost between £14,000 - £20,000. As I had no idea then if such equipment is used or available in NZ, one HOD recommended Technology Supplies Ltd in Shrewsbury as a source, but cautioned that NZ schools would need to ensure the ready availability of parts if they were ordering from overseas. When I visited the Science Centre in Delft, I was introduced to the term “Fab Lab,” a patented concept for four machines that, between them, purportedly have the power to reproduce everything in our developed lives: 3D printer, woodcutter, laser cutter, and vacuum moulder. The Science Centre could only afford two of these machines (so far), but it was interesting to note that most of the big Technology Colleges in the UK already had all four types of this equipment. This led me to the conclusion that, relatively speaking, UK high schools were very well-resourced. At the PATT Conference, David Barlex spoke about

Figure 188 Laser Printer, The Piggott School

such equipment as examples of “disruptive technologies”, claiming that their impact is going to be so profound that it will change the face of manufacturing world-wide.[14]

Figure 19 Sticker Machine, The Piggott School

Figure 20 Molding Machine Blackrod & Rivington H.S.

Figure 22 3D Printer, St. Peters Collegiate

[14] Barlex, D. & Stevens, M. *Making by Printing – disruption inside and outside school?* Readings from the PATT 26 Conference, Technology Education in the 21st Century, Stockholm, June 2012, p64.

Figure 23 High Speed Router, Dinas Bran

Figure 24 Rhys Evans, HOD, & Laser Cutter, Dinas Bran

Figure 25 Convection Oven (Bending Machine), The Marches School

Interactive whiteboards were prolific, including in primary schools. Ravens Wood School had their interactive whiteboards run from teacher i-pads which meant teachers can photograph student work in progress and instantly put it up on the screen as a demo for class discussion (an important teaching method as, one of the controlled assessment requirements for exams like GCSE is that feedback must be given to all students collectively rather than individually). In other schools, for example Rothley Primary School, scanners are used and in Rivington & Blackrod, "Visualizers" put up work samples on a big screen. In all departments at Thomas Estley College, e-Beams turn whiteboards interactive.

Figure 26 Visualiser, Blackrod & Rivington High

7.3 Computers & Software:

Computers were plentiful in most schools, with many of the colleges having additional spaces specially designated for the DT Departments to house banks of computers just for DT departmental use. At Ravens Wood (and other schools that also use e-portfolios for GCSE work), their 100 departmental computers were considered essential. Ravens Wood's DT Department avoids using paper copies, making the point that industry does not use 2D anymore. All of their templates to guide independent student learning are loaded into their Virtual Learning Environment, A.L.G. (Always Learning Gateway), characterised as a green frog portal on their website. Because of pressure from numbers of students and exam-oriented deadlines, computerised learning support is vital; the DT staff at Ravens Wood believe in enforcing deadlines to prepare students for the rigours of industry. Rothley Primary School has experimented with a Virtual Learning Environment partnership with their high school using "passports for learning." Thomas Estley Community College has a virtualised network; because "virtual servers don't crash," they can operate "2 servers instead of 16," and "use thin and fat clients." St Peters use Virtualised Learning software *Realsmart Cloud* which is utilised to run a virtualised environment across the school to give guidance for lessons; teachers can create virtual lessons and include links to *Youtube* and *Prezzi* as well as to links to other teachers' or school documents; students can elect to follow the links they need; this means they can work at their own pace and be more independent, both at home or at school.

I-pad usage, while not overwhelmingly noticeable, was certainly present. Rhys Evans recommended the following free I-pad Apps: *Force Effect, Force Effect Motion, 123D Sculpt, 123D Make.* He advises that *Autodesk* have plans to release free software all over the world to make this integral to all DT programmes and all ages. Rhys has used *123D Make* with 6 year olds; the touch on a screen generates a 3D image which converts into a pattern or plan that can be cut out using a laser cutter. All the aforementioned Apps and other 123D Apps can be used with a laser cutter.

Figure 27 CAD Autodesk design, foyer, Dinas Bran

Software that enhances DT was also recommended by David Chapman of St. Peters: *Space Claim 3D*, *Scratch* (free game-making), *Stencyl Works* (advance version of *Scratch)*, *Voice of the Learner (*Google Apps*)*, *Hypershot Bunkspeed* (rendering 3D design), *Key Shot* (rendering) *Image Manipulation*, *Lego Robotics*, *Mediator* (e-portfolio creator), *Digital Champions*, *Coveritlive* (a free App that creates a blog from a Smartphone that is useful for EOTC trips because of its live link so that parents or school can see what students are doing in real time.)

Figure 28 ICT Centre, partial view, The Marches School

Sharon Geddes at The Marches School advocates *2D Design* (younger students) *and Pro Desktop* (older students); *Space Claim*, *Circuit Wizard* (for programming chips), *Makey Makey* (an input device from the US; refer to YouTube) and *Scratch.*

Scratch is being used in UK to expose even young students to computer programming to design games. *Scratch* was developed and made available for free by the Massachusetts Institute of Technology. The *Code Club* is an initiative dreamed up by Claire Sutcliffe and Linda Sandvik and aims to give primary children grounding in programming code by offering after-hours programmes. A pilot scheme is being run at Soho Parish School in London’s West End. With Level 1 consisting of designing a game and a script called ‘Whack-a-Witch’ complete with sound effects, and Level 2 called *Fish Chomp*, it is evidently highly engaging. The *Code Club* is working on strategies to get students understanding why they are doing something, to overcome the issue they identified of children who were just matching the instructions in a pictorial way.[15]

7.4 Written Resources:

UK schools rely heavily on several main resources for DT programme guidance: QCA (Qualifications and Curriculum Authority), AQA and the newer LCP resource. The QCA was a quango of the Department for Education, responsible for matters concerning national curriculum development and associated assessments, tests and exams. Now defunct and its functions dispersed to other bodies, in its heyday it produced written material that became a standard for planning DT programmes, and the guide for high schools in the requirements for achievement in national exams. AQA, one of the three main UK exam boards, offers teachers a DT resource bank and other forms of support. LCP is the trading name of Language Centre Publications Ltd which sells educational resources including *Design & Technology Resources*, *Design & Technology Make it Easy CD* and *Design and Technology Show me How DVD Set* suitable for Years 1-6.

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[15] Marsden, R. ‘The first rule of code club: have fun!’ in *Unknown daily paper,* pp30-31*,* Thursday 19 July 2012, UK.; refer also to www.codeclub.org.uk.

Another notable resource for UK teachers of Key Stage 3 and 4 (11 - 16 yrs) is the *Nuffield Secondary Design and Technology* curriculum materials (http://www.nationalstemcentre.org.uk). I learnt about this resource from meeting one of the Nuffield Directors, David Barlex, rather than from encountering schools that were using this resource. David Barlex has been commissioned to revise this resource in line with the NZ Technology curriculum.

In Brandenburg, Germany, schools are provided with Technology textbooks for various age-levels. I saw a Year 6 text in use by Mrs Schultz, the DT teacher at Geschwister-Scholl-Grundschule (a primary school in Falkensee, Germany) who used it as a shared reading text in a woodwork lesson on safety in the workshop. Mrs Schultz used also made use of purchased woodwork kits that contained everything needed for one child's project - pre-cut lengths of wood and hardware, screws, etc., the only variation being the degree of decoration, colour and pattern added by each child.

On one hand, texts and written materials give support and guidance to teachers, especially those who have not had the benefit of on-going or wide training in DT, but they do run the risk of disengaging students and cloning outcomes. As I travelled around schools, the technological outcomes produced by students, particularly UK schools that relied just on these resources, had a monotonous sameness about them. The concern for me as a principal would be whether they were opening minds to infinite possibilities or closing them.

7.5 Web Resources

In UK, the Design And Technology Association (DATA) has a website which has been set up to support schools at different levels. There is a certain amount of helpful information available to the general public and, for a membership fee, access to more in-depth on-line resources. The Dutch Technasium schools find two websites useful: www.technasium.nl and www.platformbetatechniek.nl (in Dutch).

I discovered the Dyson Foundation website whilst writing this report. The Foundation was set by the renowned engineer James Dyson to "solve the 21st Century challenges of sustainability, housing and an aging population [requiring] more engineers." The Foundation's aim is "to support design and engineering education." It has links to videos relevant to innovative design and designers; teaching resources; product analysis and engineering resources; lesson plans and student challenges; and illustrative information about the Dyson Design Process.

III Planning, Coordinating & Evaluating Teaching

The digital age is changing the way schools are teaching DT. Some examples have already been included in the afore-mentioned Resourcing section including a reference to the potential for disruptive impact on teaching methodologies.

8. Graphics Teaching:

Schools are phasing out technical drawing on paper to mirror what they say is happening in industry. Lutterworth High School uses *Techsoft 2D* software to teach 2D design. Dinas Brân, claiming a reputation in the use of CAD, uses *Autodesk Design Suite* which they say is suitable for all ages, staff having used it even with 6 year olds. *Photoshop* was used in some schools to enhance CAD. In Year 7, Lutterworth High pupils are using *Google Sketch-up* to create CAD designs. St. Peters Collegiate in Wolverhampton used to use *Pro Desktop* but now prefer *Space Claim* which, according to HOD David Chapman, is "a free industry standard software that allows pupils to draw in 3D [and is] like *Google Sketch-up* on steroids." To David Chapman, through the use of modern industrial software and production methods such as 3D Rapid Prototyping, students can be creative on paper and realise that design in 3D. The Marches School uses *2D Design* for their younger students and *Pro Desktop* for the older, HOD Sharon Geddes believing *Google Sketch-up* to be too open – "it's good for designing houses but it doesn't lend itself to product outcomes." She believes *Space Claim* is better for sizing.

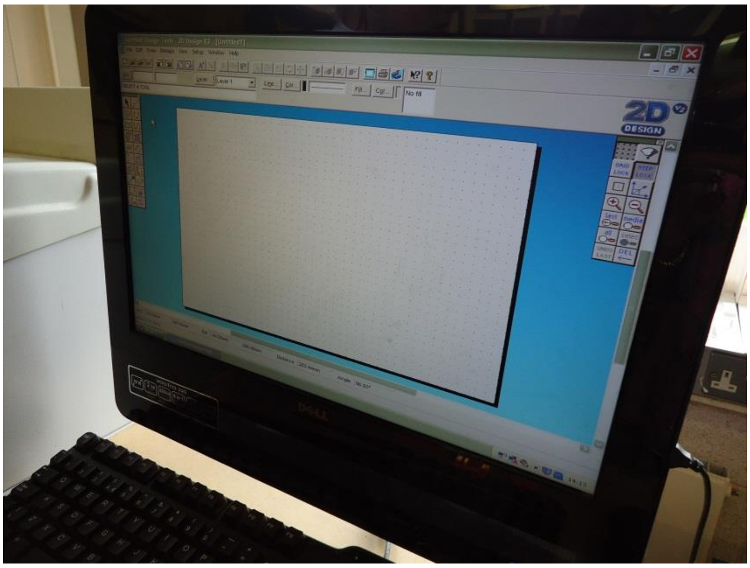


Figure 29 2D Software, The Marches School

9. Teaching Sequences & Ideas:

In teaching, most schools followed a process and skill-sets demanded by their exam systems. Some of the skill-sets reflected in portfolios at Ravens Wood were: researching particular products or technological artefacts; cultural understandings of products; sustainability issues; Creativity; the social, moral and environmental impact; students' initial ideas; the models created; the construction phase; the final design selected; orthographic depictions; plans; photos; and an evaluation of the product.

Rivington & Blackrod's Year 7 Design Theory programme looked at: Briefs, Mood Boards, Adaptions, Step-by-Step Methods, and Self Evaluation. These linked to skills required at higher levels. The textile teacher had developed a useful method of Help Cards available to scaffold pupils if they were in need of help. She also had Step-by-Step Cards that set out all the basic skills or techniques so that students could try to help themselves independently. This reduced the pressure on the teacher when too many students demanded help at once.

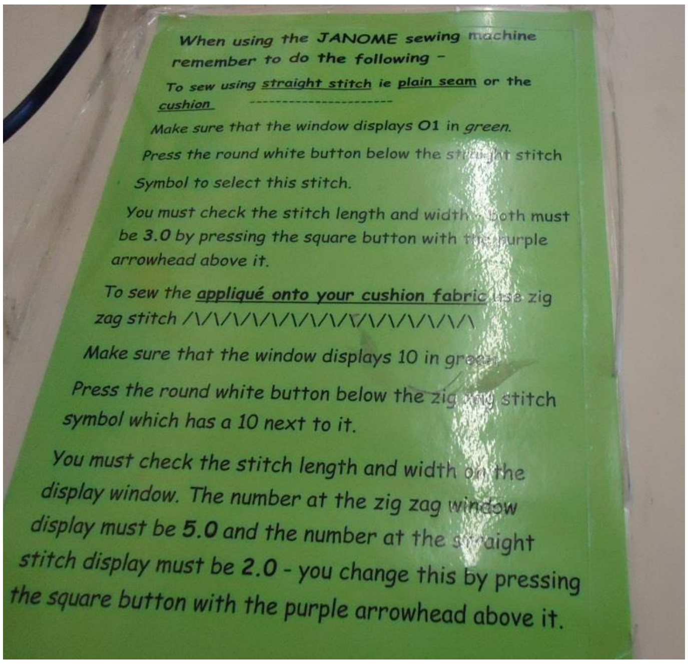


Figure 30 Help Cards, Blackrod & Rivington High School

At St. Edwards Middle School, a typical unit followed a sequence:

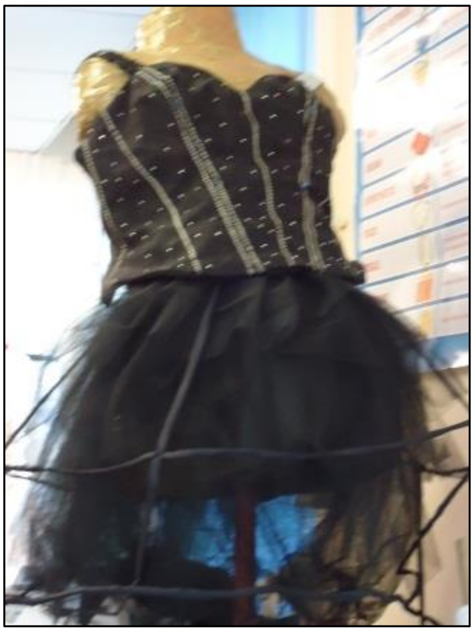
- Teacher-initiated Design Brief
- Brainstormed initial ideas
- Task Analysis which included teacher directions and a child-initiated Mind Map of things the student needed to consider
- 20 thumbnail sketches of initial design ideas from which the student selected their preferred option
- Rendering Exercise in which students practise colouring shapes to create a 3D effect and to show where the light is coming from
- Design Specification where the student considered: Aesthetics (appearance), Cost (Price Range), Customer, Environment (where it would be used and how eco-friendly the product would be), Safety, Size, Function (what job it does) and Materials.
- Design Development where the student drew up three detailed versions of a design and considered the pros and cons of each.
- Final Design - neatly rendered and fully annotated including dimensions, materials, special features etc.
- Inspiration page which contains reproduced images and photos pertinent to the design
- Health & Safety considerations and accompanying activities
- Designers Study – an activity on the role of Designers in society
- A net design for packaging for the product
- Final Packaging Design produced on CAD
- Step-by-Step Instructions on How to Make the Product
- Self-Evaluation

- Peer Assessment using a Star Diagram against the criteria of Creativity, Does it meet the specification and brief, Saleability and Quality of finished product, with the addition of written Strengths and Suggestions
- Homework – activities, for example, Safety Symbols & Which would be added to packaging and why?

