Design and technology: two cultures or unitary concept?

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Abstract
In this paper a secondary technology educator from Western Australia argues that design and technology have, in reality, little in common; design being rooted in an 'arts' culture whilst technologists are commonly trained as engineers or scientists. This, he contends, creates tensions in the curriculum when we ask children to 'design and make', activities which are seldom integrated in industry. The converse position is argued by a primary design and technology educator from England, who argues that this essentially educational model can be illustrated with industrial examples. In conclusion, both authors agree that there is indeed a strong educational rationale for the integration of designing and making in furthering pupils' technological capability, but that the purposes of technology curricula must be made explicit before introducing the complexity of the professional world into the classroom.

Introduction

In one sense, the introduction of 'technology' (however conceived) into the school curriculum is an attempt to reconcile the perspectives bound up with the 'Arts' or 'Sciences' (Snow, 1959), and create a new, third culture. However, it could be argued that this attempt has created significant problems for those concerned with the introduction of technology education in many countries over the past three decades (McCulloch *et al*, 1986; Layton, 1995; Williams and Kimbell, 1997). In England, the 'holistic' development of design and technological capability by pupils (NCC Design and Technology Working Group, 1988) was intended to enable them to bridge the divide between the two cultures. They were to be both 'creators' and 'makers', active and reflective, so that the composite activity of design and technology was indeed to be greater than the sum of its parts.

But is this in fact what happens when pupils design and make? To what extent is this an artificial activity which pupils will find difficult to translate into a professional context? If we want a technology curriculum which is more vocational in nature to prepare pupils for an innovation culture, perhaps it is more appropriate to re-title the subject 'Technology and Enterprise', as has been adopted by the Education Department of Western Australia (1994). This title embodies a different perspective on the role of a technology curriculum from the English model, yet both have as one of their core aims the development of 'technological awareness' – an understanding of the processes by which the products we use every day have been developed. In the discussion below , the authors (one a primary teacher educator from England, the other a Western Australian secondary teacher educator) draw upon professional case studies of the work of designers and technologists to debate whether 'design' would be best separated from or integrated with technology in the curriculum.

Dear Daniel,

The curriculum model adopted by England and Wales, in placing the designer and the technologist together, is one that does not sit well in relation to professional practice. The role of design comes hard to many technologists. The most effective technologists are often unusually single-minded and completely committed to the task in hand. They have in mind a set solution to a problem, and deal with obstacles in the path to that solution in a determined and uncompromising manner. They do not want divergent sets of values distracting them from their goals.

This typifies the manner in which much technology has been traditionally taught. The word technocratic is an appropriate descriptor, because it implies a linear, unambiguous, view of progress and problem solving, leaving very little room for democracy and divergent values. In contrast to this single-minded technical approach is a more 'designerly' style of thinking in which views and definitions can be altered, rather than seeing progress only in linear terms. A variety of values are encouraged to coexist, and value conflicts are dealt within a democratic value system as contrasted with a technocratic value system. Many design processes typify this considered ,open and flexible approach.

While technologists may feel uncomfortable with the breadth and essential consideration of values inherent in design, the converse situation in which designers 'do' technology is also often an uncomfortable relationship in reality. While many designers need to possess a broad range of technological knowledge about materials and processes in order to ensure their designs are workable, they do not have the skills in using the materials and implementing the processes in order to develop their design through to a product. Some designers may source the manufacturing for a client, but many lose track of the process prior to manufacturing. Their role concludes with the presentation of ideas. Even aspects of modelling and prototyping are not done by the designer, particularly with

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technologically sophisticated techniques such as 3D CAD and stereolithography which are often out-sourced. My points are illustrated in the case study which follows.

Case study: industrial design
Greg Pritchard is the owner and Managing Director of Design City, a small design company in Western Australia that has won four Australian Design Awards. He specializes in designing injection moulded casings for electrical, domestic and medical components.

The design process he follows is common enough to be able to be generalized. It begins with establishing the parameters for the design such as quantities and costings. The concept designs are then sketched, mock ups are produced and cost, estimates finalized. The design solution is then modeled, often using a stereolithographic process. The CAD drawing of the product is sent as an e-mail attachment to a company that specializes in stereolithography, and the drawing is downloaded to produce the modeling sequence. The full size or scale 3D model is then delivered back to the designer, usually within 24 hours. Final drawings and then costings are then completed, and the design process is finalized. Greg then has no more to do with the product; it is passed on to a manufacturer for production, in this case the designer must have good knowledge of a range of materials and their performance characteristics both during and after manufacture. But the physical manufacture of the designed objects is left to those with expertise in the 'technology' elements. It is surely unrealistic in a classroom context to expect pupils to become 'experts' in both fields, and so a 'design and technology' curriculum places expectations upon them which even professionals would not be expected to fulfil. The curricular model of 'technology and enterprise', in placing the emphasis on the development of innovation, manufacturing and marketing skills, effectively avoids this pitfall.

Yours, John.

Design and technology as a unitary concept

Dear John,

The first problem in discussing the respective roles of designers and technologists is in defining exactly who the 'technologists' are. Designers are relatively easy since they are often known by that label, although in such a multifaceted profession ranging from fashion to engineering design, jewellery to architecture, it will be difficult to make generalisations about how they work. But few professionals actually describe themselves as 'technologists', with the exception of food or materials technologists. When their background is examined, these individuals often reveal themselves as chemists working within an industrial setting; essentially 'applied scientists'.

