Technicity as the conceptual basis for explaining innovation in design and technology

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Abstract

At DATA's international research conference in 2004, Doyle introduced the concept of technicity. As a concept seeking to provide causal explanation of human evolution itself, as well as innovation and creativity within design and technology education, this was arguably the most significant new contribution presented at the conference and challenged those in design and technology education to fundamentally review the foundations of the subject.

> *Technicity might best be characterised by a creative capacity to:*
> *a) deconstruct and reconstruct nature, and*
> *b) communicate by drawing*
>
> *... If further studies support the technicity hypothesis then reappraisal of the conceptual framework underpinning the educational curriculum might be of benefit: a technology of language rather than the language of technology. (67)*

This paper reports one such further study and then considers how design and technology curricula might be reviewed in this context.

The research evidence which is used to explore the concept of technicity is derived from a detailed diary of designing written as one aspect of the polymer acoustic guitar project at Loughborough University. Ten characteristics of technicity are identified from Doyle's paper and the project diary is searched for corresponding examples. Numerous examples relating to each characteristic were identified. One example for each characteristic is given, with the evidence clearly supporting the conception of technicity as an aspect of human capability. Some corresponding curriculum review questions for design and technology education are accordingly identified.

Keywords: *technicity, innovation, characteristics, diary, guitar, curriculum review*

The polymer guitar project

Loughborough University's polymer guitar project was established as a case study to support a PhD research programme exploring the role of knowledge in design decision-making (Pedgley, 1999). The PhD research was based on three kinds of evidence: primary research data derived from interviews with leading designers; a design case study (polymer acoustic guitar); and secondary research data from published literature. The work was targeted at understanding designers' rationale for materials and processes selection, and the conclusions of the PhD thesis essentially relate to this. However, a secondary focus of the research was the establishment of a complete chronological record of a design innovation, the polymer acoustic guitar, given, of course, that such an innovation occurred. The patent that resulted from the work is evidence that innovation did indeed occur (Norman et al, 1999).

Some aspects of the polymer guitar project have been previously reported: its choice as a PhD case study (Norman et al, 2000), its analysis as a design and technology project (Norman, 2003) and its place in the broader agenda of design decision-making (Norman et al, 2004). However, the chronological record of the design innovation has not been published, and it provides research evidence against which the technicity hypothesis, namely that "innovation is to be expected [and that] technicity is its intellectual driver" (op. cit., 71) can be tested.

Expecting innovation in acoustic guitar design

When discussing the classification of products, Thistlewood (1990) identified three types: archetypal, evolutionary and historicist. Archetypes are products which have developed through the generations and where 'significant departure from these characteristics leads at best to less-fit artefacts and at worst ... to retrograde mutations' (ibid: 14-15).

Musical instruments are one of the examples of archetypes in daily use given by Thistlewood and in discussing the possibilities that designing archetypes presents, he comments as follows.

> They represent a phase of human design enterprise before authorship was celebrated. The contemporary designer's contribution to their re-presentation consists in attending to secondary features such as materials, colours and decorative treatments: essential forms have ceased or virtually ceased evolving and are correspondingly non-negotiable. (ibid: 14)

One example is the scale length of modern instruments, typically between 610mm and 660mm. This is clearly related to the human size range, but also the physics of stringed instruments, modern string design, guitarists' preferences, and the guitar sound, e.g. the relationship of sustain and comfort (Marmaras and Zarboutis, 1997). So as humans, guitar technology and guitar sounds have evolved, the archetypal characteristics of the guitar have become increasingly evident.

Materials selection has become standardised (e.g. spruce or cedar for soundboards), and strutting patterns pre-determined (e.g. Torres fan-strutting for classical guitars and Martin X-bracing for steel-strung acoustics). Electric guitars have been manufactured in polymers (e.g. acrylic and polyurethane) and metal (e.g. aluminium and bronze), but acoustic guitar design had reached a point close to stagnation (or a fully-evolved archetype depending on your perspective) by the 1930s.

