RSA Design & Society. *A Review of Literature on Design Education in the National Curriculum*, by Ian McGimpsey. Design education has been a part of the National Curriculum since its inception, primarily as a part of Technology, latterly renamed Design and Technology, one of the ten original National Curriculum subjects.

This literature review seeks to understand the development and the current state of Design Education in the National Curriculum. The review has been undertaken in the particular context of being a first small step in a project that aims to conduct a wide-ranging, imaginative discussion regarding the possible future of design education in schools.

RSA
Projects

Purpose of the review

— *Context of commissioning – RSA project*
— *what was commissioned*
— *themes that were particularly raised by RSA*

RSA Design & Society is a programme guided by an idea of design as a capacity that is central to citizenship in the UK in the early 21st century. This reconceived notion of design as a shared capability and as democratic is, at one level, an attempt to create greater congruence with contemporary social, ecological and economic parameters for a discipline often captured and sustained by mass consumerism. However, at another level, RSA Design & Society is an attempt at more than sustaining a discipline as it transitions to new circumstances. It is an attempt to utilise those circumstances as drivers towards a different design, one that provides insight into new models of production, consumption, service provision, systems development and collective problem solving.

Among the increasingly unstable and uncertain edifices of the 20th century, RSA Design & Society attempts to understand how design, as a widely shared and cultivated human capability, could help us find the grounds for future building. And given the concern with design as a capacity central to social progress, RSA Design & Society now seeks to consider the role of the education system, and specifically compulsory schooling, in fostering this capacity.

Among the increasingly unstable and uncertain edifices of the 20th century, RSA Design & Society attempts to understand how design, as a widely shared and cultivated human capability, could help us find the grounds for future building.

Design education has been a part of the National Curriculum since its inception, primarily as a part of Technology, latterly renamed Design and Technology, one of the ten original National Curriculum subjects. This literature review seeks to understand the development and the current state of design education in the National Curriculum. The review has been undertaken in the particular context of being a first small step in a project that aims to conduct a wide-ranging, imaginative discussion regarding the possible future of design education in schools.

Aims of the review

With this purpose in mind, the top level aim for the review was to understand how 'design' has been interpreted within the National Curriculum. The review was asked to focus in particular on:

1 *how policy has framed design as a discipline within the curriculum, including its origins and development over time, and*
2 *academic research into the how the subject has been planned and taught, including its effectiveness.*

With reference to point 1 it is acknowledged that effectiveness might not always refer to aims as they are 'officially' defined by policy texts, including the National Curriculum. Effectiveness may also be interpreted in relation to other aims or legitimations of design as a part of the curriculum asserted by, for example, teaching

professionals or other groups with an interest in advocating design.

Within this broad focus, the review was also asked to consider several themes within wider design and education discourses:

— *the nature of design as a discipline – is it only about product design?*
— *prominent policy agendas in relation to the curriculum, seeking to establish priority or high status subjects, notably through STEM and the 'English Baccalaureate'*
— *growing curriculum flexibility and interaction between subjects*
— *the nature of the knowledge taught by schools*
— *how the place of design is legitimised on the curriculum – with reference to national economic pressures, personal development and so on*

Gathering data for the review

— *Criteria for the literature search*
— *Results of the literature search*
— *Treatment of the literature within the constraints*

The process of the literature search took place in three steps:

1 *Establishing a search strategy*
2 *Conducting the initial search to return a large amount of material*
3 *Filtering this material*

The search strategy involved establishing relevant keywords to search, and the relevant sources of materials. Establishing keywords in this case was complicated by three factors:

1 *the wide and varying usages of the terms design and technology - the terms 'design' and 'technology' are ubiquitous in the wider education literature, being used in relation to curriculum design, school accommodation design, the rise of ICT and the role and integration of technology in pedagogy, and technological progress figured as a driver of social and economic change.*
2 *Design and technology is multidisciplinary – design education is rarely referred to in isolation in the education discourse, and principally in relation to technology. Indeed, the origins of design and technology on the curriculum lie in a bringing together of disciplines focussed on crafts skills, on working with particular materials, and more. And of course, technology and engineering are rapidly developing fields with many specialisms. Thus there is a continual proliferation of subjects closely associated with design and technology on school and college curricula, including a large number of vocational routes, as well as a number of specialist 'technical' institutions. See appendix A for a, no doubt incomplete, list of related terms.*
3 *Design and Technology as a subject in school curricula is relatively new and thus so is the language associated with it - the UK was a world leader in establishing design and technology as a curriculum subject, and this innovation has subsequently been taken up in a number of other countries. However, its newness and rapid trans-national spread has meant less consensus on the usage of terms than might be the case in other fields, and a tendency for slippage between terms across time and geography (Harris and Wilson, 2003)*

Given this complexity, it was important to attempt to understand how authors and education collections sought to describe relevant materials and make them findable. Having developed this long list of related terms, in search databases the following terms were primarily used:

— *Design AND Education*
— *Technology AND Education*
— *[These terms] AND Curriculum*

This was the basis of the search, but I also proceeded using other terms listed in Appendix A, or as guided by the thesaurus or subject listing contained within research databases, in an attempt to narrow the searches.

In the end there was no clean way to pinpoint relevant materials, and a large amount of manual sifting was required.

In terms of sources of information, I used:

— *search engines of education library catalogues which returned over 300 results*
— *British Education Index – this returned just over 300 results.*
— *CERUK*
— *ERIC – yielded just over 2000 articles*
— *a website search of various Government departments, think tanks and relevant professional organisations (see appendix [x] for a list) – this returned a further 32 reports and policy documents*
— *I also conducted a manual search of journals that were prominent in the design and technology community of practice but which were not listed in academic databases (see appendix [y] for a list of journal titles the review as a whole covered)*

Of these just over two and a half thousand results, I manually filtered for relevance against a five point criteria for inclusion based on the RSA's requirements:

— *A publication date between 1988 and 2011*
— *Either a policy text, a text describing empirical research, or a text conducting conceptual development in relation to design education*
— *Relates directly to design education in the UK*
— *An emphasis mainly on design on the curriculum – either in CDT, DT, or Art and Design. Therefore, texts primarily about art, crafts, woodwork or metalwork, technology, Food Technology, Home Economics, IT / ICT, Science, Engineering or Maths, Architecture were excluded.*
— *Relates directly to the secondary phase of education*

In total from the database search, following deduplication and manual filtering, the review returned additional 661 articles and reports.

It should be noted that the criteria was not deployed completely rigidly. If for example I came across a text that was compelling enough to include, but was published in 1987 I would not exclude it. Or a document that did not focus on design but that nevertheless held interest for design would still be included (which might notably be the case for policy documents).

This review was, however, significantly constrained by time. Thus it could not be the goal of this review to conduct a thorough review of all these 661 texts. Rather, the review provided a thematic review of all of these articles and texts based on titles and abstracts or summaries, and I conducted a further filtering, according to the aims and concerns of the RSA.

This should shape readers' expectations of the review. This review cannot provide a definitive view of DT over the last quarter of a century. It is a necessarily partial view, and one that seeks specifically to provide the RSA with an overview of design on the curriculum that is relevant to their project development aims.