Figure 31 Inspiration Board, The Marches School

For Textile DT at The Piggott School, under AQA exam board requirements the key steps were:

- context or brief; research;
- design specs which were a summary of all the research;
- Product Analysis;
- a Client Profile identifying the client;
- Inspiration or Mood Boards which included pictures from magazines, web, words, sketches;
- a Trend Board that looks at current and future products. Products could be linked to historical trends, or designers' influence, or design movements (e.g. in Resistant Materials, this could be Memphis or Art Deco).
- Considerations pertinent to the context were accounted for, such as whether the product was a costume, whether it was going to require links to other areas of DT such as addition of



Electronics (for example, the use of LED technology in a Katy Perry-influenced costume design, or circuitry in an i-pad docking station design).

- Development of initial ideas included a large number of sketches; developed ideas; developed designs and the final design.
- Development Plans included identifying what the student had to look at (e.g. colours, materials, components, etc.); this was further developed into a Development Plan for Fabrics, a Development Plan for Materials, and the Development of a CAD drawing or, in Textiles, a pattern which should include how the pattern becomes altered and the making of the pattern.
- Development of Current Trends would show how these might influence the product.
- A Project Plan was required to identify a timeline and actions to be taken; this was usually in the form of a Gantt Chart (a type of bar chart that shows a project schedule)[16].
- The Manufacturing skill-set was about the actual making process.
- A Making Diary required that every little step taken was recorded and demonstrated using a series of small thumbnail sketches that were annotated.
- A Flow Chart was part of the Making skills.
- Materials Testing should test fitness for purpose (e.g. of any fabric proposed to be used).
- A Standards section looked at aspects such as risk assessment, quality control, and health & safety standards.
- Product Assessment followed.
- The Evaluation skill-set required that the product was tested or used (e.g. the garment worn), wearer/user feedback obtained; a critique of whether they had met their specifications or not, a comparison made to an existing product, and client feedback obtained.
- A Manufacturer's Report was expected to identify what problems the manufacturer of the product might expect (e.g. slippery fabric).

The processes and skills taught at earlier levels of schooling, as illustrated in the St. Edwards example, illustrate how they form building blocks for later development in high school, as illustrated by The Piggott School example. Below are photos of some of the skills and processes developed at Ysgol Dinas Brân.

[16] Refer to Gantt Chart on YouTube for 'how to' instructions

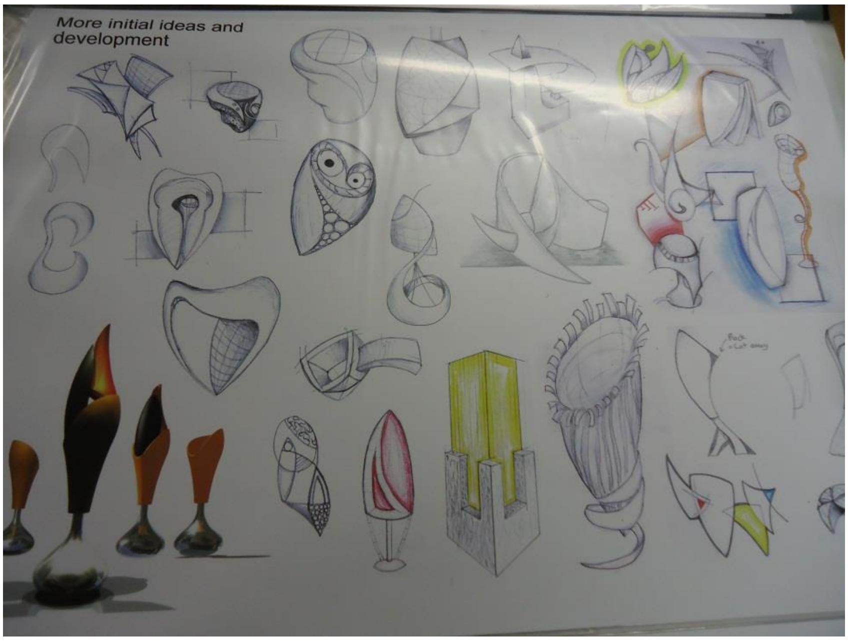


Figure 32 Stage of Ideas Development, Dinas Bran

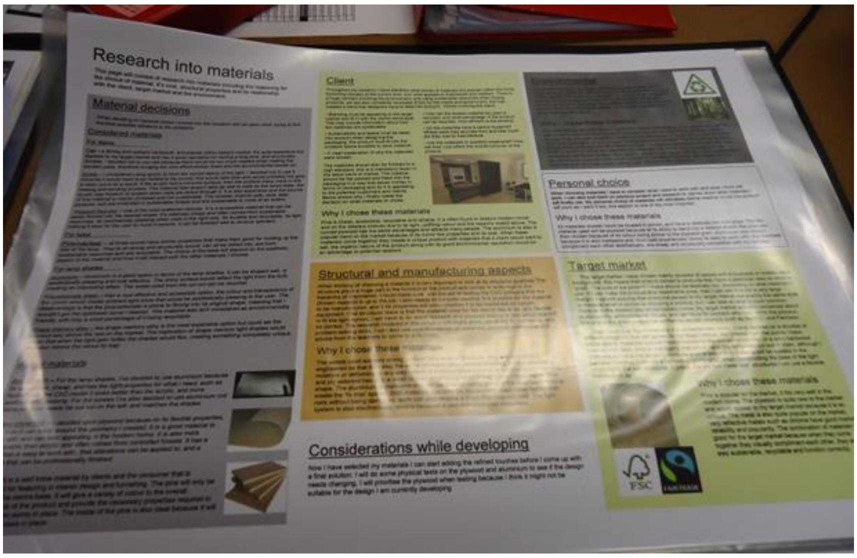


Figure 33 Research into Materials, Dinas Bran

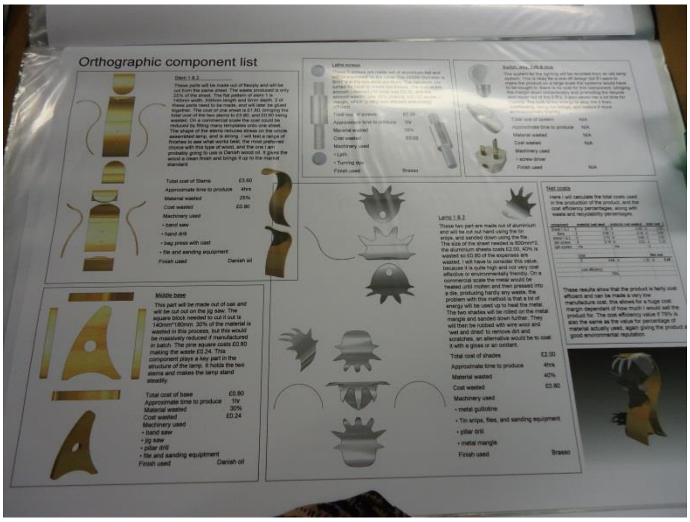


Fig 34 Orthographic Component List, Dinas Bran

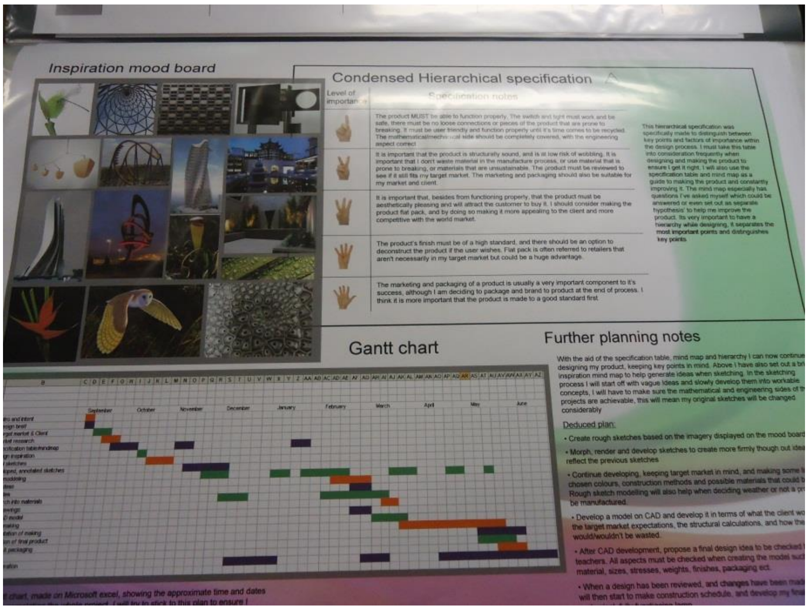


Fig 35 Inspiration Mood Board and Gaant Chart, Dinas Bran

Figure 36 Stages of Making Chart, Dinas Bran

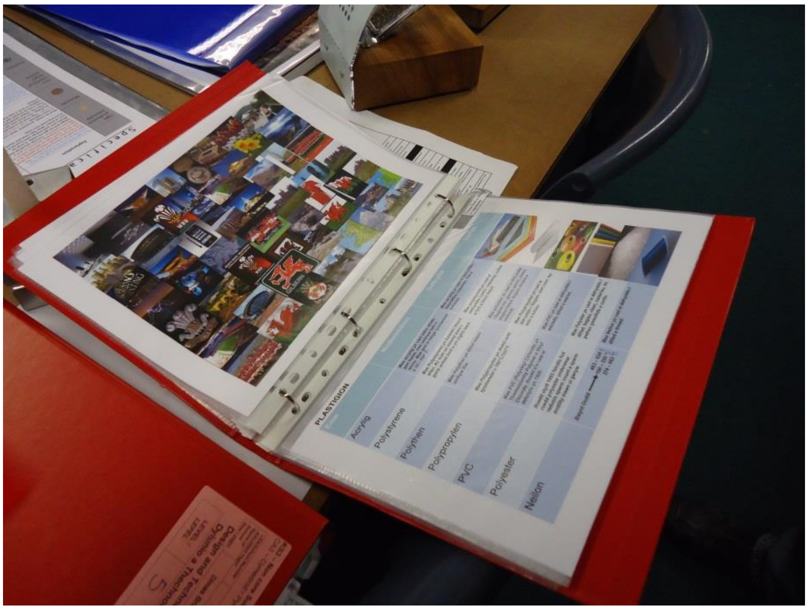


Figure 37 Year 8 Portfolio Mood Board, Dinas Bran

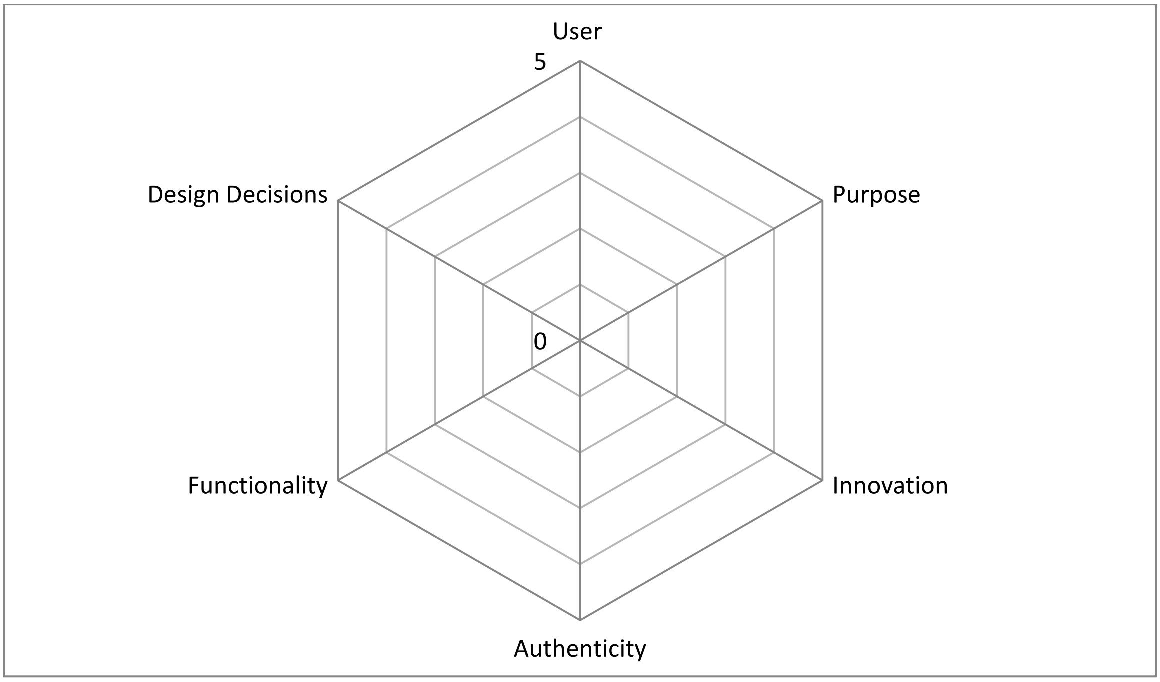
In Potsdam at the Ernst-Haeckel-Gymnasium, pupils start their learning journey with basics such as learning to read drawings. The programme is heavily teacher-directed. From the 10th Class (16 years), students may start to have more discretion over design and make their own ideas. From the 11th Class (17-18 years), students are given a problem to be solved and Mr Zube believes that there is more openness about how they can go about it, for example, a class of 18 year olds, in an electronics lesson, was given a task of designing a circuit to fit in the confines of identically-sized circuit boards, incorporating a super-conductor; it was up to their discretion where they placed the components as to how the circuit looked, so long as it worked. Translation difficulties meant I was not able to ascertain how teacher-directed, or open and problem-solving, the ultimate aim of designing a street lighting system was to be.

