Special TERU Edition (20:3)

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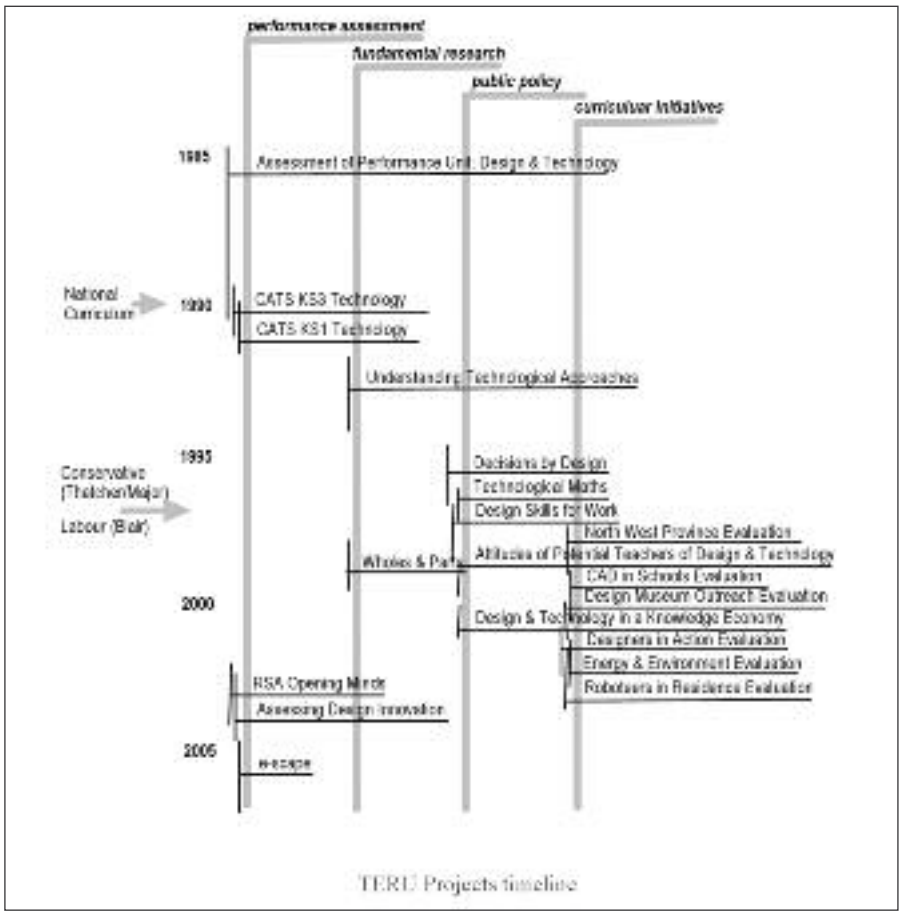
This is an unusual edition of the journal. The Technology Education Research Unit (TERU) at Goldsmiths, University of London has been invited by the D&TA team and the journal's editors to create a Special Edition of the journal. Specifically (and for a reason that will become clear later) we have been invited to compile an edition from papers that we have written based on our research over the last 30 years. One of these papers appeared in an international journal; two in a book that we wrote together that was published in 2007; two were keynote presentations at conferences in South Africa and Australia; and one (oddly) has never before seen the light of day. We have made our selection on the basis of bringing into one edition things that we have written over the years that we consider have particular relevance in today's educational climate.

We are using this editorial to set the scene for the collection by summarizing and categorising the entire body of research that we have undertaken at Goldsmiths, and we need at the outset to clear up the start-date for this body of work. Whilst TERU was formally established in 1990, our research activities really started before that with the APU project (1985-91). So in total our research spans a period of 30 years, 25 of them as TERU. We have structured the story so as to be broadly chronological and interestingly this chronology also reflects a series of shifts in the nature of the work. Originating in research concerning *assessment* we moved progressively through phases of *fundamental* research, *public policy* and *curricular initiatives* before returning once again to *assessment* priorities. We have mapped this chronology in the graphic that appears at the end of this editorial.

TERU AND PERFORMANCE ASSESSMENT

In 1984, the UK Department of Education & Science announced design & technology as a new field of enquiry to be tackled by its research branch, the Assessment of Performance Unit (APU). Established in 1975, the APU's prime task was surveying and monitoring levels of achievement in schools. By the time the design & technology contract was issued, it had conducted extensive surveys in mathematics, English, science and modern languages, typically at ages 8, 11 and 15. Much had been discovered about what learners could be expected to achieve in these subjects at those ages. Progressively, however, a change of focus was detectable in the conduct of those surveys. APU began to focus less on mere monitoring, and more on providing support for curriculum development.