The structure of the report

In attempting to speak to the RSA's concerns, the report is structured in four main sections following this introduction that will discuss:

— *the overall shape of the literature – where it seems more or less well developed - and the themes contained within the literature*
— *a short history of the development of design education as it is primarily bound up in Design and Technology*
— *an account of the discourse of design in the curriculum*
— *A concluding section that attempts to provide an overview of design and technology, with particular regard to the current education policy climate*

Section 1 - The shape of the literature on DT

Harris and Wilson (2003) in their authoritative review of the literature on the impact of design and technology up to 2002 argued that the literature lacked what they term 'research-based evidence', and that literature on impact was largely based on 'small-scale case studies' drawn from practitioner research and 'concentrates on a narrow area of research interests' associated with the context of practice (Harris and Wilson, 2003, p. v). And it remains the case that peer-reviewed academic research has been a relatively insignificant context of literature production in comparison to a context of teaching practice. However, the other dominant context of text production is that of professional bodies with an interest in DT's place on the curriculum. Significantly, this is a site of what might be regarded in a broad sense as policy texts, that is to say, texts that attempt to frame what design and technology is, how it is practised, and how its benefits should be understood. A fourth context of text production is from central government.

This appears to have been the situation since the establishment of design and technology on the curriculum. The result of the dominance of these contexts of text production is a literature that broadly speaking revolves around advocacy for design and technology (essentially the making of, often un-evidenced, claims on its behalf), the reconceptualisation of design and technology drawing on the discursive resources of policy and sometimes wider education research contexts; and accounts of policy interpretation or application (which might be the communication of policy to professional teacher audiences, or the accounts of 'delivery' of national curriculum or schools policy by teachers).

On one level, the energy among those dedicated to design and technology is impressive, and the amount of writing about practical initiatives seems likely to be the sign of a committed professional community. However, this bias in production is also a cause for possible concern, in at least three ways.

First, within the proliferation of texts about small scale projects, there is a tendency for the notions of 'good' DT in the classroom to separate from the aims of DT as they might be articulated and

developed by advocates in professional associations. By this I mean that good DT classroom practice may well rely on characteristics of pedagogy that are generally valued in schooling, and not on DT as a distinct subject with unique pedagogical demands. That is to say, if notions of 'good' or 'better' are not systematically developed in relation to DT aims, but on, for example, unsystematically developed or uncritically applied ideas of the good classroom or the good curriculum, they may well fail to make a meaningful contribution to DT as a discipline. For example, if the use of new materials in a DT classroom is seen to be good only because they are new, then any practice involving new materials in which young people seem to be learning becomes difficult to question. Yet there may be no clear reason why in relation to wider agreed aims of design and technology this material should be advocated or preferred, nor a consideration of the problems of using it, or the loss of what it has replaced. And so, this research is unlikely to provide any evidence that DT can fulfil the claims it makes to social and economic benefit, and to the development of young people as capable citizens in a technological society.

A second effect of the general lack of DT literature production in academic contexts is that policy implementation has driven what systematic enquiry there has been. The major sources of empirical information within DT tend to be driven by a concern for aspects of policy implementation, that is, how to implement DT as a National Curriculum subject, rather than, for example, a concern for design education and its effects. So the larger scale or more systematic studies are framed by the National Curriculum, and are concerned with: policing implementation of the National Curriculum Orders by schools (Great Britain. Office for Standards in Education and Ofsted., 1993a; Great Britain. Office for Standards in Education and Ofsted., 1993b; Great Britain. Office for Standards in Education and Ofsted., 1995; Ofsted, 2008; Ofsted, 2011; and note the annual DATA Survey of Provision for Design and Technology); DT teaching activities that fit within the National Curriculum; developing methods of DT assessment appropriate to the National Curriculum framework (Kimbell, 1991; Kimbell et al, 2004); and the take up and quality of qualifications (Gill, 2010a; Gill, 2010b; Ofqual, 2010; Qualifications and Curriculum Authority, 2004; Rodeiro, 2005; Rodeiro, 2006; Rodeiro, 2007).

Whatever the reasons, it remains the case that the systematic production of empirical evidence regarding DT at any scale is restricted to policy implementation, while the rest of the literature emphasises stating and restating largely un-evidenced claims for design and technology.

Finally, this significant imbalance in the literature that is evidenced by a focus on narrow policy implementation concerns can also be understood in terms of significant silences within the literature. Specifically, claims are made that design and technology on the curriculum supports wider policy agendas. This is distinct from what I have referred to as 'policy implementation', an example of which would be the development of DT models of assessment that are compatible with the National Curriculum standards framework of levels and attainment targets. Rather, support for wider policy agendas are claims that, for example DT, because it engages students who do not enjoy traditional classroom teaching, helps to reduce truancy. Or that, in the course of a design and make project, it can improve some young people's numeracy and literacy standards. These are important policy agendas, which DT, it is claimed, helps achieve, but it is not designed directly to implement truancy policy. However, there are no rigorous bodies of research undertaken to evidence these claims of the

wider benefits of DT (Harris and Wilson, 2003). Equally significant is the lack of evidence related to wider educational aims associated with design and technology by its advocates. That is to say, there appears to be no research base that systematically seeks to deepen professional knowledge of how best to deliver educational aims that are claimed for design and technology (Sherman, Sanders and Kwon, 2010).

On the basis of this description of the literature, one could seek to argue that the DT community of practice and the associated education research community have failed to research DT systematically, and thus failed over the last two decades to create a firm case for DT on the National Curriculum. Another possibility is that the DT community of practice has simply recognised that policy makers have not been meaningfully influenced by education research beyond that which relates directly to the implementation of their goals. To take this suggestion further, given the relatively heavy emphasis within the community on continually reconceptualising and rearticulating DT, perhaps there is an implicit recognition that the status of design and technology relies less on evidenced progress against education aims, and more on being discursively well positioned as supportive of policy makers' political goals.

Whatever the reasons, it remains the case that the systematic production of empirical evidence regarding DT at any scale is restricted to policy implementation, while the rest of the literature emphasises stating and restating largely un-evidenced claims for design and technology. Whether this situation is a symptom of failure or a reflection of the wider relations of education practice to policy making is outside the scope of the study. Either way, there is a distinct lack of evidence that DT has or can fulfil its loftier aims.

Section 2 – A brief timeline of the development of DT on the curriculum

1988–1995 – the establishment of Technology as a subject on the National Curriculum

This review deals with the period between the establishment of the National Curriculum in the Education Reform Act 1988 and 2011 . This section establishes a brief sequence of the major events related to design and technology on the national curriculum during this period, and highlights some of the major themes within the discourse during these times.

The National Curriculum, established in the Education Reform Act 1988, was organised around ten subjects. Three of these were the 'core' subjects of English, Maths and Science, while there were a further seven foundation subjects, of which 'Technology' was one.

In 1988, the then Secretary of State for Education Kenneth Baker set out the terms of reference of the Design and Technology Working Group who were asked to report on 'Technology' as:

> *'that area of the curriculum in which pupils design and make useful objects or systems, thus developing their ability to solve practical problems. The working group should assume that pupils will draw on knowledge and skills from a range of subject areas, but always involving science or mathematics' (DES, 1988).*

The Working Group produced its interim report (National Curriculum Design and Technology Working Group, 1988) which, following consultation, formed the basis of the order that established Technology as a compulsory subject, incorporating Design and Technology and Information Technology, in Key Stages 1-4 in schools in England and Wales (Department of Education and Science and Welsh Office, 1990).