At Newtown School, Deputy Principal and DT expert, Rebecca Higgins modelled an example of a typical DT lesson for me, using her Year 5/6 class. She began by stating the aim of the lesson in true AfL fashion, then linked to students' prior learning where the class had looked at an old-fashioned blade-type electric fan and had compared it with the new Dyson Co. fan that has no blades or wire protection.

Figure 38 Rebecca Higgins, Newtown School, Wem

Using a spiderweb diagram, which is a common graphic organiser used in UK DT programmes (see Diagram B), Rebecca talked the students through each of the 6 Essential Areas which constituted good design. Each area was discussed, with Rebecca ensuring that the students first knew what each term meant. Students related each area to the design qualities of the new-style fan; sometimes they used the areas to also compare and contrast with the traditional electric fan design. Using the criteria, students could come to their own conclusions about whether the new fan met all the six criteria for a "good design."

Diagram B: The Six Essential Areas of Good Design



Rebecca then showed a number of photos of different products and invited the students to work in pairs, discuss and rate the object from 1 to 5 on their web diagram (these resources are available to members on the DATA website). The pairs then shared their thinking with the class as a whole. This process was repeated for a variety of artefacts that were depicted in photos:

- Butter cutter
- Toaster with see-though sides
- T-shirt with symbols on it to enable the wearer to ask questions in a non-English speaking foreign country

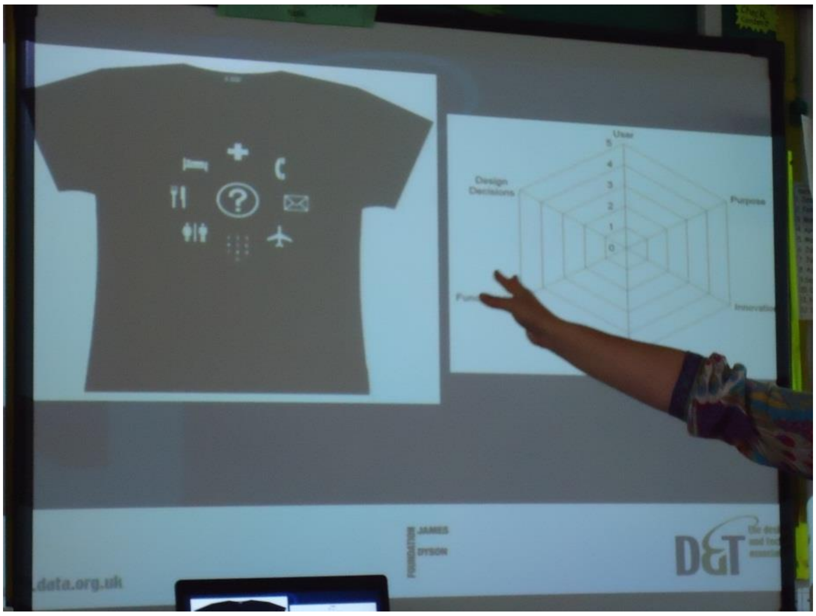


Figure 39 DT lesson, Newtown School, Wem

The children became more and more adept at using the Six Essential Areas to identify the strengths and weaknesses of the artefacts.

Over the year, the class has also had a lot of exposure to the concepts about good design by looking at all sorts of artefacts around the classroom. Rebecca also encourages students to take an everyday object and ask, ‘can we make it better?’ They think about whether it needs a new design or a re-design. Sometimes they send off their designs to the Dyson Foundation which promotes students coming up with better designs. She sets out to raise student awareness of the world of design, looking at the work of, or background of, designers. A favourite story of is Fiona Fairhurst, a housewife who got an idea for a swim-fast swimsuit that she took to Speedo who adopted it. Rebecca said she might highlight designers’ inventions or things like the importance of resilience and perseverance when your efforts do not succeed (Dyson had about 4,000 trials or potential designs (not “failures”).

Rebecca later modelled a lesson similar to the BP Technology Challenge to reinforce the 6 Essential Areas. Each pair of children was given a white bin liner and a larger black bin liner, masking tape and scissors. They were invited to create something useful from these materials. Students had to be able to rate their creations against each of the 6 Essentials (she conceded that the Innovation Criterion would be low because their authenticity was contrived). They were given 35 minutes to construct and 5 minutes to tidy. Children were expected to follow the Junior School of **Plan – Do – Review,** which meant they should stop and think and plan.

Rebecca maintains that a typical good primary school DT lesson should follow this sequence:

- Look at an authentic product example (e.g. slippers). Use the 6 Essential Skills and evaluate different types of slippers against the criteria.
- Take apart some slippers to look at how they are made.
- Follow with lots of practical tasks so that students can practice the pertinent skill-sets, whether those are stitching, chopping, kneading, etc.
- Using a teacher-directed design brief, move on to designing.
- The whole class develops success criteria together
- Designing – teach the skills, e.g. strategy/ drawing skill 2D/ different drawing perspectives. Useful software for this is *“Sketch a Day”* - drawing household objects
- Skills of designing can include thinking skills, e.g. match 2 sets of vocabulary e.g. make something “green” and “furry”.
- Students then make the product and evaluate against the original specifications.

At Newtown School I was also invited to see a DT lesson in a Nursery class (3yr to 4yr olds). Two children in the class had previously made a “chocolate factory” out of play materials so for this lesson the class had decided to make chocolates and sell them in a chocolate shop. They had designed chocolates in a drawing. However, when it came time to make them, they didn't follow their drawing, which is a not-uncommon trait identified in the academic research on very young children. The teacher and Assistant attributed this to the fact that a lot more decorations (smarties and jellybeans) were available at the making stage that had not been on the original list of ingredients. Children named their chocolates and showed me the packaging they had designed packaging. Age is no barrier to quality DT lessons.

10. Outcomes or Products:

On my travels, I saw examples of all kinds of technological outcomes. Year 7 and 8 products were more basic, and teaching was more focussed on basic skills and workshop procedures. Included in the outcomes were: clocks, graphic art pop-ups, pencil cases, gimmicky electronic pianos and 'Jitterbugs', pewter necklaces, badges, key rings, phone holders, cushions, slippers, board games, and making a puzzle for a child on a long distance flight. Most schools had an overview that identified the different year levels and product to be made. For example, in Ernst-Haeckel-Gymnasium, Germany, each year they do something different with varying levels of difficulty. In the 5th Class (10-11 yrs) they build from Construction kits, e.g. a windmill; at 14 years old, a lamp; at 11-12th Class (17 years), a Synthesiser (which does make music); and in the 11th Class, as part of Control a Technical Process, they design street lighting.

In some cases, products were developed to the nth degree, for example in making board games, some schools' pupils CAD-designed and produced laser-cut counters, and vacuum-formed containers to hold the pieces, and designed and made the packaging - including designing the graphics. Without being privy to the sequence of such lessons, the same basic skills may well have been taught, but the use of digital technologies, or not, was often the determinant of whether, for example, board games looked uninteresting and more amateurish in one school while dynamic, polished, and professional-looking in another.

11. Topic/Product Authenticity and Relevance*:*

One of the most important aspects of the better DT teaching programmes was how authentic and relevant to students were the topics teachers elected to study. One of the critical aspects where DT leadership can make a big difference to high quality outcomes are those curriculum leaders who promote to their teaching staff ideas for fresh, authentic and relevant product briefs. Fiona Parr, Head of Rothley School, made suggestions that classes design an outdoor cross, and shoebox nativity scenes, to reflect their school faith. At Ravens Wood, they have a policy of refusing to do what HOD Gary Hunt calls "the bird box approach." Cloning of products is anathema; their aim is to encourage personal creativity. Every product design I saw there was completely different. They never say 'no' to any idea a student comes up with, instead they sit down together and try to work out how it can be made practicable.

Year 8 students at Lutterworth High advised me that in Food Technology they like it when instead of just getting them to cook something, they are asked to design their own recipe, such as adding their own ingredients into a curry and then taking it home and having to ask their parents to rate different aspects on a Star Chart. They say this makes them feel their recipe is original and, by being asked to do a consumer test, they can see the relevance to DT skills being taught. Thomas Estley College runs an outreach programme involving teaching cooking skills to vulnerable primary-age children; the learning is made doubly relevant by inviting the parents or grandparents the next week, so the children can teach the adults, then the family eats together. Students from the College also run an outreach programme in the Village library, where they teach older people in their community how to use mobile phones and the internet. An example of an authentic brief used by Dinas Brân for Year 7's is to design a food product suitable for selling at their local historical sites (a castle and an abbey), and to design a souvenir for sale in the local shops that would bring in revenue to the National Trust for upkeep of historic buildings.

Christelijh Lyceum Delft (CLD) is one of 60 Technasium specialist schools in Holland. Technasium schools choose their programmes systematically over time from a range of subject contexts to expose pupils to a range of different types of engineering. This is intentional, to target different prospective career paths. The top sectors focussed on are: *Food, Horticulture & base materials, High Tech systems & materials, Energy, Logistics, Creative industry, Life sciences & health, Chemistry, and* Water. (Water Technology is one of Holland's biggest export industries, I was told). At CLD, students always work in groups of 4 and focus on the 8 Competencies: *Cooperation, Planning & organisation, Working product oriented, Working process oriented, Being inventive, Push through if project gets tough, Obtaining needed knowledge.* [17]

Figure 40 Christelijh Lyceum Delft

Projects are based on a Problem-solving methodology. Some examples of projects or topics CLD utilises are: Robotics; a medical research project which looks at a solution for the long-term users of medication to help them keep track of their medicine; designing a building for an architect client that will involve visiting the architect who will give them an assignment which they will work on for 8 weeks, then present it to the architect. Designing a wind tunnel for the Delft Science Centre is being proposed. The most recent topic was to answer the question posed by a local farmer who owned a big tomato-growing farm of greenhouses, 'what colour LED lights

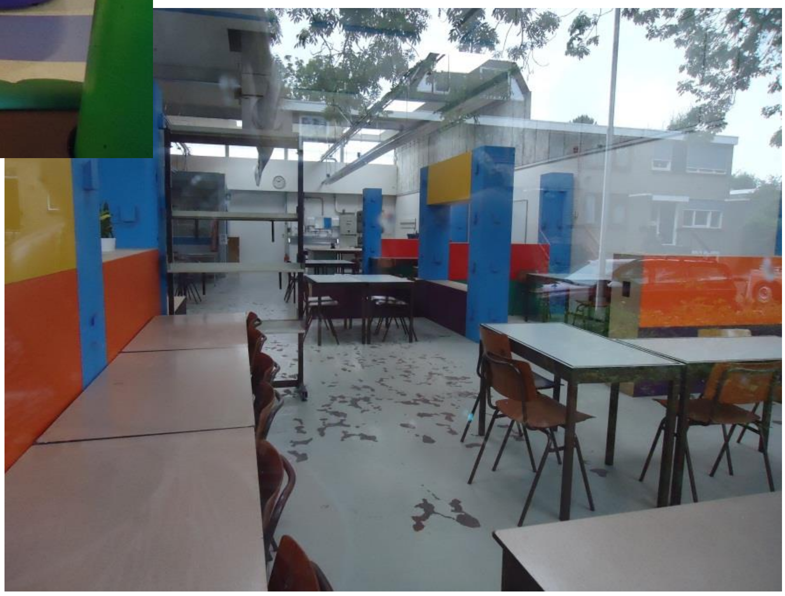


Figure 41 Technasium Room, Christelijh Lyceum

[17] *For more info go to www.technasium.nl; or www.platformbetatechniek.nl (in Dutch)*

effect best growth in tomatoes?' When teaching, Maaike starts with 2 or 3 workshops in skill-building. So, for the tomato lighting project, they started with Biology classes in understanding plant leaves and plant growth, then a 3D designing programme and sketching workshop, research skills such as fair testing, and also knowledge of electronics. Students then had 7-8 weeks to do the project, 5 hours being at school and then they were free to plan their time.

To find a new project, teachers must find an interested company or organisation, discover what its problems are and make up the research proposal with them. Or teachers can select "cool assignments" from other Technasium schools and then find a company in their area that matches the project. An example of this is the Design a Zoo project which is very popular in their part of Holland. All assignments have to be approved by the Institute Technasium. First schools must standardise new assignments on to the Technasium planning format and render it down into smaller teaching steps then apply for approval. They can then teach a pilot to one class and if it proves successful then they are permitted to teach it to others. Schools can keep repeating successful projects if the company client is happy. Fifth year students have to come up with their own problem and find the company. Sixth year students must do this completely independently including finding their own university coach.