There have been very few attempts to move the design of acoustic guitars on from this position, but Maccaferri was one maker who did. He designed the guitars played by Django Rheinhart for acoustic jazz. These have relatively thin soundboards and consequently give greater volume and a distinctive tone. The tensile load from the strings is carried to the sidewall of the instrument through a tailpiece, because the thin soundboard cannot carry the load. The design is still being produced commercially. He also produced the first polymer acoustic guitars, which were injection moulded from Dow Styron, but had poor tone. There have also been polymer bowl-back guitars made by Ovation and carbon-fibre guitars by Rainsong.

This was all known, and part of the challenge, as the Loughborough project began in 1995, and the essential focus of the hoped-for innovation was a design suitable for mass-production processes (not the composites used by Ovation and Rainsong) to bring some freedom to acoustic guitar design, as well as facilitating low cost manufacture in Western economies and sustainable design (given the diminishing world supply of tonewoods, which are often also endangered species). Figure 1 shows a recent interpretation of this concept by a professional product designer (Adrian Dartnall), which is a good visual representation of the project's goals, as they are perceived retrospectively, but the instrument had to sound 'musical' and 'guitar-like' as well. Most commentators at the start of the project expected failure, not success, and so it is an interesting context for discussing the expectation of innovation embodied in the technicity concept.

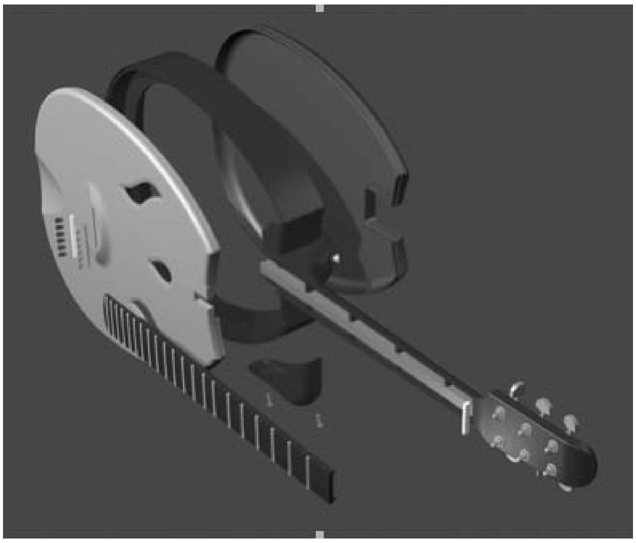

Figure 1: Polymer acoustic guitar design (Adrian Dartnall, September 2004)

The chronological record of the polymer guitar project

During the polymer guitar project, various uses were made of 2D and 3D modelling media to assist with product design and development. Over the course of the project, these built-up into an archive including sketch sheets, logbooks, card and foam models, and working prototypes, as is usual for product design activity. Unusually, however, a detailed diary of designing was kept (Pedgley, 1997) in parallel to the product design activity, to satisfy the research objective of generating documentary evidence of designers' decision-making in relation to materials and manufacturing processes. The diary was generally completed at the end of each day's designing and often made specific references to design thinking embedded within 2D and 3D media. The resulting catalogue of diary entries comprised a chronological 'running commentary' of designing, spanning 227 project days over approximately two and a half years, with over 500 individual entries. For Owain Pedgley's PhD, the catalogue was analysed to track various aspects of materials and manufacturing decision-making, including the nature of cognitive modelling and information searches (Figure 2). For this paper, the diary catalogue has been re-analysed for evidence of technicity.