The Technology Order was unusual not only in that it marked the establishment of a new subject, but it detailed a subject that was profoundly multidisciplinary, incorporating CDT, Art and Design, Home Economics and Business Education. Beyond being a simple amalgam of these subjects, the Order did, however, establish a distinct and unitary concept of design and technology, which the knowledge and skills from the incorporated subjects were intended to serve.

Technological capability was summed up as the development in the student of the 'capability to operate effectively and creatively in the made world' (National Curriculum Design and Technology Working Group, 1988). The concept relies on a combining of 'knowing how' and 'knowing that', or 'action' and 'propositional' knowledges, and was further detailed (as required of all National Curriculum subjects) in terms of a knowledge-focused taught Programme of Study, and four separate process-focussed Attainment Targets which were to be the basis of assessment. In distinction to other subjects, DT was to be led by this process, and set in specific contexts and wherein knowledge and skills (including the crafts which the subject incorporated) were to be placed in the service of design tasks. Thus the subject was intended to be experienced as a 'purposeful' design activity, subject to 'specific constraints' and demanding 'value judgements at almost every stage'.

The notion of a design process was most clearly articulated through the Attainment Targets. The Working Group's original interim report set these out as being to 'Explore and investigate contexts...Formulate proposals and choose a design for development... Develop and design the plan... Make artefacts and systems... Appraise the processes, outcomes and effects'. However, the distance between this exciting original idea, and its enactment in schools quickly became apparent.

The implementation of that Order was far from smooth, perhaps because the understanding and skills anticipated by the Working Group were not widely shared in the teaching profession. From an early stage, there seems to have been a sense of crisis about the subject, and the first Ofsted reports were sharply critical of implementation.

While Technology was a 'new' subject in 1990, Kimbell and Perry argue that it had a heritage in the best practice of a small proportion of schools that were drawn on in the formation of the 'visionary' Order (Kimbell and Perry, 2001). However, the implementation of that Order was far from smooth, perhaps because the understanding and skills anticipated by the Working Group were not widely shared in the teaching profession (ibid.). From an early stage, there seems to have been a sense of crisis about the subject, and the first Ofsted reports were sharply critical of implementation (Great Britain. Department of Education and Science. Inspectorate of Schools, 1992). Not only were teaching methods poorly worked out in the Order(Barlex, 1998), and a different process of assessment required (Kimbell, 1991), but teachers appeared to be struggling to understanding the wording of the Order, the concepts it contained, and in particular the separation of a taught Programme of Study from the Attainment Targets to be assessed. By 1992, the National Curriculum Council were recommending a revision of the Order that sought to provide clarification (National Curriculum Council., 1992).

It is worth noting that from this earliest stage, concerns were raised by those committed to design education that Design and Technology could be seen to encourage a linear design process of moving through stages, and that the language of 'procedural' knowledge might foster

a notion of design as moving through a procedure. Such voices have continually argued for schools to foster a design where at every stage of design the needs of the user, the context, the plan, the design and the making and evaluation are continually combined.

In the years following this initial period of difficulty, Ofsted did note some improvement (Great Britain. Office for Standards in Education and Ofsted., 1993a; Great Britain. Office for Standards in Education and Ofsted., 1993b). Nevertheless, problems persisted, and as a part of a wider review of the whole curriculum, a revised Order for Design and Technology was produced in 1995. In an attempt to slim down the curriculum, and to clarify it conceptually, the Revised Order focussed Design and Technology on 'Design and Make', lowering the stress on contextual research for design problems, and incorporating planning and evaluation within designing and making. While some have been critical of this conception of the design process and its product focus, others note that the revision did bring 'better clarity to the subject by defining the fields of knowledge and understanding and the principal activities through which teachers should teach their pupils' (Breckton, 1998).

In recent years policy makers have identified groups of strategically important subject areas in Science, Technology, Engineering and Maths (STEM), and latterly the English Baccalaureate, that significantly do not include design education.

Since then, there has been relative stability in the DT National Curriculum. The current 2007 revision of the curriculum is largely an evolution of the 2004 revision, which itself is a revised version of the curriculum published in 1999. However, it is noticeable that in the statement of importance of the current compulsory DT curriculum at Key Stage 3, there are echoes of the original 1990 Order as it references the importance of context and the identification of 'needs and opportunities' to which students are to respond with 'ideas, products and systems'. The subject continues to combine 'practical and intellectual skills' with important values-based considerations including 'aesthetic, technical, cultural, health, social, emotional, economic, industrial and environmental issues'. It is also noticeable that creativity has found greater prominence than in past statements, in association with problem solving. The key processes still contain a significant 'design and make' emphasis in terms of key concepts and key processes, however, key concepts now also contain 'cultural understanding', 'creativity' and 'critical evaluation' (QCA, 2007).

Despite relative consistency in the National Curriculum Orders over the last decade, there have nevertheless been two important, and perhaps not unrelated, developments that have caused considerable anxiety among advocates of Design and Technology. The first is the removal of compulsory status of Design and Technology at Key Stage 4 as a part of the revision of 14-19 education in 2004, though it remains an entitlement to all students at Key Stage 4, and compulsory at Key Stage 3. That is to say, it is no longer the case that every student must take a DT GCSE course at age 14, however, every school in England that is subject to the national curriculum must make available DT courses as a choice for their students at this key stage. The period before the removal of compulsory status was preceded by an opening up of the possibility of disapplication of compulsory design and technology (Harris and Wilson, 2003). Design and Technology Association (DATA), following their surveys of DT provision in schools, argued this possibility of disapplication in fact gave way to a period of illegitimate non-compliance with the National Curriculum

requirements by some schools in the provision of Design and Technology, against which the government failed to act (DATA, 2005). This process has been interpreted by DATA as indicative of a longer term trend of the 'systematic dismantling of the compulsory status of the subject' (Design and Technology Association, 2005). In addition, and potentially feeding this anxiety, in recent years policy makers have identified groups of strategically important subject areas in Science, Technology, Engineering and Maths (STEM), and latterly the English Baccalaureate, that significantly do not include design education.

Section 3 – Analysis of specific themes within the National Curriculum DT discourse

In any area of discourse, over the period of nearly a quarter of a century there will be a plethora of themes that texts engage with. This section is not an attempt to account for them all, nor could it be. Rather, it is an attempt to highlight themes that are both relevant to the RSA's concerns, and are prevalent, in the sense of creating important continuities in the discourse.

In order to provide a structure, I have tried to organise this section under a series of related questions within which a number of themes are collected together. However, this structure is intended primarily to provide accessibility to the reader, and should not be interpreted as asserting any particular pattern of association between these themes.

What is DT?