To make a difference to pupils' attitudes, particularly towards engineering, Umit Koycu from Melanchthon Bergschenhoek uses "Dynamic Modelling".[18] To get pupil engagement, he teaches using real environment-based problems. An example is, in Physics, he poses a question to students on how they could make a model to show why Hussein Bolt is faster than other runners. Umit believes students have to see the importance of an area of study to their own lives before they can see it in their minds. They need to recognise that engineering is part of their own life – "when can I use this in my future?" This means they will work very hard, be intrinsically motivated, and do a lot in a very short time. In a Technasium school where research is part of the curriculum, students are not working for marks; they are working for long-term personal benefits.

At the end of their school career at Melanchthon, students must do their own experimental research. An example of this was four Grade 11 pupils made Applets (Flash products) as dynamic models of all the formulae that students find hard to learn; they made 3 years of curriculum models in just one year. This was exciting to Umit, because first the group had to understand the formulae before they could design the products for others.

A Technasium curriculum at Melanchthon involves:

- Tech education that is engineering-based, includes marketing, production, and presentation
- Problem-based education
- Research and producing an outcome
- Learning research methodology, thinking steps, cycles of thinking
- 80 hrs per year over 6yrs
- A belief that students should spend time out of the school or working with industry.
- Working with local industries is integral

[18] Umit's Master's thesis is on Pupil Attitudes to Engineering- see also reference to 'Social & Emotional Attitudes' on page 62.

- A lot more Biology in the environment field trips than other schools (bio-tech engineering)

At St. Peters Collegiate, the DT department uses real life contexts only, which is a big contrast to the "make a door-wedge" approach they used to take. They pride themselves on 'Product Innovation' and on "products not projects" which has transformed the way they do DT. Where they can, they use real life contexts where an innovative product could make a difference to a given market place. This approach, David says, allows the student to work beyond the subject, encourages them to work with industrial experts and beyond the constraints of what already exists.

For example, a brief set by their Religious Education and DT departments together was to raise students' understanding of cultures and religions. This brief resulted in all sorts of products. The one I was shown was a *dreidel*, a four-sided spinning top played with during Hanukkah; it had been beautifully crafted by a Year 8 pupil, having been drawn using *Space Claim Engineer*, rendered using *Keyshot*, and manufactured on a 3D printer. David Chapman's ideas-promotion is inspirational. All sorts of things inspire David. When David was on crutches and experiencing difficulties carrying cups of coffee, this stimulated a brief for students to design a method for people using crutches to carry everyday objects without using their hands. When David was at an outdoor concert one day, he saw that the riggers were trying, with great difficulty, to duct-tape cables to wet scaffolding, so David set a brief for Year 13 A Level students that resulted in many different designs of scaffolding clips, with one student having since taken his design forward to university for further development, to the interest of several manufacturing companies. Another Year 13 A-Level brief was to design a skirting board that never needed painting, arising out of an issue prevalent around the DT department's rooms. It seems to me that David cannot look at the world through any other lens than opportunities to seek solutions! Like the few schools that seek ways to make the curriculum relevant to pupils, the result is a unique, innovative curriculum.

Fig 42 Product display, foyer, St Peters Collegiate

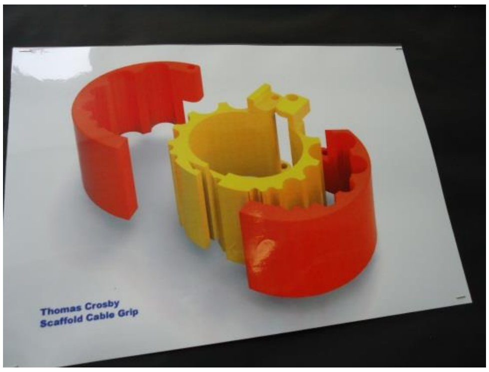


Figure 43 Product display, foyer, St Peters

12. Innovative Curriculum:

An innovative curriculum is difficult to achieve within a system that is bounded by exams. Particularly in the UK and Germany, even at the primary level, DT is still very subject-based rather than integrated. Britain was in the process of developing a Creative Curriculum but a change of government meant a return to discrete curricula. Examples where schools are employing strategies to overcome this have already been referred to, for example, Thomas Estley College's Personal, Learning and Thinking Skills (PLTS) curriculum, their Modules programmes of 12 cross-curricula themes, and Year 9 Specialisms Afternoon linked to vocational contexts. Another way some schools have created an enriched curriculum is by allowing an additional year to achieve GCSE to free up ‘spare’ academic time. Ravens Wood utilises extra-curricular activities to create different kinds of learning opportunities – anything and everything, from mountaineering in Nepal, rugby trips to South Africa, orchestral performances at the highest level, to name just a few.

As well as their emphasis on “product innovation,” St. Peters Collegiate has come up with other innovative approaches. One was to re-structure their school into four Schools of Learning. David Chapman heads up the School of Enterprise Innovation as an Assistant Principal as well as being the DT HOD (for now). His school comprises: Business, IT, DT, Art, and Health & Social Care and Work Related Learning. The school of Investigation & Inquiry comprises Research, Science, Maths & PE. Communication & Creativity comprises English, Music and Languages. The fourth school, Culture & Society, comprises Religious Education, History and Geography. The reason they have done this is to try to set up a structure to make it easier to create learning links and cross-curricular ideas. In addition to the 50 minute weekly Personal Social Health Education (PSHE), they sometimes pair up departments. The combined teachers from the pairing plan and teach a unique integrated programme. An example of this was cited previously with the RE and DT departments designing products that would lead to greater religious/cultural understandings. Lutterworth High also mixes subjects together; once a term they randomly assign combinations for special programmes, such as physical education and science, and French and Religious Education.

13. Evaluation of Teaching:

13.1 Curriculum Review:

For curriculum review, Fiona Parr at Rothley School, who is a trained Ofsted Inspector as well as a Church School Inspector, has an intensive process. She bases it on the Ofsted report cycle. She reads the Ofsted subject review report and uses it to reflect from. She highlights anything she is not sure of or does not think her school is doing well. She writes a summary of this process and uses it as the basis for a discussion with Sue Trantor, currently DT HOD. She also asks students what they like/don't like – this revealed that while they all like Art she suspects this is because they do not know the difference between Art and DT. Also, a folder of evidence collected by every HOD, a fat folder with photos showing exemplars, visits to places, incoming DT experts, etc., is used to look at an overview of what has been accomplished.

Fiona uses the Ofsted recommendations for best practice in their curriculum report to compare their school practice; anything identified as not being done well goes into the development plan. She shares Ofsted's recommendations for Best Practice with her staff and they discuss and agree on goals. This is a useful approach for review and continuous improvement.

The schools in the Wolverhampton panel offered the suggestion of conducting a “Skills Audit” which involves giving out a questionnaire to staff which can be colour coded, to ascertain what skills in DT staff have across the curriculum, individually and collectively. This acts like a self-evaluation. For example, a Food Tech teacher might realise that there are packaging skills involved with food.

At Newtown School, review is performed via the Subject Leader's Annual Evaluation of their subject in which they report to the Principal about their observations of teaching, their scrutiny of planning, children's work & books, and scrutiny of tests at Key Stage 2. Subject leaders also do a mini-SEF (Self Evaluation Framework) of their subject each term, reviewing pupil progress and the quality of subject teaching. This used to be available on-line but now schools have their own systems which feed into their Ofsted review. For any subject area being reviewed in any particular year, Andrew and the subject leader do paired observations twice a year which form part of PD in the School Development Plan.

13.2 Performance Management:

Performance management is another strategy a Principal exercises for quality control. At Rothley School, goals are identified from their School Improvement Plan for the Head's appraisal. These then are cascaded down through all levels of the school – DP's, HOD's, teachers, Assistants. Performance Review is done by the principal. Upper Pay Spine teachers MUST lead a school subject area to get the £3,000+ extra salary. They have to keep a portfolio of evidence about school performance in their subject. As part of their management role they must complete a sheet that gives a picture of their subject across the school – the headings are: Learning Walk, Child Discussion, Learning Environment, Work Samples, Planning, Lesson Observations, External Other. The lesson observations are often done with the Principal, the principal not being an expert in every subject. The Head uses this report as the basis of the SED School Evaluation Document she must do for Ofsted (the evidence folder supports this report).

At St Peters, along with other schools, Learning Walks are a key performance review strategy. The frequency of these is once every half term and the length of time, one session. They target the following criteria using a form that is filed as part of the performance review:

- Level of learning during the lesson
- Students knowing their target grade, their current grade and how to make progress
- Standard of homework, use of the H/W planner
- Evidence of assessment policy being used
- Tracking of pupil progress

At Newtown School, a 5 teacher school, the Head does observations of teachers, looking at targets (i) subject leadership (ii) pupil progress in core subjects and (iii) personal and professional development. They have a mid-term review of teacher goals.

IV PROMOTING & PARTICIPATING IN TEACHER LEARNING & DEVELOPMENT

In a climate where Professional Development (PD) (referred to in UK as Continuous Professional Development or "CPD") was identified as one of the biggest issues for schools, I came across only a few examples. While acknowledging that schools may well have been engaged in other school-wide PD, I have cited the few DT subject-specific examples mentioned to me.

Thomas Estley College is in a number of networks that support one another by mentoring and sharing staff expertise. Tim Moralee, Head at Thomas Estley College is a "National Support Leader (NLE)" who is deployed for 1 day a week for which he is paid to help struggling schools with systems leadership. Similarly, schools in Wolverhampton work collaboratively, sharing staff expertise. Ravens Wood School is part of a project called Challenge Partnerships that provides mentoring and support for network schools. Ravens Wood School has Technology Department PD days once a year; holidays are regarded as the time for personal up-skilling. At The Piggott School, the HOD said that "PD opportunities were limited but the Exam Board provides workshops oriented to how to get students passing and STEM run occasional courses." Fiona Parr, Head at Rothley School, is an Ofsted Inspector and a Church School Inspector which means she is seconded out of her school for 2-day inspection periods; this gives her the opportunity to pick up new ideas. Fiona promotes teacher risk-taking through PD, likening new learning to participating in ski lessons. Rebecca Higgins at Newtown School attributes membership in DATA and attending their courses as helping her expertise grow.

In Holland, the Technasium Network supports the learning of Technology teachers; this affects 60 schools (10% of Dutch schools) so it is not widespread. Remke Klapwijh's research in Delft, referred to in the section on Creativity, is providing interventionist PD for schools within the "Kleuterprojecten 'Nieuwsgieng? Graag!'" Project. Partnerships with Universities, Houses of Science & Technology, and promotion by researchers such as Marc de Vries, provide a valuable mentoring role where they occur.

In Sweden, a PD project called *Tekniklyftet,* a 2-year project funded by the European Social Fund, is one year into trialling a new approach for teaching DT which it is hoped will help teachers increase student interest in the subject. There are 28 participating schools mostly Years 6-9 in Stockholm, where teachers are being tutored in DT under the auspices of the House of Science.

The issues associated with provision of PD are set out in a subsequent section *Overcoming Barriers to Learning (Section VI).*

IV Creating Educationally Powerful Connections

14. Business Partnerships:

One of the hallmarks that made schools stand out for innovative ideas was the way they promoted partnerships with business or industry in their local areas. ' Some examples have already been provided, such as the involvement with the local farm business in Delft. Some other examples will be included as part of the section following on: ‘Competitions and Extra-Curricular Activities. These activities all have the benefit of promoting high quality innovative DT in schools.

John Betts Primary School has developed a partnership with Harper Collins whose offices are located nearby. When Harper Collins want to develop technology resource books, they come to John Betts who develop teaching units around their needs. An example was ‘the Oympic Games.’ Rothley Primary have DT-oriented field trips outside the school and encourage DT experts to work with or talk to students. The Marches School makes use of its local Business Forum, Sarah Longville, the Head, meeting with them once a half term. The school does IT projects for local firms; local farms and firms donate ingredients and materials for DT, and support the running of an Enterprise Club.

Ravens Wood has developed partnerships with designer-brand businesses. Students design products suitable for a company’s requirements and the company will give feedback and, if they like the designs or features, they produce them for retail. Examples were innovative retail display boards, and I-pod furniture units. This makes the students realise real-world exigencies exist, that customers set the requirements including deadlines.

Figure 44 Retail Display Stand, Ravens Wood

Figure 45 HiFi Docking Station, Ravens Wood

Dutch Technasium schools, as mentioned, must develop partnerships with businesses or organisations as part of their problem-solving philosophy and pedagogy. Examples were: utilising local farming businesses at Christelijh Lyceum, while Melanchthon School works with Axel, a chemical production company (chemical engineering), and Unilever (a Dutch company, purportedly the biggest food production company in the world) where their students visit a research lab and look at Magnum production (food engineering).

In Brandenburg, Germany, a project involving schools with the Transport System, the Electricity company, the Recycling Water company, and the Potsdam Council has been successfully looking at real world problems. Examples were 'Cleaning Water' e.g. if the water cycle lasts 80 years, won’t we have a problem with chemicals and pesticides going into the ground water ? The problem with electricity is that any solar energy generated in summer gets lost because the heat is not needed, what can we do? At the Ernst-Haeckel-Gymnasium, for Project Week, Volkswagen comes in and presents activities and students get to do activities such as designing car chassis, etc. DT HOD, Mr Zube, has developed a relationship with IBM who come in to the school every year and interview identified students and look for opportunities to place them.