TERU Projects timeline

wished to survey design & technology, tenders were invited. The contract to undertake the research was won by Goldsmiths.

The proposal enabled a research team to be created in the design & technology department at Goldsmiths. This team was directed to Professor Vic Kelly (a curriculum specialist) and the research was coordinated by Richard Kimbell (a lecturer in design & technology). At the launch of the project, the team additionally comprised Kay Stables (a specialist textiles teacher), John Saxton and Jim Patterson (both craft, design & technology teachers). Other appointments were made during the subsequent 5 years. We found new ways to describe the domains of performance in design & technology and developed new approaches for supporting and enriching learners' performance. We developed this approach into 26 tests that we took into 700 schools across England, Wales and Northern Ireland, and in total we assessed the performance of approximately 10,000 learners. The resulting performance data were analysed from many perspectives, and the final report contained national performance levels analysed in relation to gender, ability, and the curriculum that had been experienced by the learners. We also revealed generalised features of design & technology activities that have serious effects on performance levels, such as the nature of tasks and their contextual setting as well as the structures of activity through which learners tackle those tasks. The full research report was published in 1991 (Kimbell et al., 1991).

But before then, in 1989, other research ventures were appearing on the horizon – not least concerning the planned implementation of design & technology in the National Curriculum. With the imminent prospect of a number of new research and development projects coming into the (re-named) Design Department at Goldsmiths, in 1990 Richard created TERU – the Technology Education Research Unit, as a Unit within which we could draw together all these research and development activities in support of design & technology in schools.

On the strength of *APU Design & Technology*, we acquired three new projects – two of which centred upon approaches to the performance assessment of learners in design & technology classrooms, workshops and studios. Specifically, we were invited to create prototype tests for National Curriculum design & technology – at age 14 (1989–1992) and at age 7 (1990–1992). Both these projects took further the models of research that had been originated within *APU Design & Technology*; the age 14 project being directed by Jim Patterson, and the age 7 project by Kay. Richard directed the third project – developing curriculum support materials for design & technology for the newly created National Curriculum Council – alongside the preparations for publication of the *APU Design & Technology* report.

THE NEED FOR FUNDAMENTAL RESEARCH

APU Design & Technology had been the first large-scale research to be undertaken in design & technology. The subject itself was a new concept – drawn together through a series of curriculum initiatives that gradually coalesced into design & technology in the late 1980s. Plenty of curriculum development projects had taken place in these evolutionary years, but nothing of a fundamental nature to enable the design & technology community to create the conceptual underpinning that is necessary for real understanding of a subject. Design & technology – at this time – was best described as 'what was done' by a group of practitioners who shared a set of ideals about teaching and learning in workshop and studio settings.

In our own national context, these ideals and practices had been rationalised (in 1985) as part of the revision of 16+ examinations. Prior to this point, there had been a twin system of qualifications at 16+; the General Certificate of Education (GCE), for the 'top' 25% of ability of the population, and the Certificate of Secondary Education (CSE) for the rest. In 1985 these two systems were merged into the General Certificate of Secondary Education (GCSE) and the opportunity was also taken to consolidate and update the content of the subjects to be examined.

Two of those GCSE subjects, Craft Design & Technology (work in wood, metals and plastics, graphics and technological systems) and Home Economics (work in food, textiles, child development and home management) were the core of what was subsequently to become design & technology. In both groupings, the role of **designing** was accentuated, and this subsequently became the organising feature that dominated design & technology when it was launched as a 'new' subject as part of the first England and Wales National Curriculum. This new subject drew from all its founding formulations, most notably Craft Design & Technology and Home Economics, but there was at least as much doubt and confusion about its composition and practices as there was clarity and light. The formulation of National Curriculum Programmes of Study and Attainment Targets – built around designing and making – forced the amalgamation of these two groupings into design &

technology as it now (broadly) exists. The disparate traditions and practices created enormous tensions within design & technology. The situation cried out for some fundamental research that could build a conceptual framework to make sense of the beast that had been created.

In 1991, Richard applied to the Economic and Social Research Council (ESRC) for a grant to fund a project to explore – and seek to understand – the practices that proliferated at this point. In 1992 the ESRC approved the award and a new 2-year project was launched within TERU: *Understanding Technological Approaches* to teaching and learning in the curriculum.