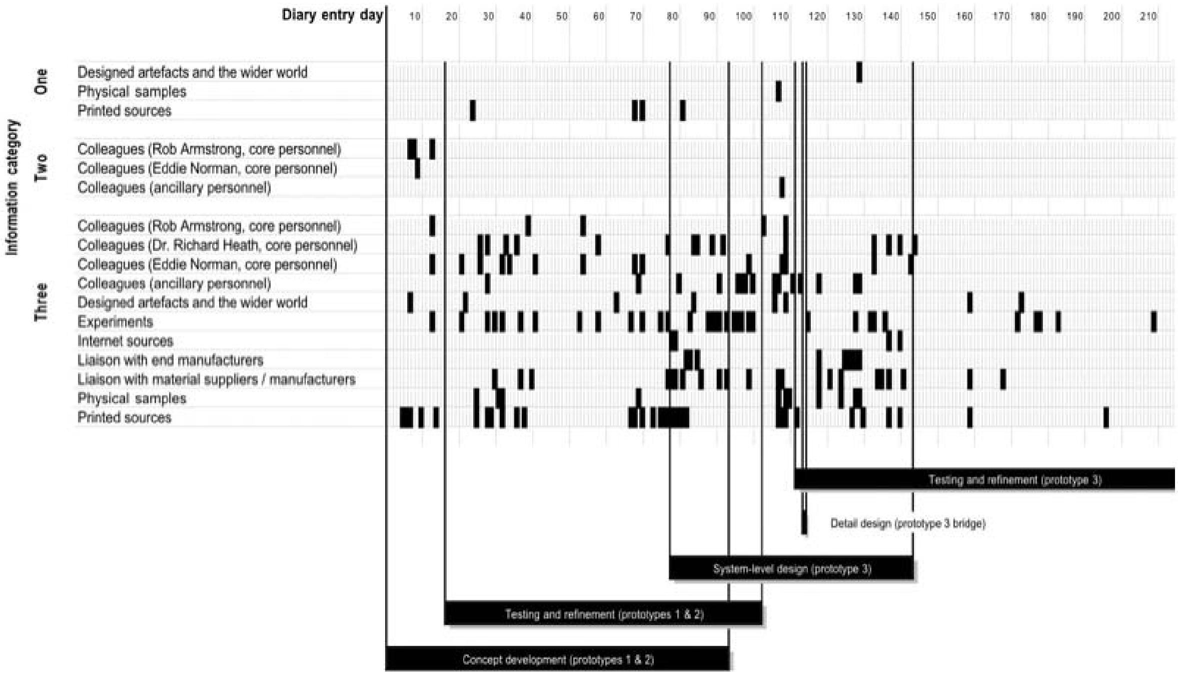

Figure 2: Materials and manufacturing information searches for the polymer acoustic guitar (Pedgley, 1999:231)

Grouping	Technicity characteristic	Page	Comments
Language	an organ of social cohesion	68	'Creativity is not in language, though creativity co-opts language'. (70)
	intentionality	68	... related to our theory of mind
	shared memories	68	... essential for meaningful descriptions
Deconstructing and reconstructing	identifying different making strategies	69	... described in terms of making a ring
	rehearsing alternative scenarios	69	... linked to imagination and the human theory of mind
	a secure cultural foundation	69	... historical evidence is cited suggesting that this is a requirement for innovation
	blindingly obvious	69	... a characteristic of 'creative leaps' in retrospect
Drawing	use as an external memory system	69	... part of the construction process
	development to serve a novel application	70	... sketching styles relating to particular aspects of deconstructing and reconstructing?
	use of drawing instruments	70	... indicated as drawing tools, but would clearly extend to CAD

Table 1: Ten characteristics of technicity identified from Doyle's paper

Mining for evidence of technicity
Table 1 shows some characteristics of technicity identified from Doyle's paper (op.cit., 2004) grouped under three headings: language, deconstructing and reconstructing, and drawing.

Many of the entries in the diary catalogue could be identified with one or more characteristics of technicity listed in Table 1. The following illustrate just one diary entry for each characteristic.

1. Language: an organ of social cohesion

Date 5.8.96	Day 15	"Currently transferring all pertinent info. regarding what has been learnt/decided upon on the polymer acoustic guitar for writing up report. Particularly keen on noting down any technical features decided upon (primarily for PDS (product design specification)). This process is like a 'final sweep' so that the report can be written and completed."

2. Language: intentionality

Date 20.6.96	Day 10	"I have started work on the PDS because I feel that I have raised enough issues and that it is the right time. The PDS will focus my attention to start homing-in on design details - and to prioritise design work. Without it, design work would tend to float and the chance of doing misguided or misplaced design work is much greater. Starting work on Report I also has the same function and allows me to 'form the most complete picture of design work as it stands' - giving me confidence (and an appropriate level of understanding/planning) to move onto the second phase of design work."

3. Language: shared memories

Date 13.6.96	Day 7	"Continuing product analysis exercise at the moment. Formulating ideas/getting to know 'guitars' rather than specifically designing a new one ..."