Technological capability and its relation to knowledge

Calling for, and attempts at, conceptual revision or clarification is a remarkably stable part of the discourse of Design and Technology. This continuity is perhaps well evidenced by relatively recent articles that refer back to debates surrounding the original order and the design education movement of the 1970s and early 1980s (Archer, Baynes and Roberts, 2005; Norman, 2010; Wright, 2008). Such attempts often do one or both of two things: articulate an 'essence' of DT while indicating that practical realisations of DT or the accounts of DT within policy are not aligned with their conceptual ideas; and realign DT with prevalent policy discourses, often in the process conveying a sense of insecurity about the status of DT.

The most prevalent themes within these conceptual discussions are:

There is consistent discussion about what makes for technological capability. Often such discussions deploy some conception of a binary notion of knowledge, where knowledge is either some version of propositional/content based/'knowledge that', or it is procedural/action/technique/'knowledge how'. Technological capability is usually seen to require a combination of both these types of knowledge.

As time has passed, and the prevalence of conceptions of meta-cognition or meta-languages have grown in prevalence, it has become increasingly common to make reference to the requirement for some form of meta-knowledge in relation to design. Typically, such constructions concern the ability of the student designer to decide when is the appropriate time to draw on different types of knowledge, and on specific pieces of information or specific procedures. Such ideas might refer to the development of the design discipline as a kind of meta-language for the process of designing (Keirl, 2004), or to the development of 'strategic knowledge' (Hope, 2009) in design

students. Earlier in the discourse it was perhaps more common to refer to some similar conception of these processes as the development of a capacity for 'mental modelling', a process that was particular to design as a discipline and equally distinctive as a capacity of human beings (Barlex and Pitt, 2001). Further, design in its early period on the curriculum and latterly has used the concept of contexts of constraint to argue that design is not only the application of scientific knowledge and of technique, but also the arena for values-based choices and the consideration of need from the perspective of people other than the designer. It is this concept of purposeful activity in context that tends to be used to distinguish DT from design within Art and Design, which might be more associated with self-expression (Benson, 2004).

It has become increasingly common to make reference to the requirement for some form of meta-knowledge in relation to design. Typically, such constructions concern the ability of the student designer to decide when is the appropriate time to draw on different types of knowledge, and on specific pieces of information or specific procedures. Such ideas might refer to the development of the design discipline as a kind of meta-language for the process of designing, or to the development of 'strategic knowledge' in design students.

Indeed, the applied and active nature of design tasks along with their required utilisation of bodies of knowledge has been used to argue that DT is a subject that uniquely breaks down vocational and academic divides in the curriculum. In turn, this feature has been said to be at the heart of DT's popularity with students (Ofsted, 2008).

DT's origins as a multidisciplinary subject, and its articulation as a process focussed subject wherein content knowledge serves design tasks, raises consistent discussion of the relations of DT to other subjects. Such discussion in the early 1990s often concerned criticism over the relegation of craft skills and the arts or aesthetics within DT (National Society for Education in Art and Design, 1993). Latterly, texts have focussed on the proper relation of DT to science and maths, particularly given a lack of evidence of DT as supportive of these increasingly (politically) valued subjects. Barlex and Pitt's report Interaction (2001) is perhaps the best example of an attempt to conceive of the relations between these 'separate domains of knowledge', in which they resist what they argue is a popular tendency for technology to simply be subsumed into science, and instead look for a basis for collaboration or cooperation between the subjects. However, as discussed below, these considerations are increasingly bound up in a loss of status for design in relation to STEM subjects. Kimbell and Perry sum up the interrelationship of DT with other subjects in the idea that DT not only cuts across vocational and academic divides but is also

> *'neither a specialist art nor a specialist science. It is deliberately and actively interdisciplinary. The design sub-label leans towards the arts, and the technology towards the sciences. But neither will do as a natural home. It is a restive, itinerant, non-discipline' (Kimbell and Perry, 2001)*

Not unrelated with the sense of design as lacking a disciplinary nature is the movement of creativity towards the centre of definitions of design on the curriculum, a shift that has accompanied the rising importance of this concept within the wider education discourse.

Building on understandings of DT as a subject framed by the process of designing, creativity is linked to DT by its centrality to the discipline of design.

Not unrelated with the sense of design as lacking a disciplinary nature is the movement of creativity towards the centre of definitions of design on the curriculum, a shift that has accompanied the rising importance of this concept within the wider education discourse.

The process of design appears in these texts as a disciplined creativity, a creativity that is progressive towards an end (Benson, 2004). Such conceptions of creativity within design often serve to highlight the (potential) distinctiveness of DT as a subject. For example, Keirl (2004) in seeking to make sense of DT through the notion of creativity, argues that creativity pertains to any intervention that alters the domain in which it takes place. In his consideration of design as a creative, task-led process, he argues for a re-conception of the school curriculum not as a space of territorial dispute between separate subjects, but as a 'lily pond' – a fluid medium in which student designers can move more freely as the design task leads them. Further, the fact that his description of DT as a creative subject requires him to make a metaphorical shift (from curriculum as a terrain composed of separate territories to lily pond), DT can be understood as fundamentally creative not only in fostering creativity in young people, but in the sense that it alters the curricular domain of which it is a part. That is, DT as a creative discipline acts creatively, changing the school and the curriculum around it in order to fulfil its potential. Others make similar contrasts between DT as a creative process and the imperatives of the wider curriculum and assessment framework.

Such arguments suggest that the non-linearity of creative design processes - the need for risk taking, greater student autonomy, and less end-product focus - means that the curriculum priorities of content, assessment and economic instrumentalism inhibit DT's ability to realise opportunities for creative design processes (Stables, 2004). In essence, the curriculum restricts the ability of DT to be designerly.

The non-linearity of creative design processes - the need for risk taking, greater student autonomy, and less end-product focus - means that the curriculum priorities of content, assessment and economic instrumentalism inhibit DT's ability to realise opportunities for creative design processes. In essence, the curriculum restricts the ability of DT to be designerly.

What is DT on the curriculum?

Technological capability as a distinctively human characteristic

A second persistent tendency in the DT discourse is the articulation of the purpose of the subject in terms of high level aims. By 'high level', I mean that these articulations serve as legitimations of the subject on the curriculum, not in terms of the individual learner (their interests, their individual talents or proclivities), but in terms of more universal concerns.

A consistently told narrative is that of human beings' distinctiveness and success as a species resting on some notion of a 'visionary' capacity, i.e. the ability to imagine futures that are essentially better than our present, and the capacity to mentally model

means by which we might manipulate our environments to realise those futures. This capacity for purposeful technological innovation has resulted in our world becoming a 'made' environment. DT comes therefore to represent an intervention through schooling in young people's lives whereby the attempt is made to cultivate this distinctively human characteristic. Thus it is, in turn, allied to expressions of the aim of schooling which concern enabling young people to become more fully human, or to realise their potential as human beings.

Citizenship in a modern technological world

Within the idea of technological capability as a distinctively human characteristic is the idea of our world as a 'made world', and our society as increasingly defined by technology. This is a legitimation of DT as playing a role in promoting citizenship, and enabling young people to, or to develop into adults who can, participate fully in a democratic society. This idea is more often expressed than explained. However, when it is set out more fully, it is associated with two ideas. First, that the rapid evolution and growing dominance of technologies in our lives mean that participation in society is increasingly reliant on the capacity to understand and to utilise technologies well. Second, this is sometimes more radically expressed in terms of developing in young people the capacity to intervene creatively in their made world, and to develop the distributed capacity to, as citizens in a democracy, (quoting Ken Baynes) 'to be actively involved in shaping the future of material culture' (Norman, 2010). This idea is perhaps particularly associated with the design education movement that helped define DT prior to the National Curriculum.