St Peters, Wolverhampton, has developed links with industry and with universities. One is with Wow Stuff, one of the top one-hundred companies, specialising in toys. One of next year's challenges is to develop a new Sony Play Station hand held device for the future. The school has a close relationship with Jaguar Landrover (JLR), as JLR has realised that a large number of their staff come from the Wolverhampton area so it is in their best interest to play a role in developing local DT education. In the new school year, the school will be doing 11 projects with Jaguar. These include:

During Year 9 PSHCE time:

- In Product Design, design a new model of Jaguar car aimed at a younger demographic
- In Product Design, investigate the way people drive and interact with the car in relation to the design of its dashboard
- In Art, create 3D forms and art based on Jaguar and its leaping mascot
- In ICT, produce a webpage about the project for children, a monthly e-magazine and a promotional video to promote a Jaguar from the viewpoint of the next generation of owners.

In Year 12 Product Design:

- Look at the ergonomics, aesthetics and functionality of the ignition key with a view to linking with A-Level Electronics

In Year 13 Electronics:

- A mini-project leading to individual work based on climate control, Comms, IR, directional control, displays, etc. in relation to the ignition key

In Year 13 Product Design:

- To investigate how to improve the provision and comfort for the passenger by facilitating the use of modern mobile technology.

Other possibilities being considered are for Product Design to consider ‘do we need a steering wheel any more?’ and designing a third brake light that shows how hard the brake is being applied; the Textiles class to design beaded Jaguar jewellery; and the Business School to manage a Jaguar Fund to go towards Jaguar’s Save the Jaguar at Chester Zoo. Whether they will have time for this, too, only time will tell.

Students are expected to keep a blog or use webcam uplinks to keep Jaguar formed, and to Skype JLR personnel at specified intervals to report progress. To support this project, JLR was committed to providing access to a Jaguar, providing a car chassis, dashboard, etc., archival information about the leaping mascot and the company, access to staff to be interviewed and to receive updates, and access for pupils to the JLR site for defined visits. Each group is expected to visit JLR to report on and deliver outcomes by a pre-set date. Jaguar are also offering careers advice support. The icing would appear to be the offer by JLR of a Track Day and Landrover Experience!

Another partnership St. Peters actively pursues is with the R.A.F. Museum which is a local tourist attraction. Museum Education Officer, Philip Clayton, supports schools by helping to organise learning opportunities. Year 9 students from St. Peters were asked to consider alternative production techniques for the wing ribs of a Horsa Gilder. They had to first plot the aerofoil shape using actual numerical data before they went through various modelling approaches. To start they used art straws before modifying the data, then they made a jig and laminated the rib using spruce in the same way restoration workers use. Next, they used absolute and relative coordinates to plot the shape in CAD before using a laser cutting machine to produce the part. Finally, they used *Space Claim 2011* to generate a 3D version which, following testing and evaluation, was produced on a 3D printer.

Figure 46 RAF Education Officer Philip Clayton

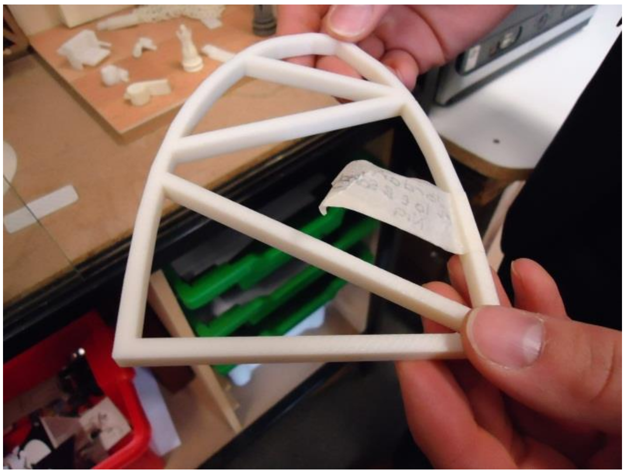


Figure 47 3D Wing Glider, St. Peters Collegiate

As part of a national Big Bang Event in June, three schools including St. Peters, participated in a Reverse Engineering activity with the aid of personnel from British Aero Space, the Michael Beetham Aviation Conservation Centre, an RAF officer, and STEM ambassadors, who all offered their time and support free. Students were allowed to climb over a Jet Provost wing and remove and examine an access panel that was cracked. With the aid of Siemens who provided held-held 3D scanning equipment, students measured the panel. Unbeknownst to the pupils, there was a deliberate flaw inserted into the data which the students encountered after realising their design was not aerodynamic. The aim of the project was to come up with a working drawing to aid the manufacture of a new panel. They finally made a model panel from plywood by using a laser cutter to test before making the panel.

On another occasion, local schools participated in a World War II Cooking Day where students had to feed 200 people under canvas using gear provided by the R.A.F. The Museum ran a Young Curators Day where there was a DT focus on display cases.

15. Other Partnerships:

Rothley Primary promotes a partnership with their local high school who have worked with the younger students on bridge-building, which gave their teachers an opportunity to realise they were 'dumbing down' their expectations of what young students can achieve.

Thomas Estley College is involved in working with 6 primaries, their contributing schools, and a Yr14-19 school, in a partnership called 'Our Family of Schools.' Heads meet half termly. The schools do curriculum planning and training planning, put on events such as Science Day and plan for transition. The partnership allows them to plan a continuous curriculum. They all put in and share resources, e.g. a mini-van. The school is also part of Learning South Leicester in which 53 schools work closely with their Local Education Authority. Fifty one of these are becoming Academies. They will continue to meet, and also continue to meet with the LEA but will develop system leadership to take place of the LEA function in improving schools. The creation of Academies means setting up an Umbrella trust, a new organisation which so far has one primary, Lutterworth College (Yr14-19) and two Yr11-14 High Schools, but others are in the process of joining them, probably 7-8 other schools. There will be benefits of working together.

This Community College is particularly noteworthy for its huge array of community outreach programmes including hosting an old age pensioner club whose members eat at the school waited on by students several times a week (seeing an old person using a zimmer frame in the middle of a crowded corridor of bustling high school students is quite common). Amongst the huge array of programmes running is Science Crest for one night per week for vulnerable Year 6 students to work with a high school Year 7 student.

St Peters has a partnership arrangement with two local high schools so that students from the three schools can go to 6th Form options at any of the schools and each school offers a a DT subject speciality. St Peters has also created a Gallery from an old defunct shop in town to display their products. The Business Studies students are running the shop as an enterprise.

The Wolverhampton panel convened for my visit suggested a variety of partnership approaches could enrich DT programmes. Some of their ideas were:

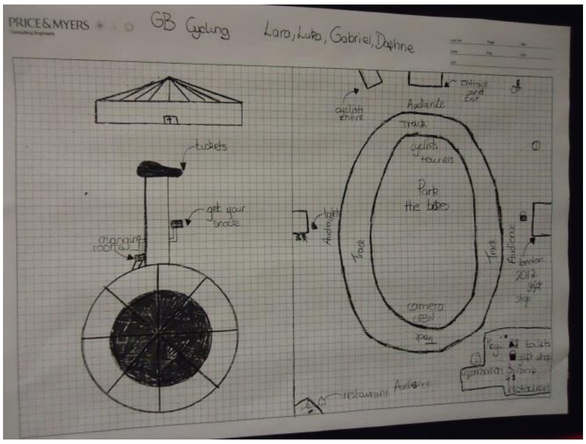
- Collaborating with other schools to organise DT experiences, sharing staff strengths
- Groups of schools run different competitions in DT, e.g. Primary Engineer
- In collaboration, build a resource bank
- Share exciting ideas, e.g. design a hovercraft from a leaf blower.
- Outreach programmes –
  - inviting Technology students from high schools to come in and work with students for a day, filming it and passing it on to the next school so they learn from it too. One school could do an outreach on things like new technologies, SMART materials – 2 days, 2 hrs per school x 5 schools.
  - High school students can try their products on the younger students
  - Buddy/mentoring systems
- Hold DT Days, e.g. Dads and sons come in and build a glider together for a whole day

- Recruit a staff member to liaise with companies and organisations
- Bring employers into the school, e.g. people on the Board of Governors, local apprentices. Students could submit CV's to volunteers and be given feedback based on what employers would be looking for in real life candidates. Or volunteers could conduct mock interviews or hear presentations. Getting pupils out of school so they have to travel independently and be punctual, and practice being out of their comfort zones.

16. Competitions and Extra-Curricular Activities:

To enrich students' experiences of DT or accelerate or enhance potential talent, many schools choose to take part in competitions or run lunch time clubs or after-hours experiences.

For John Betts Primary School, competitions are a great way to obtain some free resource support. Competitions and activities are held annually for children by *Open-City, London*. This includes activities such as an architecture festival aimed to excite and engage young people on the value of architecture and their city; architectural tours and workshops; *My City Too* aimed at enabling young people to voice their ideas, aspirations and solutions for the future of London; *ArchiKids* which is a virtual club to explore the world of architecture; and a *Summer Architecture Academy* that brings teams of young people, building professionals, architecture students and educators together to design and model something on a super-scale to benefit the city. When I was there in the lead-up to the Olympic Games, the school had just entered a competition to design a community sports venue for any Olympic sport that would leave a lasting legacy. Working with an architect, students were taught skills such as 2D drawing, drawing to scale, and building models.



Figs 48& 49 Architecture Competition, John Betts

Dinas Brân gets involved in competitions like *World Skills Engineering*. Compared to teams from Germany and Japan, the first time they entered they were novices. But they have just come second in the world at the competition in Calgary. Believing that Robotics is the future direction to take, they enter the *VEX Robotics Competition* each year and do very well. They also take part in the *Primary Engineering Competition*, involving a small number of pupils. The programme is run in Bolton by a Manchester-based company. It took the HOD 3 years to raise the funds, but he was gratified that they got runner-up in the recent national competition.

Students at the Christelijh Lyceum in Delft (CLD) have begun learning Robotics as part of their regular Technasium programme and intend to enter the *Lego League Competition* in which a robot has 10 tasks to perform and a team of 10 students 'do battle' with other schools. In Germany, companies like Volkswagen promote design competitions in schools.

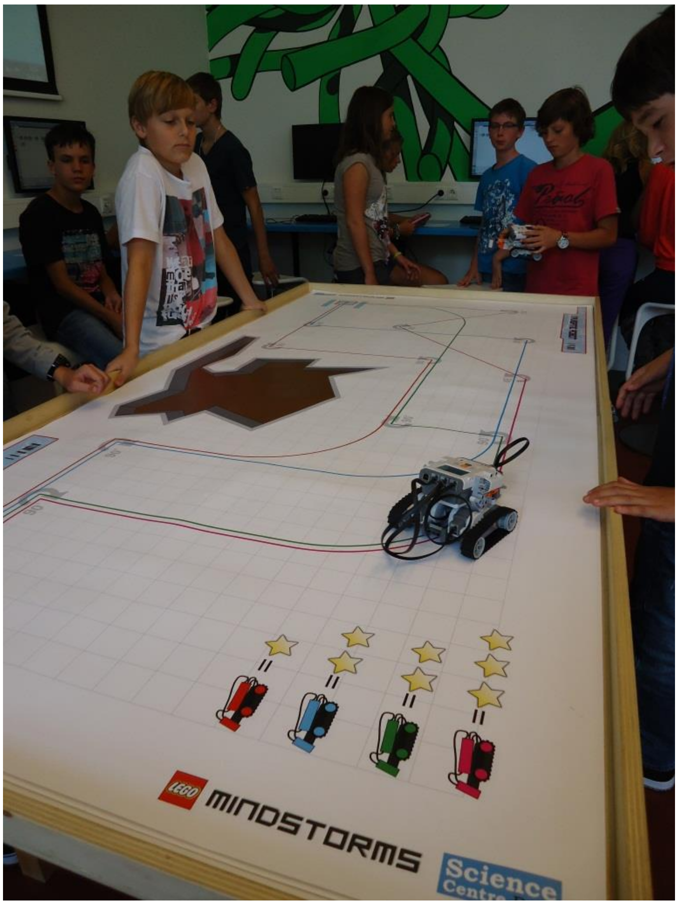


Figure 50 Robotics, Christelijh Lyceum Delft

Rivington & Blackrod students had just won the *Key Stage 4 Challenge Trophy* in a Science Challenge for the second year, the latest theme to design and produce products needed for a Mission to Mars. In their Summer School, students completed a range of design tasks to enable them to devise a platform ICT game inspired by the Olympics. Year 9 students, in groups of 3, were taking part in the *Britannia Glider Challenge* to design, make, market, and test a propelled glider.

Thomas Estley College runs a lunch-time *TED Technology Engineering and Design Club* for pupils to apply design solutions to problems. The club is run by Design and Science teachers. The latest challenge was to design out of recycled materials a vehicle that would propel itself across a distance. In the teaching phase, there had been involvement by STEM ambassadors. I saw them at the final, competing against one another, and one of the teachers, to see whose contraption could travel furthest across a hall. A Year 9 student had won for the second year; he was moving to the College where he had chosen to do a Tech Engineering course. Rocket design featured in an earlier design challenge. Their next TED challenge will involve researching the history of warfare and designing machines that are projectiles. One of the benefits of a club like this is that it promotes departmental collaboration and breaks down subject compartmentalisation and creates synergies for students.

17. Science & Technology Centres:

I had an opportunity to visit two Science Centres: one in Stockholm, and the other in Delft. Partnerships enable them to operate. *Vetenskapens Hus*, The House of Science in Stockholm was initiated in 2001 as a collaboration between KTH (Royal Institute of Technology) and Stockholm University with the aim of bringing about greater interests in science and technology subjects, offering laboratory experiences which schools do not have either the expertise or the equipment to provide, in order to up-skill both students and teachers.