In this project we explored in detail real-time projects in design & technology at every school year from year 1 to year 11 in the new National Curriculum (i.e. with learners from age 5 to 16) in every area of design & technology. The approach was broadly to **observe** projects from start to finish – usually 3-4 hrs with year 1 and 2 but as long as 48 hrs with year 11. The observations were built around as common framework – enabling us to make direct connections between the approaches to designing and making across this complete age range.

Analysing these detailed observations (taken over 2 years) enabled us to characterize approaches to design & technology teaching & learning, and describe it in ways that had hitherto not been possible. We published this work in 'Understanding Practice in Design & Technology' (Kimbell et al., 1996).

THE DEMANDS OF PUBLIC POLICY

By the mid-1990s design & technology had become a fixed point on the educational landscape. Having escaped from the obscurity imposed by its fractured history, design & technology – as a single entity – began to assert itself into areas of public life. All kinds of issues began to emerge with interested professional bodies, not least with the UK Design & Engineering Councils, both organisations with certain responsibilities for managing, promoting or regulating their professions who also have a brief to inform and educate the general public about their activities. Particular interest in design & technology is related to:

- Its role as a university entrance qualification
- Its employment value for school leavers
- Its role as an economic driver in a knowledge-economy
- The challenge of recruiting and training teachers

From 1995, we were approached on a range of these issues to run projects that could illuminate areas of public policy. The first of these arose through the Design Council, building case studies of 'good practice' so as to exemplify what was meant by design & technology. However, the bodies for these public policy projects were typically **less** concerned with developing good practice in schools, and more concerned with understanding the distinctive contribution that design & technology could make in areas of public and professional life. Their priority was to seek **conceptual** clarity.

We presented a case to the Design Council, that **designing** is a distinctive way of thinking, and they awarded us a grant for a 2-year project exploring exactly that territory. The project *Decisions by Design* (1995–1997) explored the power of designerly thinking for those who are not (and do not intend to become) designers. How is design thinking similar to and different from 'ordinary' thinking? What is its distinctive character? The successful conclusion of this project led to further projects in the general area of transferable design skills for employment. The first, *Design Skills for Work* (1997–1999), addressed the general question 'what are designers good at, if they are not being designers?' This was followed by a project exploring the attitudes of design students towards a career in teaching – *Attitudes of Potential Teachers of Design & Technology* (1999–2000).

At the same time the Engineering Council – interested in routes from school into engineering – was concerned to explore the role of mathematics in design & technology. The serious drop-off of candidates coming forward with pure and applied mathematics and physics, along with the increasing awareness of the engineering nature of some design & technology, had encouraged some universities to seek students who had successfully completed design & technology Advanced Level examination courses. The project *Technological Maths* – seeking to identify the nature and extent of the mathematics in design & technology – ran in TERU from 1996–1997. A second project for the Engineering Council – *Design & Technology in a Knowledge Economy* (2000–2001) – aimed to locate design & technology within the wider debate about the need for curriculum change to support future knowledge economies.

Towards the end of the 1990s, the National Curriculum formulation of design & technology had worked its way through the entire school population, primary and secondary. It had evolved through two official versions (1990 and 1995, and the 2000 version was looming) as well as a number of unofficial ones, inspired by particular

interest groups. A centre of gravity had emerged for the subject, consolidating into forms of classroom and workshop practice that were more commonly understood and accepted. So changes at this point were destined to be less sweeping and more incremental – tweaking the formula rather than slinging it out of the window.

So the need for evidence about the performance of particular approaches to learning and teaching within this curriculum became ever more necessary and in TERU we became involved in all kinds of evaluative projects – seeking to understand and make evident the particular strengths and weaknesses of this or that curriculum initiative or approach.

EVALUATING CURRICULAR INITIATIVES

Ironically, the first of these evaluation exercises was for a foreign government. The presence of design & technology in the UK had for some years been exerting an influence on the international scene, and the consolidated form of National Curriculum design & technology had been influential, especially in the English-speaking world where UK journals and conference speakers were available.