Relations to economic productivity

The notion that DT enables young people to participate in the economy has been used to legitimise the subject's existence and to give it purpose ever since the terms of reference were given to the Design and Technology Working Group (DES, 1988). However, the specific nature of this economic articulation has evolved somewhat over the years. Initially, the argument rested on the idea that the practical, economically useful skills that were to be incorporated into DT would enable young people to apply the theoretical knowledge developed both in DT and elsewhere, including in science and maths.

However, in the late 90s and early 2000s, the notion of the 'knowledge economy' has risen to prominence in policy. This narrative sets the UK education system within a backdrop of increasingly difficult global economic competition, particularly with China and India. Success in this economic competition is said to rely on innovation. Innovation in turn relies on the widespread inculcation of i) knowledge of Science and Maths; ii) technical skills; and iii) some capacity for the creative synthesis of these knowledge and skills in their application to the solution of problems or the realisation of goals (Cox, 2005; Sainsbury and Britain, 2007).

Within the idea of technological capability as a distinctively human characteristic is the idea of our world as a 'made world', and our society as increasingly defined by technology. This is a legitimation of DT as playing a role in promoting citizenship, and enabling young people to, or to develop into adults who can, participate fully in a democratic society.

This economic legitimation of some subjects that develop these capacities has led to the development of policy designed to increase students' uptake of these subjects. It is notable, however, that in this wider economic narrative, design and DT seem to play a more limited role than might be expected (though the Cox report does make

significant reference to design). In terms of education policy, part of the reason for this may be, ironically, that DT has remained a popular subject (see below) whereas broadly speaking Science, Maths, Engineering and subjects developing Technological skills have, during the 2000s, seen downward trends in their uptake by students at Key Stage 4 and in Higher Education. This has led to the identification of these 'STEM' subjects as 'strategically important and vulnerable', a categorisation that DT does not fulfil, if by vulnerability is meant student uptake in the short term (HEFCE, 2005; HEFCE, 2008; HEFCE, 2010).

This economic legitimation of some subjects has led to the development of policy designed to increase students' uptake of these subjects. It is notable, however, that in this wider economic narrative, design and DT seem to play a more limited role than might be expected.

Nevertheless, within the DT literature at least, the subject is argued to be supportive of the UK's ability to compete in a knowledge economy:

> *The real products of design and technology are empowered youngsters; capable of taking projects from inception to delivery; creatively intervening to improve the made world; entrepreneurially managing their resources; capably integrating knowledge across multiple domains; sensitively optimising the values of those concerned; and confidently working alone and in teams. Design and Technology is in the vanguard of those preparing youngsters for employment in the knowledge economy. (Kimbell and Perry, 2001)*

Most recently, there are signs in the literature that the DT profession is seeking to tackle its low profile within the STEM policy agenda. A recent issue of the journal Design and Technology Education has issued a call for papers on this topic, allied to an editorial that argues the issue is one the DT research community must deal with (Norman, 2010).

Another recent discursive move, that may be seen more in future, attempts to secure a more prominent positioning for DT by restating the nature of the economic challenge that faces Western economies. In this mode, Lee and Breitenberg (2010) argue that we should move from concern to develop in terms of a knowledge-economy to the pursuit of a successful creativity-based economy wherein:

> *the processes of the designer – holistic thinking, empathy, imagination, creativity, visualising problems and solutions – have become more important in business than the traditional analytic skills taught in MBA programmes.*

It is notable that this is argument is developed not only in economic terms, but in accordance with a less commonly developed (in the DT discourse) notion of design education as crucial to new cultural modes of communication. This draws on the work of Gunther Kress (Kress, 2003), and the argument that design as a process of the assemblage of media in multiple modes is increasingly central to literacy. While this is an interesting direction with important possibilities for conceptualising design in education, it is worth noting that both Kress' work and the discussion of the creativity-based economy are relatively isolated, and the discourse of the knowledge economy that emphasises the importance of maths and science is clearly dominant.

Finally in this section, in recent years, it has been common to align DT with narratives of the need to respond to the ecological problems caused by modern mass production and consumption, a rising global population, and growing energy demands. This discourse sees authors argue for the development of sustainability as a theme within, or even a framing device for, design education (Baird, 2008; Filho, Manolas and Pace, 2009; Lilley and Lofthouse, 2010; Pitt, 2009; Stables, 2009).

It is worth noting that discussion of the creativity-based economy is relatively isolated, and the discourse of the knowledge economy that emphasises the importance of maths and science is clearly dominant.

The practice of Design and Technology

This section concerns the presence of practical issues pertaining to the provision of DT as they appear in the literature. This is typically represented from the perspective of individual schools in terms of resourcing and organisation, and from the perspective of teachers in terms of the pedagogical demands and expertise requirements of the subject. It is also notable that, particularly following the early problems with the implementation of DT and the emphasis on standards in the wider education discourse, issues of quality and achievement are also frequently referenced in these texts.

Resourcing and organisation

It is not within the scope of this review to undertake a comparison of per capita expenditures according to subject. Nevertheless, the literature makes regular reference to DT's specific resource requirements in terms of accommodation, machinery, materials, ICT equipment and software and so on. Ofsted, while initially critical of DT accommodation and resourcing have grown increasingly positive overall. In particular, recent national programmes to encourage utilisation of CAD/CAM have been seen as successful. However, there are challenges which Ofsted assert will require long-term strategic planning to solve, a capacity they say the sector currently lacks (Ofsted, 2008). These challenges include a lack of teacher expertise in specialist areas, most notably food and control systems. DATA also highlight in their national survey a long term trend of per capita spending within the subject that is significantly lower than (their judgement of) the adequate amount (Design and Technology Association, 2005).

The organisation of DT is complicated by its requirements for specialist teaching (in Systems & Control; Food Technology; Resistant Materials; and Textiles) around a set of core competences mostly in the design process and associated skills (Design and Technology Association, 2003). DATA recommend that a teacher can reasonably specialise in two areas at Key Stage 3 and one at Key Stage 4. Perhaps unsurprisingly therefore, not only is the recruitment of specialist teachers an issue, the organisation of the timetable is also complicated. While the literature contains discussion of a number of models of organisation, Ofsted have consistently raised concerns regarding a 'carousel' approach, where students rotate around classes, and the usage of separate projects, on the basis that these make provision of continuity and progression for students difficult (Ofsted, 2008; Ofsted, 2011).

Teaching and Pedagogy

As well as requiring greater cooperation, team planning and more complex timetabling demands, DT is widely acknowledged as pedagogically demanding in at least two senses. The first is that teaching the subject requires a pedagogy sophisticated enough to allow students to develop procedural and content knowledges, provide them

with enough autonomy to be creative and take risks, and yet ensure the level of structure necessary to allow students of varying ability to gain from the design task. The second sense is that the curriculum itself is a restriction on this breadth of pedagogy, focussing teachers on the assessment of a final product, communicating certain knowledge and so on (Keirl, 2004). While such constraints are true of any subject, DT perhaps experiences this as a particular tension given the design process at its heart, a process that advocates a diversity of end product and the application of knowledge as it is, unpredictably at the beginning of a project, relevant.