There are three Science Centres in Holland, the NEMO Science Centre in Amsterdam, Eindhoven in the South of Holland, and the Centre in Delft. The latter is funded by the Delft Technology University (TU), with some government subsidies for particular aims. Its purpose is to show the future and the current state of everything coming out of Delft TU. It is both an exhibition centre for technology and applied sciences, but also provides educational opportunities for schools and the public. It provides experiences in advanced applications which schools would not otherwise be able to access. Examples are Nano Technology and Quantum Technology. Some topics are classics such as bridge-building but they try to do this in a fresh way. The ages they cater for at no cost, are 12-18yrs. The Centre employs students from Delft TU to work with students and the TU students receive training from the Centre in student management and making lessons fun.

All of their courses fall into the University big 4 subjects: Engineering, Energy, Health and Design & Architecture. Classes can access courses such as:

- Hot and cold energy computer game – teaches knowledge about Energy, students get rewarded for correct answers by receiving components to make a balsa and card sailboat or oven.
- Marquetry – architectural model
- Lego – Robotics
- Solar car, propeller car, design car
- DNA, make necklaces
- Cradle to cradle – re-using materials from huts, into something else
- Soldering – very popular, making small items
- Bamboo construction
- Constructing an “impossible tower” - pure science
- Foam bridges – crack them with weights until they break, try to get students to see the triangle of cracks
- Will develop courses on any new invention or development, might be something that has been in the news or a new group wanting to promote itself or something they know visitors would like; could be a workshop or an event or a lecture or a project.
- After school projects – children come five times to do a design theme and Megatronix (programming & electrical systems) – computer and production line/control systems

Some of the displays/ exhibits/ activities on offer are:

- Memory cupboard – to train brains into remembering

- Fab Lab– 4 machines that have power to reproduce everything in our developed lives – 3D printer, woodcutter, laser cutter, vacuum moulder. This room is open for workshops by schools, visitors and start-up companies alike.
- Werkplatz – workshop space open to be used by Delft TU students or schools
- Earthquake Room – construct a building then test whether it survives when the room shakes like an earthquake
- Brainbreaker Room / aka Birthday Room – full of games & puzzles – this is going to become a wind tunnel room soon
- 3D Room – scan your head and see the image; see a 3D virus, very beautiful; enjoy 3D participation in soccer game
- BioTech Room – workshop on turning waste (banana peels, corn, paper, yeast (Ethanol)) into Bio Diesel.
- Sports Studio/Sports Materials Room – research demos of equipment the University has developed for sports, such as a bob sleigh for the National Dutch team, prosthesis showing bending materials, engineering, etc.
- Flight simulator
- Eco Runner – the world's fastest car using 1 litre of normal oil
- Hydrogen car
- The green car – does not emit CO_2.
- Blue car – solar car NUNA, won the World Solar Car Challenge 3x, 109 km per hr.
- Construction to show why a bike stays upright – not that the wheels turn round but the position and balance of the components that prevents the bike from falling
- Superconductivity – the closest demo they have of quantum physics – cooled with CO_2 to minus 270 degrees

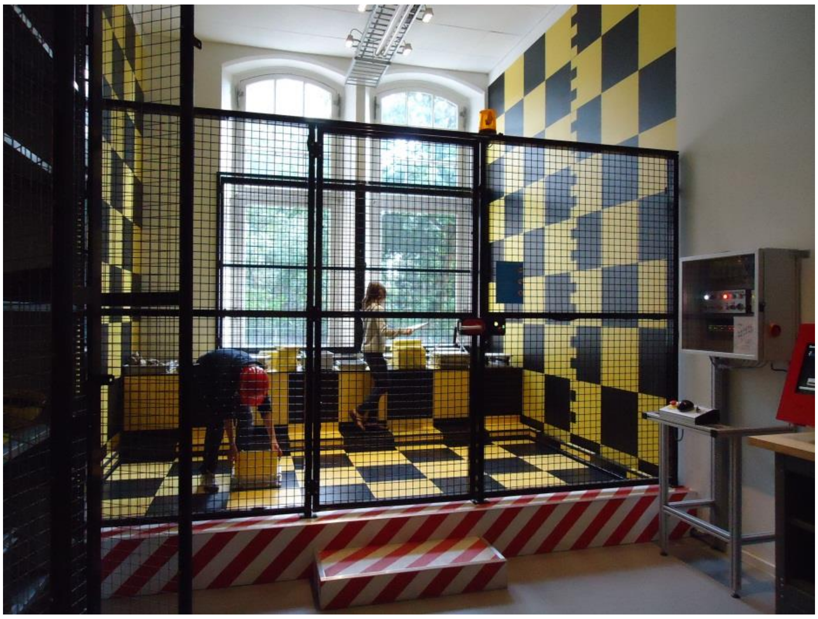
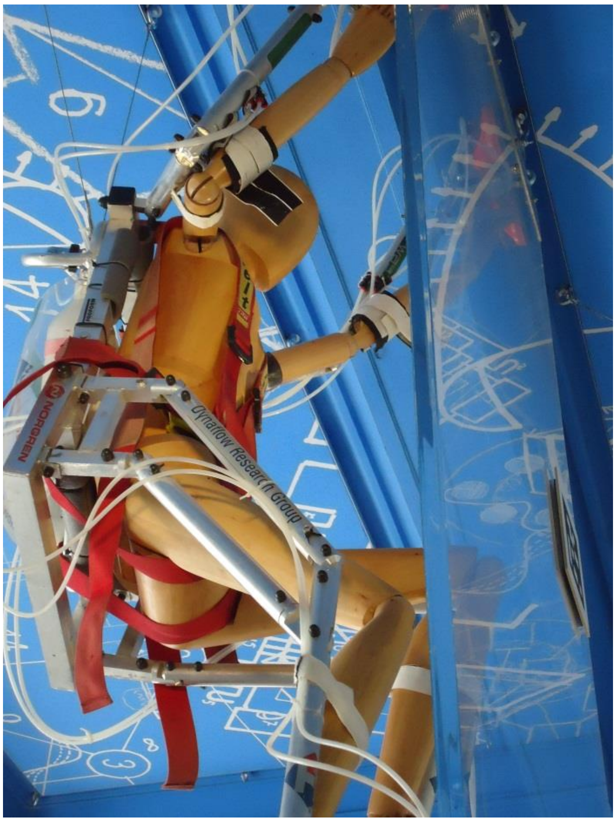


Figure 52 Earthquake Simulation Room, Delft Science Centre

Figure 53 Science Centre, Delft



Figs 54 & 55 Robo Spiderman and Hydrogen Car

These Centres offer opportunities that children would otherwise never experience. The dazzling array of displays in Delft's are utterly fascinating inspirations to children to pursue science and technology. This sort of Centre would be a marvellous boost to Technology education, were we to develop something similar.

Importance of Partnerships in Technology Schools

Partnerships have proven to be one of the most significant features of quality DT programmes during my study. The concept of partnerships is inherent in Enterprise Education which features in the NZ curriculum. In its report on *Enterprise in the NZ Curriculum*, the NZ Education Review Office (ERO) defines Enterprise as having 3 facets: (i) learning about business, (ii) developing and applying skills to operate businesses, thereby developing entrepreneurial talents, and, (iii) of increasing importance, students solving real problems for an actual audience or client where students work with a business or community partner to create a new solution, product or service. ERO cites case studies where this is happening already in NZ. They advocate the increasing importance of authentic learning using partnerships.[19]

I found so many examples of Enterprise Education featuring in the best overseas schools I visited that I have concluded that this Sixth Dimension of the Best Evidence Leadership must have high prominence in schools' thinking if they wish to be leading in Technology. The examples I have quoted liberally in this study illustrate that this pedagogy is at the heart of cutting edge schools and is a perfect fit with the Technology curriculum.

VI. OVERCOMING BARRIERS TO LEARNING

18. Issues Identified

One of the key strategies for education leaders, from my experience, is overcoming barriers that are hindering achievement. These can arise across all the leadership dimensions and across all leadership levels of the education system. On my travels, patterns of problems emerged. In order to find solutions, the first step is to identify what the problems are. An overarching problem I identified as affecting DT stems from the influence of educational leadership at a political or systems level. Details are set out below.

The key issues inhibiting quality D&T that I encountered were also identified by Clare Benson (2012) in her research undertaken in English primary schools.[20] From my experience, these issues are prevalent in many schools irrespective of country. These issues, as set out below, are: *a lack of understanding of the nature of DT; lack of teachers' confidence in their subject knowledge; issues in planning the DT Curriculum; issues in not valuing the subject; and attitudes to DT.*

[19] Education Review Office, *Enterprise in the NZ Curriculum,* (August 2011).

[20] Benson, C. (2012). 'The Development of quality design and technology in English primary schools: issues and solutions' in *Technology Education in the 21st Century: PATT 26 Conference Readings,* Sweden, 2012, p.81.

18.1 Political/Systemic Educational Influences

As I travelled, there was a general air of pessimism at tertiary and Principals' level of the weakening of DT as a subject. Academics at the PATT Conference bemoaned the lack of progress in implementing quality DT programmes in their countries; government funding cuts were putting DT programmes under threat; and there was a lack of access to quality professional development at both the pre-service and in-service levels of the system. As already outlined, I saw evidence of the tension in schools where Heads were facing choices as to where to make corresponding cuts. In the UK, this gloom is being heightened by concerns that curriculum changes are looming; though couched positively as "freeing up" choices for schools, the concern from educational leaders is that this might side-line DT. Underlying this state of affairs is a belief that politicians, parents, and principals do not appreciate the potential economic value to their nations from having strong DT programmes.

There are tensions created by choices governments have made about their DT curriculum designs. The UK DT curriculum is heavily oriented to 'Product Design and Make.' Just by separating 'Design' from 'Technology' (i.e. in the curriculum title) has created an assumption in some schools that Technology should be the provenance of the Art Department, thus Art teachers with no DT backgrounds or training were required to take over curriculum delivery. Adding to this situation the paucity of DT PD, this situation has not always augured well for robust DT programmes.

This state of affairs has given rise to a push back by 'STEM' advocates who are dissatisfied with the direction of DT, believing that Technology should be more about applying Science, Maths and Engineering to Technology. In the opinion of Marc de Vries, Britain used to lead the world in its Design curriculum. Because it was an exemplar, people came from all over the world to look at it. De Vries thinks its weakness lies in its theoretical base (epistemology), whereas the German curriculum is much stronger in teaching theoretical concepts (but weaker on teaching Design). Holland has tried to blend both. New Zealand's curriculum, in De Vries' opinion, is "the leading one in the world."[21]

In Sweden, similar issues to other countries' has occurred, according to Thomas Ginner from Linköping University, with Technology frequently having become the provenance of "Craft" teachers, Craft being a traditionally highly-valued part of the Swedish curriculum. Without strong DT PD programmes, the teaching of DT by Craft teachers is problematic and can result in Craft subsuming or side-lining DT.

In Holland, DT is often the provenance of the Physics teacher, with the same type of ensuing issues.

Solutions to this come down to the vision for DT of individual countries, districts and schools as to whether it encompasses outcomes that will lead countries and students to expanded economic careers and prosperity in its present form and with the current level of funding, or whether it deserves more support. The old adage, 'you will get out what you put in,' was never truer than for improving DT resourcing, but it must deliver a curriculum that will deliver the optimum outcomes not just 'more of the same.'

[21] Personal interview, Delft University, 29 August 2012.

18.2 Lack of understanding of the nature of DT

Political leaders, school leaders, teachers, students, parents and Boards of Trustees may fail to appreciate what a quality Technology programme involves.

In Benson's research, 90% of the teachers had limited understanding of the subject; their students were taking part in craft activities or 'appliance of science' activities such as making a torch without an identified user or purpose, or without any designing. A common issue Benson identified was the common practice in UK of making a Tudor house or a Roman sandal and believing this to be DT. Benson says believing that 'making' was at the heart of the subject was one of the popular misconceptions. Concepts such as designing, exploration of materials, and evaluation were missing or were paid lip-service to.[22]

Rebecca Higgins of Newtown School referred to this very issue spontaneously in front of her class. In referring to "good technology design," she said she had been in schools whose pupils created "one cardboard slipper, covered this with fur, stapled it to the wall and then claimed they had "done DT."" I had seen exactly this kind of outcome during a few visits, slipper(s) and all! The problem is that teachers do not know what they do not know. If they are to know, then it must come about through continuing PD.

Benson's contention from her research is that *students* also do not have a clear understanding of the nature of Technology. This is understandable; if teachers do not know about the nature of Technology then how can students. Even in a school such as mine where we have been developing our Technology content knowledge, research data collected by Vicki Compton, Ange Compton and Moira Patterson demonstrated clearly that this was an area we needed to improve. The New Zealand-wide research project showed that most students, irrespective of whether they were 5 years or 17 years old, could not define Technology and many students did not have an appreciation of the differences between man-made and natural world objects.

However, the benefits from research involving continuous Professional Development has meant that teachers could identify the areas of weakness and address these in their teaching programmes. The result for our school showed a tremendous leap in achievement within a year. Without the interventionist CPD, teachers and students would have all remained ignorant.

This lack of understanding about the nature of DT also applies to parents and political leaders alike. Parents and politicians of today went through school at a time when Technicraft programmes focussed on "life skills" and used a 'follow-the-recipe' approach. This approach is not what is needed if our country is to build an enterprise culture and develop the national economy. We need to educate parents and other influential adults that we must do Technology better if we want a different outcome to what we have now. (This is dealt with further in Section 18.6).

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[22] Benson, C. (2012). 'The Development of quality design and technology in English primary schools: issues and solutions' in *Technology Education in the 21st Century: PATT 26 Conference Readings,* Sweden, 2012, p.82.

18.3 *Teachers' confidence in their subject knowledge*

Mature teachers either have had little initial teacher training or professional development in Technology since graduating. Even NZ teachers trained prior to 2007 who did receive some Technology training will find that since the advent of the NZC in 2007 their subject knowledge will be out of date. The new Technology curriculum demands a technological literacy incorporating terminology and concepts that are quite esoteric.