It was the new Mandela administration in South Africa that invited TERU to undertake its first evaluation of a curriculum initiative, funded by the Department for International Development (DFID). In the North West Province – centred on Mafikeng – the provincial curriculum team, in association with a non-governmental organisation (NGO), had undertaken a pilot study to introduce a technology education curriculum for learners in their final 2 years of schooling. The scale of the challenge of undertaking this curriculum in rural schools in South Africa is difficult to imagine in more 'developed' countries:

- Schools with minimal facilities and (sometimes) no electricity
- Involving teachers from subject backgrounds as diverse as geography and Afrikaans
- Traveling huge distances to attend training sessions
- Training for a curriculum that was dramatically different from former (craft) practice
- Resources brought into the schools by van across huge distances
- With the curriculum expert (the van driver) visiting perhaps twice a year

Our evaluation of the curriculum and of the Province's procedures for developing and disseminating it became part of the wider South Africa education debate when technology was absorbed into their national curriculum framework.

Other evaluation projects followed; for London's Design Museum, exploring the effects of their educational outreach programmes; for the Design & Technology' Association (D&TA), evaluating the impact of Pro-DESKTOP computer aided design software; for the National Endowment for Science Technology and the Arts (NESTA), developing a new **systems and control** curriculum with LEGO soft and hardware; for Middlesbrough Local Education Authority (LEA), evaluating literacy developments through design & technology in primary schools; and for the BBC, evaluating their Roboteers in Residence programme that brought expert roboteers into schools to work with learners developing robots for a BBC TV programme.

THE NEW MILLENNIUM

In 2000, a number of related events took place that shaped the activities of TERU over the following 5 years. The latest version of the National Curriculum (NC2000) was launched, with some amendments to the Programmes of Study and the Attainment Target. Most critically, however, it included for the first time a statement about the importance of design & technology in the curriculum. It may seem odd that such a 'vision statement' should not be published until a decade after the original launch of design & technology in the 1990 National Curriculum. The recognition of this need for a clear statement of intent was reflected right across the curriculum – from all subjects – and these statements were drafted with expert subject groups in 1999 as cornerstones for the launch of the fully revised curriculum.

However, the issue ran deeper for those of us concerned with learning through design. The tortuous history of design & technology, and the rapid evolutionary steps that it had progressed through in the decade immediately prior to the establishment of the National Curriculum in 1990, all contributed to the recognition – in the UK Government Department for Education & Employment; in D&TA (the Design and Technology Association), the subject's professional Association; and in Higher Education and teacher education establishments – that the newborn baby would need careful nurturing in the immediate years ahead. Accordingly, the Department for Education & Employment established a Design & Technology Strategy Group to oversee these years and to bring forward recommendations for the immediate future.

One of the earliest tasks undertaken by this group was to analyse the internal coherence of design & technology as presented in its revised version, and specifically in relation to the 'fit' between the newly created vision statement and the Programmes of Study and the Attainment Target,

both of which had evolved through three versions of the National Curriculum. Some discrepancies became apparent. Among these was the recognition that whilst the vision accentuated the importance of developing learners' creativity and innovation, and significantly through the vehicle of teamwork, teachers – particularly through the assessment criteria for the GCSE examinations – were not required to acknowledge or reward these qualities.

In the light of these mismatches, TERU was commissioned to undertake a project to reinvigorate the creative heart of designing and develop approaches to the assessment of design & technology that would reward teamwork and innovation.

PERFORMANCE ASSESSMENT AND INNOVATION

In January 2003, we launched the project *Assessing Design Innovation* and in many ways this drew TERU back to its origins in the Assessment of Performance Unit in the mid-1980s. We were back to exploring approaches to performance assessment in design & technology, but with the additional requirement that the approaches we developed should be focused on supporting teamwork and enhancing learner innovation.

But by now we had a great deal more experience of research and development approaches. We were able to draw on the wide range of techniques that we have developed in our earlier work:

- Exploring the nature of design & technology
- Supporting the development of public policy
- Evaluating curriculum initiatives

Over 2 years from January 2003 to December 2004 we worked with a small number of LEAs and schools across the country, and produced models for assessing design innovation that were subsequently not only reported to the (now renamed) Department for Education and Skills and its curriculum and assessment 'watchdog' the Qualifications and Curriculum Authority, but were also shared with the General Certificate of Secondary Education Awarding Bodies. One of the immediate outcomes of this project was the development by one of these awarding bodies of a new form of syllabus and examination based on the approach we had developed in the project. (See OCR Product Design… 'The Innovation Challenge')

In the process of developing our approach to assessment in this project, we explored a range of new technologies to see how they might be helpful. Among these technologies were the use of digital cameras to record learners' emerging work, and of some simple computer aided design interfaces to support their ideation. It became apparent to us that these digital technologies offered the potential radically to transform the assessment process, and we proposed to Qualifications and Curriculum Authority and the Department for Education and Skills that these technologies should be the explicit focus of a research and development project. This proposal came simultaneously with the challenge to the examination Awarding Bodies to accept portfolios on disk. This was – at one level – a natural evolution of good design & technology practice, but – at another level – represented a serious challenge to the established assessment procedures of the Qualifications and Curriculum Authority.