Teaching the subject requires a pedagogy sophisticated enough to allow students to develop procedural and content knowledges, provide them with enough autonomy to be creative and take risks, and yet ensure the level of structure necessary to allow students of varying ability to gain from the design task.

Indeed, Ofsted reports over the years seem to require DT to combine what might typically be seen as dichotomous in education discourse; e.g. to provide creativity and structure and discipline; practical and procedural and abstract and paper-based work; team and collective and silent and individual working; opportunities for project based, contextual learning and coverage and continuity; breadth and depth.

A further challenge for DT teaching which has become more urgent from Ofsted in recent years, is the requirement to be up to date and relevant. DT has persistently been criticised for failing to incorporate new materials, or to sufficiently incorporate into curricula CAD/CAM, electronics and control systems, and robotics. However, as noted above, there are contradictions, given Ofsted's complaints that the use of CAD by schools can obscure assessment of student's progress.

What is the status of DT on the curriculum?

The review up to this point has already noted a number of issues relevant to this topic: from the early difficulties with implementation; the uncomfortable distinctiveness of a design led process on the national curriculum; its lack of a disciplinary home as an 'art' subject or a 'science'; its exclusion from articulations of strategic priority by policy makers through either STEM or more recently the English Baccalaureate; and its loss of status as a compulsory subject at Key Stage 4.

In this section, however, it remains to briefly discuss the status of DT with students. DT is consistently referred to as a subject that is popular with students, by Ofsted and by advocates within the profession. However, in texts that reflect on the future of the subject, it is notable that assertions of the popularity of DT as a subject choice were relegated in importance with respect to the moves by policy makers to remove its compulsory status. It seems DT advocates' fear for the future of the subject is irrespective of its popularity among students.

While the review did not uncover any comprehensive analysis of the effect of the removal of compulsory status on DT at Key Stage 4, there are some statistics available on the take-up subjects. A statistical analysis of uptake of GCSE subjects during the years 2000 to 2006 noted that:

> *Although Design and Technology is no longer compulsory at key stage 4 due to changes in the National Curriculum in 2004, the uptake of these subjects has not dropped very much between 2000 and 2006 and similar percentages of students are taking them (on average). The design and technology subjects are, in general, not favoured by the high attaining students. (Rodeiro, 2007)*

It is also worth noting that the subject was more popular among boys than girls except with regards Food Technology, despite the fact that girls' achievement is significantly better than that of boys. This reflects a long-standing literature examining gender as a factor in students' subject choices with reference to DT. Since 2006, however, the proportion of GCSE student choices involving DT courses has begun to decline, falling from approximately 8% to 6% (analysis based on figures taken from Gill, 2010a). Ofsted acknowledge this recent trend, and also point out that uptake of GCSE Systems & Control (one of a number of DT courses at GCSE, and one of perceived economic value) is particularly low (Ofsted, 2011).

At A-level, DT uptake climbed from 2% to 6% between 2001 and 2005 (Rodeiro, 2007), and, unlike at GCSE, appears to have held steady (analysis based on figures drawn from Gill, 2010b). Of course, it remains to be seen if the decline at GCSE will precipitate a similar decline at A-level, or whether the proportion of students converting from GCSE to an A-level at DT will rise. Similar patterns of gender difference apply to A-level subject choice as at GCSE.

In common with overall trends, Ofsted note that the achievement of young people studying DT has consistently improved over the last six years, and indeed since its introduction in 1990 (Ofsted, 2008; Ofsted, 2011).

Section 4 – concluding remarks

This review began with the observation that much of the literature was concerned with policy, in terms of its implementation, translation, or DT's positioning in relation to policy discourses. Policy, of course, has framed DT in the straightforward sense of establishing it as a subject. And the subsequent policy texts that have sought to define what should be enacted at a local level have changed in their view of what DT is. Thus we have the initial vision of DT as a subject that incorporated the bodies of knowledge of several other subjects and set these in the service of their creative application to a real, contextualised problem via a non-linear and complex design process. Problems of implementation within the context of schooling were quickly evident. The vision of DT was not easily communicated, nor did it sit easily with schools' teaching and physical resources, or many schools' values and organisational cultures, or within the context of the reforming (content-led) National Curriculum and high stakes assessment framework.

This was a reforming vision in many ways, and an important one, but one which ran counter to both the existing culture of schools and the transformational direction of the Education Reform Act 1988 of which it was a part. The policy response was to redefine the subject, to narrow it to 'design and make', and to describe a design process that was thus more easily grasped and more linear. And this was a definition which seems to have been more easily interpreted in contexts of practice. Subsequent redefinitions have retained design and make, but have sought to broaden the subject to incorporate the cross-cutting aims, values and skills of the evolving National Curriculum, and to keep the subject up to date.

However, the second aim of this research was to review academic research into the implementation of design on the curriculum. The main conclusion of this section of the review must be that such research is limited, except with reference to issues of policy implementation. That is to say, research has been concerned, for example, to develop and test models of curriculum, teaching and assessment that would offer practical interpretations of policy texts, or to assess the success of the implementation of policy (and the latter was often through Ofsted inspection reports, i.e. not academic research). Much of the rest of the literature produced has been by professional associations (rightly) concerned with positioning and repositioning DT in policy, or small-scale research in classroom contexts which, while also important, sadly does not accumulate to offer a strong foundation of empirical research regarding the effectiveness of DT in meeting the aims and possibilities claimed for it (whether by the design industry, DT subject leaders, or policy makers).

So, the review argues that there is a strong sense of a policy orientation to the DT literature; a sense that policy has driven DT. In concluding by way of overarching analysis of the discourse, I take this observation and consider its effects, and argue that this policy orientation produces an important sense of ambivalence in the DT discourse in at least two important ways.

Problems of implementation within the context of schooling were quickly evident. The vision of DT was not easily communicated, nor did it sit easily with schools' teaching and physical resources, with many schools' values and organisational cultures, or within the context of the reforming (content-led) National Curriculum and high stakes assessment framework.

First, in policy discourses the direction is always forward, towards the new, the better, the more efficient. Given the common orientation of texts to policy, this forces the DT literature to move along at a certain speed, to align with the ever onward and upward trajectory of policy. But this is difficult. DT is implemented not in texts, but in real contexts of practice, in buildings, by people with values, skills and commitments that may struggle to (or indeed, struggle not to) move at the pace of policy. After all, DT contains within itself the 'old' – crafts, materials, skills such as drawing. In other words, one source of this ambivalence is the tension created between the pull to something new, and the weight of what is already there, of the old.

There are several reasons that 'newness' might be a particular tendency in DT texts. Part of the value of DT centres around the idea that the subject should work harder to be 'up-to-date', keeping in touch with a rapidly developing technological world. Newness has also been key for DT as a new subject that sought to establish itself in part through making big claims, even as it struggled with new and unforeseen problems of implementation.