In Benson's research, only 5% of the teachers had studied DT in any depth in their Initial Teacher Training and even the majority who had had a little DT had forgotten it, even the recent graduates. Therefore 98% of the teachers in Benson's research group lacked confidence in subject knowledge including practical skills and the use of tools and equipment. This reduced to 16% after CPD, although most teachers still felt the need for more sustained Continuing Professional Development (CPD) beyond the initial PD.[23]

Fiona Parr, Head at Rothley School, spoke for a large number of Heads when she said, "CPD has dried up". Schools pay for courses but her school "has only sent one teacher on a DT course in the last two years." The Piggott School's HOD said that "PD opportunities were limited." Rebecca Higgins is acknowledged in her district as an expert DT facilitator but, in order to share her expertise with other schools, her school needs to pay for her release out of their own budget or her Head releases her from class. Her facilitation would usually only be done on a reciprocal 'you scratch our back' basis. Her Head, Andrew Hodson, described "the CPD system in Britain as grim, with everything cut other than what a school can provide out of a very limited budget."

In Germany, according to Professor Geist, Student Teachers trained in DT are the only ones out in schools who are training the teachers. In Holland, Marc de Vries says the dominant number of Technology teachers came from existing teachers whose Major subject did not provide fulltime employment and Technology was seen as a way to fill up their hours to fulltime. In Primary education, primary teachers do not have a science or technology background so these subjects are weak, non-existent almost in the case of DT. The solution obviously lies in CPD.

Former Dutch PD programmes, VTB and VTB-Pro, which the Netherlands government had established to address the need for up-skilling teachers in DT, were most successful, according to de Vries. VTB-Pro was set up to encourage whole schools to train their teaching staff in Technology & Science (always combined), and to encourage curiosity and creativity in pupils, to get them to ask questions and to come up with practical solutions for everyday problems. However, this DT PD has been cut because of fiscal restraints.

Solutions to most identified issues involve continuous teacher training. Yet schools are operating in a cost-cutting climate which is negatively impacting on schools' abilities to make this happen.

[23] Benson, C. (2012). 'The Development of quality design and technology in English primary schools: issues and solutions' in *Technology Education in the 21st Century: PATT 26 Conference Readings,* Sweden, 2012, p.83.

Benson states that "there has been little CPD over the years [in England] on a regular or sustained basis."[24] Benson declares quality CPD to be "essential… and it should be mainly face to face."[25] ERO in NZ identified that the key driver for change to occur in Enterprise education is PD. For teachers to make the big shift necessary to adopt the authentic learning approach involving students solving real problems for an actual audience or client, and for students to work with a business or community partner to create a new solution, product or service, PD is vital.[26] Solving this problem is as much an issue for political educational leaders to resolve as it is for school leaders.

The situation is even more of a challenge for educational leaders in primary schools. Even at Green Bay School where there has been a high level of PD over time, there is a challenge to build teachers' self-belief that generalist teachers who are not specialist Technology teachers (such as are associated with staffing in Intermediate and High Schools), can still be empowered to deliver a high standard of Technology teaching. All schools, of course, also face challenges around sustainability with new staff so the challenge is ongoing.

18.4 *Planning the DT Curriculum*

Planning the approach to teaching of DT is problematic for school leaders. High schools, with the exception of some innovative pockets, feel constrained by their exam schedules and specialisation bias, and therefore tend to teach DT as discrete subjects. They feel that this sometimes limits their ability to integrate with other subjects to make a more exciting and creative programme. On the other hand, as Benson found with 88% of her research teachers' schools moving from a discrete-subject basis towards a more integrated curriculum approach, the majority of teachers had to fit DT in to whatever topic or theme had been planned which then could lead to an inappropriate DT activity. 24% of the teachers receiving the CPD felt that there was no hope of their making changes to this school approach once they returned to school. Schools can be too integrated to the point where DT outcomes are shallow or irrelevant, just to tick the DT box.

I acknowledge that artificial integration can weaken the subject but so can artificially compartmentalising DT into discrete subjects. The key approach to me is "flexibility". New Zealand primary schools are fortunate that they can make decisions as to whether some DT skills or outcomes are better approached as part of a larger thematic unit, or whether they are more suited to 'stand-alone' lessons. In our research project, some teachers have had outstanding success in building students' technological literacy through short, daily oral language lessons focussed on technological artefacts children bring from home. Holland's Technasium approach, as described, focussing on problem-based learning where different disciplines are integrated meaningfully, offers a shining example of what is possible.

What is needed is the will and vision to plan well for DT; creative solutions will follow.

[24] Benson, C., ibid, p. 83.
[25] Ibid, p.85.
[26] Education Review Office: *Enterprise in the NZ Curriculum* (August 2011)

18.5 *Social & Emotional Attitudes*

The importance of 'SEAL' attitudes in DT (the 'Social & Emotional Aspects of Learning' i.e. risk-taking, communicating, sharing ideas, supportive environment) were identified as vital for DT as there are no 'right' answers, only many solutions for selecting the 'best' depending on the criteria for judging (Humphrey et al. 2008; Benson and Lunt, 2009).[27]

In the Netherlands, Umit Koycu has completed a Masters Thesis on Pupil Attitudes to Engineering. Using a world-wide sample of 8,000 students including New Zealand, Umit found that pupils know what engineering is but they think it is difficult, yet surprisingly, they think maths and physics is not difficult. Fifty per cent thought engineering would be hard, only the former Soviet countries thought it would be easy. The lower age groups thought it would be easier for boys, but in grades K9-12 there was no difference in gender beliefs. All others thought it would be hard, (even in countries like Iran and Middle East). The sample all appreciated that there were different types of engineering including a category Umit calls "casual engineering". Pupils do not see engineers as part of the development of a country. They see them as workers in a factory. In countries with little infrastructure, such as third world or developing countries, they see engineers as a "wonder person" and certainly as an upwardly mobile opportunity. Western countries see engineering more as being about marketing and sales rather than the manufacturing/production side. Umit finds this interesting because manufacturing in these countries has virtually ceased. Umit's conclusion is that New Zealand and Netherlands have to pay more attention to boosting student knowledge about the part developed countries play in design, research & development, and prototype production. They should appreciate that we can develop and then hand over designs to the manufacturing countries. Developed countries like New Zealand and Netherlands have to pay more attention to the image of engineering to counter a negative attitude to this subject.[28]

18.6 *Valuing the Subject*

Not valuing DT was an important issue identified in Benson's research. Lack of commitment of the Principal to develop DT, lack of opportunities such as staff meetings and CPD for support, and a change needed in the school development plan, were reasons cited by 60% of the teachers for believing that they would face a struggle back in their schools to disseminate necessary changes to implement robust DT. Teachers who believed they *could* bring about change all indicated the Head's support was the important factor.[29] What is needed here is for the Principal to be challenged in their thinking about the importance of this subject to students' and the nation's future.

[27] Cited in Benson, C. (2012). 'The Development of quality design and technology in English primary schools: issues and solutions' in *Technology Education in the 21st Century: PATT 26 Conference Readings,* Sweden, 2012, p.85.
[28] Interview at Bergchenhoek, Netherlands, 30 August 2012.
[29] Benson, C. (2012). 'The Development of quality design and technology in English primary schools: issues and solutions' in *Technology Education in the 21st Century: PATT 26 Conference Readings,* Sweden, 2012, p.84.

The attitude of parents was also identified as important. Parents may not have studied DT, and those in business and industry can think it is all about computers or manufacturing. Some parts of the UK report a drop in numbers of students taking DT as options. This is partly attributed to a perception that DT is not "academic" enough, a concern instrumental in influencing particularly higher socio-economic parents' thinking. The solution here is both to educate parents and to ensure that DT programmes move beyond a technicraft level and become truly significant to a futures-focussed world. After all, there is only room for so many lawyers and accountants, especially if there is no-one to develop new and exciting products for the 'white collars' to service! In Benson's research, parental attitudes to DT improved greatly after parents took part in DT activities and parents realised the extent of thinking and knowledge involved.

Professor Geist, Head of Primary Education: Science and Social Studies at Potsdam University, attributes some of this de-valuing to a loss of girls to the subject. He believes Technik is too abstract for what girls are interested in; therefore it needs to be applied more to real world solutions. "Girls must experience that science is good for dealing with the problems of every-day life. Girls are not interested in bridge-building; it has no meaning for their life so they are not interested in it."

The problem is also that Germany (and similarly, other countries) needs more women teaching Technology. "Women teachers," Geist says, "have a problem with Technik and Physics." This is particularly a problem for Germany, highlighted he says by research by Beate Blaseio who has analysed the German curriculum as to the relationship between the different perspectives and has found that the biggest aspect of the curriculum is Technik and Physics.

According to Geist, Cornelia Moller's research studies show that even when teachers try to teach a good Technology lesson, the lesson will be 30% technical and 70% associated with social, life, culture, and whatever teachers are more familiar with. Geist says there is a big disparity between regions where primary teachers are trained as generalists and those teachers who have been well-trained in the integration of understanding and applied Technology. Student Teachers trained in DT are the only ones out in schools who are training the teachers. In Holland, Marc de Vries says that in Primary education, primary teachers do not have a science or technology background so these subjects are weak, non-existent almost in the case of DT.

The state of primary technology education in the Netherlands is similar to the situation in other countries, according to de Vries,[30] in that it has always been more problematic to introduce Technology education in the primary sector than in the secondary (De Vries 2006).[31] He says the reason is "the same as in most countries: primary teachers have no background in science and/or technology nor do they like it [being] mostly women, with a preference for human and social rather than natural and engineering sciences… In the Netherlands, this certainly was an important factor that hampered and still hampers the implementation of technology education at the primary level."

Even at the high school level, the Netherlands suffers from issues over Technology claiming its due status. In 2002, Technik could be merged with other subjects instead of being a prescribed separate subject, so the 'Vocational' school sector merged Science and Technology - but the aim was to

[30] Marc de Vries, interview at Delft Technology University

[31] Notes provided from Marc de Vries, draft Chapter *Frühe technische Bildung in den Niederlanden*

make Science education more attractive, rather than to strengthen Technology. In the ‘General Education’ sector, Science was – and still is – seen as higher-ranking so there was hesitation to include the “weaker” Technology subject. Therefore a lot of schools kept Science separate. If the Technology programme was already strong, it gained in status by adding Science; if it was weak then the science teacher took it over and Technology vanished (other than being paid lip service to by way of superficial teaching to tick the boxes for attainment targets). The quality of the Technology programme depends on how seriously the teacher takes it. Pupils have to do assignments, for example, involving Design, but if it is relegated to being taught in one afternoon then the quality will be poor. De Vries says at the moment, practice is very mixed. By axing the PD programmes, VTB and VTB-Pro, there is little demonstration of valuing the importance of the subject.

VII Solutions and Recommendations

At National Level*:*

(i) Fund and support continuous face-to-face Technology/Enterprise Professional Development as a priority.
By way of acknowledging that High School and Intermediate Schools are already well under way with their specialist services, Government-funded PD should start with delivery to the primary school sector.

(ii) Continue to fund research in Technology Education, coupled with direct interventions at school level designed to improve DT teaching and learning. A fruitful area to work with could be the links of Technology to literacy and student engagement.

(iii) Educate political Leaders as to the national importance and nature of Design Technology, whether through professional bodies and/or influential academics.

(iv) Design Technology, Enterprise Education, creativity and innovation should receive more status within the NZ Curriculum in the same way as Literacy and Numeracy are being singled out for special support.

(v) Investigate the feasibility of developing Science & Technology Learning Centres, in partnerships with tertiary providers.

At Wider Community Level*:*

(i) Parents need to become better educated as to the value and nature of Design Technology and its future career opportunities. Strategies could include involvement with Technology learning experiences at school or as part of homework, or through parent workshops, leaflets, displays in community buildings/ shopping malls as well as websites such as TechLink or TKI; invitations to local businesses, industrialists, and retailers to support Design Technology challenges or attend Design Technology events.[32]

(ii) Schools should develop partnerships with local businesses, industrialists, and retailers to support Design Technology/Enterprise programmes in schools.

(iii) Secondary schools should play a more active role in supporting their primary schools to develop Design Technology (this could include applications of Science in authentic, problem-solving scenarios).[33]

(iv) When planning DT contexts at all levels of the system – tertiary to primary – account should be taken of gender differences. If women and girls are to be catered for, note should be taken of research suggesting that girls are likely to be more interested in authentic 'every day' type problems, as opposed to engineering contexts.

At School Level:

1. Establishing Goals and Expectations:

(i) Schools should develop a Design Technology Vision within their school's holistic Vision. The Vision should go beyond an ordinary "Technicraft" view of DT. It should be extraordinary. It should give Design Technology a special status and priority in a school's curriculum. Strategies for alignment and shared understanding of the Vision across the school should be implemented and owned by staff.

(ii) Underpinning schools' DT programmes should be pedagogies such as Creativity, Discovery Learning, Problem-Based Methodology, Assessment for Learning, and Inquiry Learning.

(iii) Consider how to adopt a broad view of Technology that incorporates the Technology curriculum and technological literacy with the world of work, careers and life planning, the local and global economy, economics, sustainability and consumerism.[34]

(iv) Consider integrating Enterprise Education with Technology units incorporating a shift away from a content and teacher-centred view of teaching and learning towards one that works with business and community partners to solve real problems, create relevant learning activities and engages the strengths, interests and passions of students.[35]

(v) The aim should be to share locus of control for Design Technology learning, or allow learning to be owned by students, as age appropriate, so over time there is less reliance on teacher control.

2. Resourcing Strategically:

(i) Principals must understand and be supportive of the subject or it will not flourish.[36] The Best Evidence Synthesis states that the most powerful outcomes are achieved when Principals also participate in the PD.[37]

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[32] Benson, C. (2012). 'The Development of quality design and technology in English primary schools: issues and solutions' in *Technology Education in the 21st Century: PATT 26 Conference Readings,* Sweden, 2012, p.86.