In the light of all these pressures, our proposal was accepted and project e-scape ran through three research and development phases. E-scape Phase 1 (2004-5) was a feasibility phase – looking to see how the digital technologies available at the time might (just possibly) be made to work for learners in classrooms. E-scape Phase 2 (2005-7) was then commissioned – to build a working prototype system that would allow learners in normal studios and workshops to create web-portfolios of their work, and for teachers to be able to undertake web-based assessments of them. Phase 3 (2007-10) was then commissioned as a national pilot-testing programme in association with Awarding Organisations. In total this involved 19 schools and 350 learners (mostly in year 10) and the assessment technology in particular brought a completely new set of tools to teachers making assessments and Awarding Organisations seeking reliable means for awarding grades. We developed Adaptive Comparative Judgement (ACJ), that represents a radically new assessment methodology that we believe is immensely valuable both to teachers and learners.

Stepping outside the boundaries of design & technology was also a feature of a further performance assessment project that we undertook in parallel with *Assessing Design Innovation*. This project, commissioned by the Royal Society for the Arts (RSA), was aimed at exploring approaches to assessing generic competences such as team-working, systematic thinking and managing risk that were being developed through a further RSA project 'Opening Minds: Education for the 21st Century' (Bayliss, 1999). The TERU project, *Researching Assessment Approaches*, was conducted during 2002–2003. Meanwhile, the initial *Assessing Design Innovation* project materials were being utilised in collaborative work with the University of Strathclyde (McLaren et al., 2006) and the Stockholm Institute of Education (Skogh, 2005). The e-scape project was also further developed in other national contexts – in Scotland as *e-scape Scotland* (McLaren,

2012), and in Israel as *Assessment in my Palm*, (Stables and Lawler, 2011; 2012) in both settings with greater emphasis on formative assessment and in Australia where e-scape was used in school examinations for engineering.

Finally, in 2014 we launched a new project that grew from the earlier e-scape projects. Whilst their focus had primarily been on summative assessment – since the brief from QCA related specifically to the award of GCSE – we were aware that much of the power of the approaches that we had developed lay in the *formative* benefit that they held for learners. The '*Formative Assessment*' project is in association with the UK government's innovation agency, Innovate UK, whose brief is to support innovation in the application of new technologies. The project focuses on 'design talk' (discussions between teachers and learners) and the role that technology – specifically artificial intelligence – might play in enriching it.

THE EMERGING STORY OF TERU

The major blocks of research and development outlined here, that we have undertaken within TERU over the last 30 years, were not consciously planned out from the start. But neither were they arbitrarily taken on.

The APU starting point in 1985 was unexpected, and was undertaken with more enthusiasm for design & technology than expertise in assessment research. We have progressively acquired that expertise. But after that first project for APU, the priorities for our subsequent work have reflected the concerns of a new subject emerging into the spotlight of National Curriculum from the relative obscurity of a collection of historical and typically unregarded and undervalued subjects.

One of the biggest difficulties for the new fledgling design & technology was that there was almost nothing in the way of research upon which to base decisions about curriculum, or pedagogy, or assessment. Practice in schools therefore emerged on the basis of hunches and best guesses and things that had worked in the past. There was painfully little foundation on which to build a coherent and progressive vision of design & technology.

> Design & Technology lacks a research base in pupils understanding and learning such as is available in the cases of mathematics and science.
> (DES/WO, 1988, p. 7)

> Craft Design & Technology stands out as the most under researched area of the curriculum. The literature of the subject barely exists.
> (Penfold, 1988, preface p. ix)

TERU was established in response to these challenging observations. Moreover, it was founded on the belief that learning in and through design & technology has some features that make it unusual in the curriculum, and that enable it to contribute positively and uniquely to the education of young people. The research and development that we have undertaken has been informed by this belief and has sought to throw light onto the traditions and practices of teaching and learning in design & technology workshops, studios and classrooms.

In 2008, Richard and Kay compiled a book to tell the full story of our research endeavors in TERU. The book is entitled *Researching Design Learning* (Springer 2008), and this introductory piece – and the chapter on research methodology – are taken from that book. We are grateful to Springer for allowing us to use these pieces.

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