While it is tempting to suggest that if newness represents a forward momentum, oldness therefore represents a problematic inertia, but this would not be entirely true. Firstly, newness itself may be problematic. As STEM and the English Baccalaureate indicate, there is a danger of fairly rapid shifts in policy emphasis as to what is regarded as a more or less 'strategically important' subject. Further, it is in the continuities with long established disciplines, and crucially with the established discipline of design, that DT may ensure the subject continues with the expertise to grow and develop, and to be able to communicate to a wider public. Importantly, these longer term continuities in the

DT discourse provide an identity that could be the basis for a more systematic approach to evidencing its larger claims to regarding its worth and legitimacy within the National Curriculum.

In policy discourses the direction is always forward, towards the new, the better, the more efficient. DT contains within itself the 'old' – crafts, materials, skills such as drawing. In other words, one source of ambivalence is the tension created between the pull to something new, and the weight of what is already there, of the old.

That said, there remains an important balance to be struck between ensuring a continuity with older notions of design, and losing momentum altogether. While the changes in policy priority may be unhelpfully rapid, nonetheless there are policy agendas DT could respond to while maintaining continuity with its traditions. And doing so is likely to be vital to the task of renewing the community of policy makers who understand and sympathise with the subject (Wright, 2008). The importance of getting this balance right seems clear. In his speech to the DATA Millennium Conference (DATA, 2000), Lord Sainsbury argued that the UK had a large number of designers but too few engineers. This is an early articulation of a feature of the STEM agenda that has resonated powerfully in policy circles since mid-2000s. At the same conference, Jack Hynds, then Chief Electrical Engineer at Jaguar, made the point that while too few students go on to become engineers, those that become engineers do not understand design, lack the ability to problem solve, and struggle to collaborate and communicate with others (Link, 2000). This seems to provide a compelling argument for design with STEM, but it was an argument that got lost.

Among other things, the National Curriculum was an attempt to regularise the content and practices of schooling across the country, and to subject classrooms to greater scrutiny and control by the central state. In the context of these pressures to conform, how could design on the curriculum occupy anything other than an ambiguous status?

Second, the desire driving the realisation of design within the National Curriculum is an inherently ambivalent one. The attempt to teach design in schools is inevitably caught up in contrary drives, to make space for creative, unpredictable and risky design processes amid the constraints on a school which is charged with the provision of a predictable curriculum entitlement and ever rising achievement.

DT texts tend to outline design in visionary, ambitious terms. For example, Barlex (Barlex, 2000) describes DT as a subject that develops young people's:

> *'autonomy... creativity... problem solving...[as] individuals and in working with others... recognising and responding to needs, wants and opportunities... producing products and ideas... [being] critically reflective from a variety of perspectives.'*

The educational processes that might achieve this vision, he continues, requires trust in pupils, open access to resources and equipment, and room for exploration, skills and knowledge development, and the teacher to provide constant motivation. It is notable that such aspirations are not far removed from the original Design and

Technology Working Group's conception of a subject framed by the design process that tasked pupils with engaging their technological capability in real contexts that they had explored and researched.

Given the way design on the curriculum was conceived, it is hard to see how one could expect DT to do anything other than struggle. Design took its place within a content-focussed curriculum and an assessment and qualification framework in which policy implementation was carefully policed through Ofsted, end of Key Stage testing and published league tables. Among other things, the National Curriculum was an attempt to regularise the content and practices of schooling across the country, and to subject classrooms to greater scrutiny and control by the central state. In the context of these pressures to conform, how could design on the curriculum occupy anything other than an ambiguous status?

Rather than cross-disciplinary, design could conceivably have found a way to be a discipline that existed within and through other disciplines. Rather than knowledge applied or learned, design has the potential to be an experience of knowledge which refuses the distinction between the two.

The picture of design on the secondary curriculum is mixed, therefore. As a part of DT it remains compulsory at Key Stage 3, and popular as an option at Key Stage 4. Achievement in the subject has improved, and Ofsted regards the majority of provision as good. However, design has dropped away from the centre of education policy discourse, and it lacks a strong evidence base for the claims to impact that are made on behalf of the subject. Perhaps most importantly, the literature appears to indicate that the attempt to realise design on the curriculum has been problematic, and the process of designing has often become too linear, too focussed on end-product, lacking creativity and nervous of trusting students to take risks.

Despite a strong and potentially disruptive vision for design as a process that drew upon and contextualised the knowledges of many disciplines, design on the curriculum has been realised within important continuities with its predecessor subjects of woodwork, metalwork, home economics and so on. The powerful dichotomies through which schooling is understood, and which gave DT predecessor subjects their (low) status have re-asserted themselves in the provision of design on the curriculum. Straightforwardly, design today is easily locatable in the age-old binaries of cross-disciplinary work vs. the boundaried subject; knowledge applied vs. knowledge passively stored up; irrelevant abstract classroom knowledge vs. practical material hands on knowledge; learning vs. problem solving.

Today in subjects like Maths and Physics, the government seeks to prove its commitment to the academic core of schooling and to link this core to the economic value of schooling. DT, having failed to break down or break out of these powerful dichotomies, now finds itself unable to defend its status and its share of the resources.

These are binaries which certainly did not originate with the Education Reform Act 1988, but this act reproduced and reinforced them in important ways. However, design has the potential to be disruptive of these binaries in ways that are exciting and important to our understanding of the possibilities of schooling. Rather than cross-disciplinary, design could conceivably have found a way to be a discipline that existed within and through other disciplines. Rather

than knowledge applied or learned, design has the potential to be an experience of knowledge which refuses the distinction between the two. It might be both about the material and the conceptual world. But the political moment in which DT was established was not a moment for the disruption of such distinctions. The Education Reform Act 1988 was a time in which 'standards' and 'achievement' was made more visible, more public, a greater political priority, and was associated with a core of subjects, and a curriculum defined by knowledge.

Today belongs to a different political moment, of course. Into STEM and latterly the English Baccalaureate we might read a confluence of anxieties about the knowledge required in a knowledge economy, and a sense of the loss of rigour in schooling (which undermines its success as a public policy project). In this changed time, very similar binaries and very similar judgments of worth are in operation. Perhaps most significantly for DT, the foundations of its original status on the curriculum have been undermined, or rather colonised by other subjects. DT was once, if not a traditional academic subject, a demonstration of political forward-thinking and of the economic relevance of schooling. Today, however, in subjects like maths and physics, the government seeks to prove its commitment to the academic core of schooling and link this core to the economic value of schooling. DT, having failed to break down or break out of these powerful dichotomies, now finds itself unable to defend its status and its share of the resources.

In the end the National Curriculum that afforded the potentially disruptive discipline of design its status on the curriculum has constrained and reshaped it to the image of schooling.