[33] Benson, Ibid, p.85.

[34] Refer Brandenburg Technology Curriculum, p12.

[35] Education Review Office, *Enterprise in the NZ Curriculum,* ibid.

[36] Benson, C..,Ibid, p.85.

(ii) Prioritise funding for Technology resourcing
(iii) Prioritise timetabling for Technology teaching
(iv) Schools with specialist Technology departments should consider ways to build in flexibility into the timetable to allow for Technology integration into other subjects
(v) Considered purchasing and use of Digital Fabrication equipment, as affordable
(vi) Incorporate 2D and 3D CAD drawing skills into primary school programmes to prepare students for the emerging trend in digital fabrication technologies. Teach reading of drawings.[38]
(vii) In ICT programmes investigate deployment of software to enhance familiarity with Computer Code (such as *Scratch)*. Use of software such as *Lego* will prepare students for the futures-focussed demand for Robotics expertise.

3. Planning, Coordinating and Evaluating Teaching & the Curriculum

(i) All teachers need to understand the subject, be involved in whole school planning in DT, and have ready access to support materials and resources.[39]

(ii) Principals should demand authentic DT topics/themes, tasks, outcomes and/or products. These should involve real world problems and be relevant to students. Subjects of relevance and interest to girls should be adopted. Individuality should be encouraged and "cloning" of DT outcomes should be avoided.

(iii) Consider trying some of the teaching ideas contained in this report, particularly if doing 'design and make' topics.[40] Following is a summary:

- *Teacher-initiated or Student-Initiated Design Brief*
- *Brainstorming initial ideas*
- *Task Analysis which could include teacher directions and a child-initiated Mind Map of things the student needs to consider*
- *Product Analysis*
- *Client Profile identifying the client*
- *Background research, e.g. history of product. Or, could examine current variations on the product and analyse against the 6 Essential Skills of Design*[41]
- *Inspiration Or Mood Board, poster or page which contains reproduced images, sketches, words, and/or photos pertinent to the design*
- *Trend Board, poster or page looking at current and future products; could be linked to historical or latest trends, or designers' influences, or design movements/schools*
- *20 thumbnail sketches of initial design ideas from which the student selects their preferred option*

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[37] Robinson, V., Hohepa, M, and Lloyd, C., *School Leadership and Student Outcomes: Identifying What Works and Why :the Best Evidence Synthesis,* New Zealand Ministry of Education, 2009, p.39.
[38] Ernst-Haeckel-Gymnasium, p.40.
[39] Benson, C., Ibid, p.85
[40] For example, see Teaching Sequences & Ideas, pp.34-43.
[41] Refer to Rebecca Higgins, pp42-43.

- *Rendering Exercise in which students practise colouring shapes to create a 3D effect and to show where the light is coming from*
- *Design Specification where the student considers: Aesthetics (appearance), Cost (Price Range), Customer, Environment (where it would be used and how eco-friendly the product would be), Safety, Size, Function (what job it does) and Materials. Considerations of context taken into account, such as Costume for film, theatre, etc., or links to different DT contexts/subjects*
- *Design Development where the student draws up three detailed versions of a design and considers the pros and cons of each.*
- *Development Plans – e.g. Colours, Development Plan for Materials, Development Plan for Fabrics, Development Plan for Components, Development of a CAD Drawing Plan, Development of Pattern Design (Textiles)*
- *Materials Testing – testing for fitness for purpose of any materials proposed to be used*
- *Project Plan – could be in form of a Gantt Chart*[42]
- *Final Design - neatly rendered and fully annotated including dimensions, materials, special features etc.*
- *Manufacturer's Report – identifying what problems the manufacturer of the product might expect (useful if a prototype was to be batch or mass-produced).*
- *Health & Safety considerations and accompanying activities*
- *Designers Study – an activity on the role of Designers in society pertinent to the topic*
- *A net design for packaging for the product*
- *Final Packaging Design produced on CAD*
- *Step-by-Step Instructions on How to Make the Product. Or a 'Making Diary' – could be a series of thumbnail sketches, annotated, or digital photos. Could include a Flow Chart*
- *Self-Evaluation and/or Peer Evaluation or Consumer Survey. Could include a Star Diagram or Spider Web Diagram*[43] *displaying the criteria for creativity and rating against each; or a Critique.of whether they have met the design specifications or not. Could include testing regime, e.g. if a garment worn – wearer feedback recorded; food product – consumer survey; client feedback. Could include a comparison made with an existing product.*
- *Teacher-developed 'Self Help Cards' for times when students might get stuck, to develop student independence*[44]

(iv) Give consideration to Marc de Vries' ideas on exemplary primary school Technology programmes, which he believes should include:

- *Applying pure science to solving real problems, involving developing prototypes to potentially solve the problem, and systematically working and re-working the prototype to optimise the solution creatively.*
- *Exploiting of the links between the investigations of science concepts and promoting curiosity, to learn how the Nature of Technology works.*
- *Lots of activities to promote Creativity and Curiosity.*
- *Ask the questions – no question is a dumb question.*
- *Learn what investigating is.*
- *Can we find out how to improve it?*

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[42] For example, Dinas Bran p 40.
[43] Newtown School, p.41
[44] Blackrod & Rivington High School, p.35

- *Focus children on the variables and let them see the effects on their design each time.*
- *Use all sorts of artefacts – e.g. strange things like the bird that dips into water in unceasing motion – can they explain it?*
- *Attitude is All – open-mindedness, no stupid questions, no stupid solutions – teachers need to be careful to avoid their adult judgements*
- *Make the links between Science and Technology more explicit*
- *'STEM' Education should be 'STEAM Education' because it needs the Art to create good design.*
- *Use the Discovery Approach – don't give students the knowledge*
- *Creativity is coming up with lots of different possibilities to solve problems*

(v) Review your current DT programmes, teaching and achievement. Reference against a curriculum review exemplar (e.g. ERO Technology Report), or utilise colleagues from an esteemed school or Technology curriculum leader.

4. Promoting and Participating in Teacher Learning & Development

(vi) School leaders should prioritise quality, face-to-face Design Technology continuous Professional Development, especially in primary schools with generalist Classroom Teachers.

5. Ensuring an Orderly & Supportive Environment

(vii) If leaders make Technology programmes a priority, and ensure these have shared locus of control, and are authentic and relevant to students' lives, then the experience of the schools visited suggests that student engagement and passion will follow.

6. ***Creating Educationally Powerful Connections***

(viii) Seek business and other meaningful community partnerships, to support the authenticity of programmes

(ix) Pursue opportunities for Design Technology competitions and extra-curricular activities to the highest possible standard

(x) Contributing schools should liaise with their local high school to establish what Design Technology skills are required for later success, with the view of considering what foundational skills can be built on developmentally (backwards planning).
Encourage an active partnership in teaching and learning between contributing and higher schools, particularly where a primary school is not confident in DT.

VIII SUMMARY

When in Holland, I asked Marc De Vries as an international leading Technology educator, what he would want to see in a primary school that aimed to be exemplary in the field of Design Technology. If he could wave a magic wand and make a school be the best, what would he expect to see? His thoughts are outlined in 3 (iv) of the section overleaf. I am pleased to report that during my travels I saw many exemplars of his hallmark of the best Design and Technology schooling. I am also proud to reflect that there are many of those qualities that my school (and others in NZ) are already doing.

It is tempting for New Zealanders to think that because it is sited ‘overseas’ it is automatically better. While I saw amazing Technology schools, and quality Technology teaching and learning happening, however, I was also made aware that in the wider overseas educational context, there are many schools that are not as forward-thinking as mine. My trip highlighted the potential national economic perils if this is not addressed. I also saw examples, more often in primary schools, who did not even know what they did not know, and of Principals who either assumed their programmes were robust or who knew the subject needed a boost but had not yet been able to achieve the desired standard, all a reflection of the lack of professional development at some level of the school. If attitude is anything to go by, there was not one school that did not want to deliver the best outcomes for their students. The teaching profession transcends national boundaries, a wonderful sentiment to encounter.

Overall, I came to the conclusion, more strongly than ever, that Technology deserves a paramount place in our school curriculum and that my school is on the right track with our vision to promote this subject into the forefront. We owe it to our students, if they wish to compete for jobs in a future global economy, to ensure our children are well-equipped with the highest technological capability, thinking and creative competencies. If NZ schools, collectively, do not do this – which means doing it better than we do currently – then, based on what I saw happening in cutting-edge schools in UK and Europe, our country will be left behind.

It is not just about money. It is about having the vision. Schools might not be able to compete with the financial burden of always keeping up with technological innovations, especially ICT, but there is huge traction we can gain for our students by teaching them how to use the basic, staple materials of our planet sustainably, in innovative and creative ways - especially if these can solve life’s everyday problems and enrich the lives of people.

From this study experience, I have learnt that my primary school is doing exceptionally well on our Technology learning journey, relative to many primary schools visited. However, there are always useful ideas we can learn from others. Green Bay School is not a high school or an Intermediate school, blessed with specialist facilities and staff, so in many ways we cannot compete and it would be fair to say that we should not expect to compete at this level. But we have advantages others overseas do not. Our NZ Technology curriculum provides us with a launching platform that is the envy of many overseas experts. Much of the 9edagogy that is considered innovative in schools visited overseas is routine in my school and in many NZ schools. My school has a huge advantage that other schools, here and overseas, would envy – our partnership with the University of Auckland, and leading NZ Technology experts, in particular, Dr Vicki Compton. The opportunity this has afforded us is not to be under-estimated. Continuous professional development for teachers is ‘technological gold’ and my trip will be an impetus to continue to mine it for the benefit of our students and teachers.

If my school can do it, so can others. I hope this study will provide some fresh ideas and a challenge for education leaders at all levels in NZ to prioritise this subject, and to do it better. I hope this study will also give feedback to the schools I visited, as a way of saying thank you for your hospitality.

I finish with an image planted in my mind by one of the inspirational people I met on my journey. When talking to Rhys Evans in Wales about our mutual passion and vision for Technology, Rhys said, “Think about the nature of future work… Imagine what kind of new jobs might exist in the future. We might ask someone who was educated at our school what they do for a living, and they might say, ‘I create habitats on other planets’ or ‘I’m a terra-former on Mars!’

Think of that and you will appreciate why all these inspirational people I encountered – academics, teachers, Principals, Curriculum Leaders, and schools – are all dedicated to do our best for the future of Design Technology.

Jude Black April 2013.

APPENDIX I

SCHOOLS & INSTITUTIONS VISITED

UK Schools

John Betts Primary School
Paddenswick Rd,
Hammersmith,
London W6OUA
Head: Gill Del Bravo
Head of D&T: Lucy Chatfield

Lutterworth High School
Woodway Rd,
Lutterworth, Leicester LE17 4QH
Head: Nora Parker

Newtown CE Primary School
Newtown, Wem,
Shropshire
Head: Andrew Hodson
DP & DT Leader: Rebecca Higgins

Ravens Wood School
Oakley Road
Bromley,
Kent, BR28HP
Head: Ken Saunders
HOD: Gary Hunt

Rivington & Blackrod High School
Rivington Lane, Rivington,
Bolton
also Form 7 at Albert St, Horwich, Bolton
Head: Tony Purcell
Director of Science & Technology: Nicki Robertson
HOD DT: Vicki

Rothley Church of England Primary School
Mountsorrel Lane,
Rothley, Leicester LE7 PS
Head: Fiona Parr

St Edwards Royal Free Ecumenical Middle School
Parsonage Lane,
Windsor SL4 5EN
Head: Rod Welsh
AP: Amanda Bird

HOD: Cate Stevens

St Peters Collegiate School
Compton Park, Compton Rd West,
Wolverhampton, WV3 9DU
Head: Adrian Richards
AP & HOD: David Chapman

The Marches School & Technology College
Morda Rd, Oswestry,
Shropshire, WY11 WDR
Head: Sarah Longville
HOD DT: Sharon Geddes

The Piggott School
Twyford Rd,
Wargrave, Reading,
Berkshire RG10 8DS
Head: Hiliary Winter
HOD: Linda Huntingford
Head of Design Dept: Linda Parker

Thomas Estley Community College
Station Rd
Broughton Astley, Leicester, LE9 6PT
Head: Tim Moralee
Head of DT: Mandi Collins

Ysgol Dinas Brân
Dinbren Road
Llangollen, Denbighshire,
Wales
Head: Alison Duff
HOD: Rhys Evans

Holland Schools & Institutions

Christelijh Lyceum Delft
Molenhuispad 1
2614 GE Delft
Technology Teacher: Maaike van der Vourk

Delft Science Centre
Mijnbouwstraat 120, 2628 RX Delft,
Netherlands
Coordinator: Liesbeth van Hees

Delft Technology University
Stevinweg 1
2628 CN Delft
Netherlands
Marc de Vries and Remke Klapwijh

Melanchthon Bergschenhoek
De Zide 3
2662 EB Bergchenhoek, Netherlands
Principal: Gesinus Hospes
Technology Teacher: Umit Koycu

German Schools & Institutions

Ernst-Haeckel-Gymnasium
Kesselgrundstr. 62
14542 Werder
Germany
Tech Teacher: Mr Zube

Geschwister-Scholl-Grundschule
An der Lake 25
14612 Falkensee, Brandenburg
Teacher: Mrs Schultz

Potsdam University
August-Bebel-Straße 89,
14482 Potsdam, Germany
Professor Mette, Head of Production Systems
Professor Geist, Professor of Primary Education, Science & Social Studies
Translation: Hajo Laabs

Danish School (in Germany)

A.P. Møller Skolen
Fjordvej 1, Auf der Freiheit, Holm
Nr Niebüll,
D-24837 Schleswig, Slesvig, Schleswig-Holstein, Tyskland
Germany