Within the educational community, technologists are seen as those involved primarily in the manufacturing process. This corresponds approximately to the role of engineers within industrial contexts. Conversely, many of the tasks associated with manufacture such as prototyping and 'tooling up' for production are essential parts of the research and development process which in practice are rarely undertaken in school. The traditional 'technical' teacher is in reality largely concerned with the development of 'craft skills' for the production of 'one-off artefacts, which is far removed from the role of a production engineer.

I concede that in some cases design and manufacture (if taken as synonymous with technology) are effectively separated in industry. However, in contrast to the case study above, some industrial design consultancies do undertake their own modeling and testing. Furthermore, most modern manufacturing processes are infinitely more complex than a simple two stage 'design and make' model, and it is increasingly difficult to identify the types of professional responsible for each phase. (Cross, 1994; Black, 1996)

The following case study illustrates this point.

Case study: locomotive design
The locomotive industry in its current practice provides a good example of the use of multidisciplinary design teams. The complexity of systems in the locomotive, combined with the complexity of production and the ongoing maintenance of the locomotive, makes the domain multifaceted. Traditionally in this industry the design of the product was done remotely from the production, and so the design facility was located on a different site to the production facilities. The process of design finished with the signoff of the plans then the production process began. The consideration of the ongoing maintenance was often left until after the production process and became the

responsibility of the purchaser of the locomotive.

The current design and production processes have moved to change the above practice to provide a situation where the project is treated in its totality. The outcome of this change of development has involved the formation of comprehensive design teams comprising designers of all the systems, as well as members of the production teams for those systems. Also included in the team are those responsible for the maintenance of the locomotive systems. The concerns reflected in the formation of these teams are both the short and long-term effectiveness of the product. (Williams, 2000)

In this case study, the move to involve participants from the full continuum of the design development and manufacturing process did result in issues arising which could be interpreted as complicating the whole process, evidenced in the change of communication strategies used. What is important to appreciate is that the industry has identified that the longer-term effectiveness of the design development process is enhanced by representation and participation from traditionally disparate groups of design and production practitioners from start to finish.

Yours, Daniel.

Technology education in secondary schools

Dear Daniel,

I agree that in some areas of industry design and technology are linked, although not always through the same person. The locomotive case study indicates the need for strong and continual links between design, technology and manufacture during project development. In a large project the means of achieving this is through ensuring all key aspects are represented by individuals in the team. Each individual does not become multi-skilled in order to achieve the project goals, but each expert must effectively interact and communicate with each other in order to be successful.

Although there are many examples of pupils taking on different roles within school technology projects, the notion of 'design and technology capability' requires that individuals follow the whole process, a notion virtually unheard of outside the classroom. This is the only area of the curriculum where students have the opportunity to come up with ideas and then really test those ideas in a technological context. Of course it is not as simple as that, but that is the essence of what we do. We develop techniques to ensure that the ideas are good ones, we practice presenting the ideas in many different ways, and then we skillfully bring the ideas into reality. As educators we are not only interested in developing the technical skills of dealing with technologies, we are also interested in the divergent thinking, values clarification and conflict resolution of design. We not only want to graduate students who can expertly fabricate systems and products, but we want them to be socially and ethically aware as they expertly design those products. It is a lot to ask, there is a core of activities which enables what we do to be called (in the language of the National Curriculum for England and Wales) design and technology. So whilst I question the legitimacy of this model in an industrial context, I recognise the value in an educational sense of combining these terms to develop a holistic capability in pupils.

Yours, John.

Technology education in primary schools

Dear John,

in a recent survey of 92 pre-service teachers (Davies and Rogers, 1999) undertaking science and technology projects with primary aged children, none were found to take the 'design and make' process further than the stage of a 'working model'. The children had designed boats, musical instruments, waterproof clothing and a myriad of other 'made outcomes' yet none had to consider the implications of producing these artefacts on a commercial scale. Yet all were operating within the curriculum guidelines for design and technology, which do not require children to take their ideas beyond prototypes. Comparing this situation with the industrial context discussed earlier, it can be seen that practice in primary school classrooms corresponds only to the 'design' phase of the process. With vocational issues in mind, if we are to teach what is essentially an 'industrial design' curriculum, as opposed to the 'traditional crafts' curriculum in place until recently, then the whole rationale for 'making' within design and technology needs to be challenged.

Yet few would argue that primary-aged children should not have first hand experience of manipulating, exploring, shaping and assembling materials. Such

experience is at the heart of effective learning for this age group. Perhaps this is the essential difference: secondary technology education must of necessity be more vocationally oriented than primary, and therefore it matters more that secondary practice should reflect in some way the processes undertaken by professionals in an industrial context.

Yours, Daniel

Conclusions

Although approaching from different standpoints, both authors agree that:

The integration of the designing and making phases within technology education has a strong educational rationale, which is associated with the development of a holistic capability in pupils. The opportunities to explore cultural contexts, develop ideas and make choices in the selection of materials and components to realise a design concept are important components of this capability, and are life skills which technology education is in a unique position to foster. Whether the bringing together of designing and making in this way has any parallels in the professional sphere is, in a sense, irrelevant to this argument.

However, as part of the development of technological awareness, and taking into account the vocational requirements of a curriculum for innovation and enterprise, it is important to reflect increasingly through secondary school a model of industrial design and manufacture. As we have seen, the extent to which the work of professional designers, technologists and engineers conforms to a holistic design and technology process varies enormously, with much contemporary practice taking place within highly complex multidisciplinaty teams in which the various members bring particular expertise but do not individually carry out the whole process. It is possible, however, to find rare examples of professionals whose work can truly be said to embody design and technology as envisioned by the National Curriculum Working Group, and such examples should be made widely available to schools.

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