References

Archer, B., Baynes, K. and Roberts, P. (2005). A framework for design and design education : a reader containing key papers from the 1970s and 80s. Wellesbourne: DATA.
Baird, S. L. (2008). 'Sustainable Design: The Next Industrial Revolution?'. Technology Teacher, 67 (4), 11-15.
Barlex, D. (1998). 'Design and Technology - the Nuffield perspective in England and Wales'. International Journal of Technology and Design Education, 8 (2), 139-150.
Barlex, D. (2000). 'Preparing DT for 2005 - moving beyond the rhetoric: the DATA lecture'. Journal of Design and Technology Education, 5 (1), 5-15.
Barlex, D. and Pitt, J. (2001). Interaction: A report for the Engineering Council and the EEF (Engineering Employers' Federation) on the relationship between Science and Design and Technology in the secondary school curriculum. London: Engineering Council.
Benson, C. (2004). 'Professor John Eggleston Memorial Lecture 2004. Creativity: caught or taught?'. Journal of Design and Technology Education, 9 (3), 138-144.
Breckton, A. M. (1998). 'National Curriculum review in design and technology for the year 2000'. Journal of Design and Technology Education, 3 (2), 101-105.
Cox, G. (2005). The Cox Review of Creativity in Business: Building on the UK's Strengths. London: HM Treasury.
Department of Education and Science and Welsh Office. (1990). Technology in the National Curriculum. [London]: Hmso.
DES. (1988). 'Terms of reference of the Design and Technology Working Group National Curriculum'. Studies in Design Education, 21 (1), 4-6.
Design and Technology Association. (2003). Minimum competences for trainees to teach design and technology in secondary schools. (Rev. Ed.). Wellesbourne: Data.
Design and Technology Association. (2005). Survey of provision for design and technology in schools in England and Wales. Wellesbourne: Data.
Filho, W. L., Manolas, E. and Pace, P. J. (2009). 'Education for sustainable development: current discourses and practices and their relevance to technology education'. International Journal of Technology and Design Education, 19 (2), 149-165.
Gill, T. (2010a). GCSE Uptake and Results, by School Type 2002-2009 Statistics Report Series No.24. Cambridge: Cambridge Assessment.
Gill, T. (2010b). A-Level Uptake and Results, by School Type 2002-2009 Statistics Report Series No.23. Cambridge: Cambridge Assessment.
Great Britain. Department of Education and Science. Inspectorate of Schools. (1992). Technology : key stages 1, 2 and 3, a report by HM Inspectorate on the first year, 1990-91. London: HMSO.
Great Britain. Office for Standards in Education and Ofsted. (1993a). Technology : key stages 1, 2 and 3 : second year, 1991-92, a report from the Office of Her Majesty's Chief Inspector of Schools. London: HMSO.
Great Britain. Office for Standards in Education and Ofsted. (1993b). Technology : key stages 1, 2 and 3 : third year, 1992-93, a report from the Office of Her Majesty's Chief Inspector of Schools. London: HMSO.
Great Britain. Office for Standards in Education and Ofsted. (1995). Design and Technology : a review of inspection findings 1993/94. London: Ofsted.
Harris, M. and Wilson, V. (2003). Designs on the curriculum? A review of the literature on the impact of Design and Technology in schools in England. England.: Department for Education and Skills, Nottingham.
HEFCE (2005). Strategically Important and Vulnerable Subjects: Final report of the advisory group. London: Higher Education Funding Council for England.
HEFCE (2008). Strategically Important and Vulnerable Subjects: Final report of the 2008 advisory group. London: Higher Education Funding Council for England.
HEFCE (2010). Strategically important and vulnerable subjects: The HEFCE advisory group's 2009 report. England.: Higher Education Funding Council for England.
Hope, G. (2009). 'Beyond Knowing How to Make It Work: The Conceptual Foundations of Designing'. Design and Technology Education, 14 (1), 49-55.
Keirl, S. (2004). 'Creativity, innovation and life in the lilly pond: nurturing the design and technology family while keeping the alligators fed. DATA International Research Conference: international keynote'. Journal of Design and Technology Education, 9 (3), 145-160.
Kimbell, R. (1991). The assessment of performance in design and technology : [final report of the APU design and technology project 1985-1991]. London: Seac.
Kimbell, R., Miller, S., Bain, J., Wright, R., Wheeler, T. and Stables, K. (2004). Assessing Design Innovation: final report. London: Goldsmiths University of London.
Kimbell, R. and Perry, D. (2001). Design and technology in a knowledge economy: a distinctive model of teaching and learning. London: Engineering Council.
Kress, G. R. (2003). Literacy in the new media age: Psychology Press.
Lee, H. K. and Breitenberg, M. (2010). 'Education in the New Millennium: The Case for Design-Based Learning'. International Journal of Art and Design Education, 29 (1), 54-60.
Lilley, D. and Lofthouse, V. (2010). 'Teaching ethics for design for sustainable behaviour: a pilot study'. Design and Technology Education: an International Journal, 15 (2), 55-68.
Link, N. (2000). 'Millennium Conferece - A Once in a Life Time Experience'. The Journal of Design and Technology Education, 5 (2), 119-125.
National Curriculum Council. (1992). National curriculum technology : the case for revising the order, advice to the Secretary of State for Education, May 1992. [York]: Ncc.
National Curriculum Design and Technology Working Group. (1988). National Curriculum Design and Technology Working Group : interim report. London: HMSO.
National Society for Education in Art and Design. (1993). 'Technology for ages 5 to 16

(1992): NSEAD response'. Journal of Art and Design Education, 12 (2), 227-240.
Norman, E. (2010). 'A silent D'. Design and Technology Education: an International Journal, 15 (2), 3-5.
Ofqual (2010). The new GCE AS level examinations: Finding from the monitoring of the new qualifications in 2009. Coventry: Ofqual.
Ofsted (2008). Education for a technologically advanced nation: Design and technology in schools 2004-07. London: Ofsted.
Ofsted (2011). Meeting Technological Challenges? Design and technology in schools 2007-2010. London: Ofsted.
Pitt, J. (2009). 'Blurring the boundaries - STEM education and education for sustainable development'. Design and Technology Education: an International Journal, 14 (1), 37-48.
QCA (2007). Design and Technology: Programme of study for key stage 3 and attainment target. London: QCA.
Qualifications and Curriculum Authority. (2004). A level design and technology review of standards 1978-98. [Online]. Available at: http://www.ofqual.gov.uk/files/6903_a_level_d_and_t.pdf.
Rodeiro, V. (2005). Provision of GCE A-level subjects Statistics Report Series No. 1. Cambridge: Cambridge Assessment.
Rodeiro, V. (2006). Uptake of GCE A-level subjects in England 2001-2005: Statistics Report Series No. 3. . Cambridge: Cambridge Assessment.
Rodeiro, V. (2007). Uptake of GCSE subjects 2000 – 2006: Statistics Report Series No. 4. Cambridge: Cambridge Assessment.
Sainsbury, D. and Britain, G. (2007). The race to the top: a review of government's science and innovation policies. London: HMSO.
Sherman, T. M., Sanders, M. and Kwon, H. (2010). 'Teaching in Middle School Technology Education: A Review of Recent Practices'. International Journal of Technology and Design Education, 20 (4), 367-379.
Stables, K. (2004). 'The elusive keys of imagination and play: unlocking creativity and innovation in design and technology education. DATA International Research Conference: UK keynote'. Journal of Design and Technology Education, 9 (3), 161-171.
Stables, K. (2009). 'Educating for Environmental Sustainability and Educating for Creativity: Actively Compatible or Missed Opportunities?'. International Journal of Technology and Design Education, 19 (2), 199-219.
Wright, R. (2008). 'The 1992 struggle for Design and Technology'. Design and Technology Education: an International Journal, 13 (1), 29-39.