4. Deconstructing/reconstructing: identifying different making strategies

Date 20.11.97	Day 76	"Laying down (written) what manufacturing processes can be used with the Forex (a combination of my own knowledge, helped particularly by my 'list of processes' which I produced a few days back, and information from the Forex data sheet). Again, laying out my options regarding the technicalities of joining two plastic parts." [with reference to Figure 3]

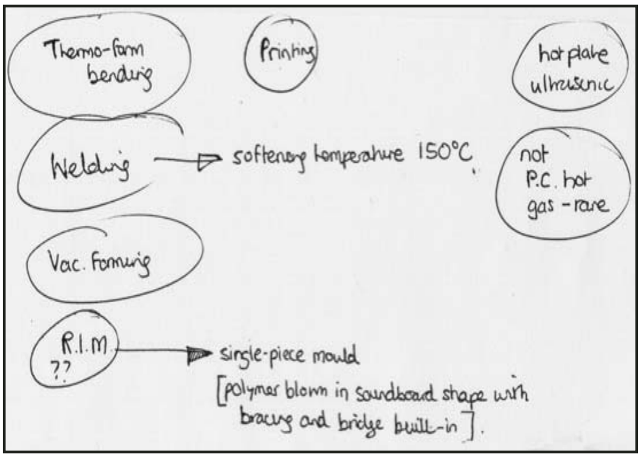

Figure 3: Identifying different making strategies (Pedgley, 1999)

5. Deconstructing/reconstructing: rehearsing alternative scenarios

Date 28.10.96	Day 20	"To have bridge interconnecting with soundboard (i.e. 1 mould) would be tricky. Bridge= reasonably intricate = std. moulding with non-reinforced plastic (i.e. a different material to the soundboard, so, therefore, could not be integral). Fibre reinforced would not allow for such intricacies (also, means soundboard is no longer a flat 'sheet' which could, if appropriate, be cut out - a lot cheaper than moulding)." [with reference to Figure 4]

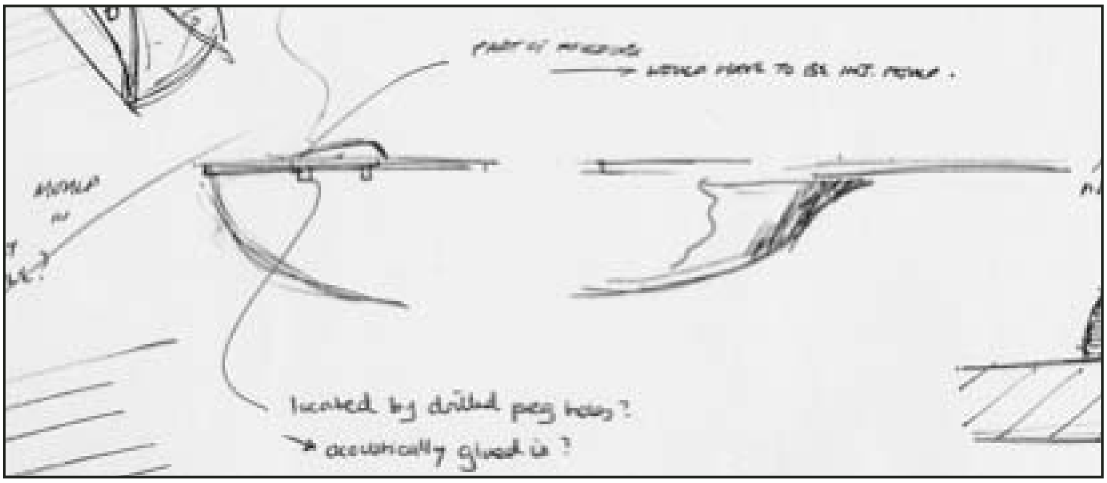

Figure 4: Rehearsing alternative scenarios (Pedgley, 1999)

6. Deconstructing/reconstructing: a secure cultural foundation

Date 16.7.97	Day 39	"[Meeting with Rob] Rob explained to me how I should go about building the top-plate, and gave an indication of the materials to use, giving me confidence and a 'green light' to go ahead with building something that he was happy with. It had been a long time since I had seen Rob, so I wanted to get his 'stamp of approval' on the work done and the direction now being taken, especially concerning what materials to start with. It had been up to me though, to find a design direction from the conflicting ways of working of a crafts-designer client (Rob) and a materials specialist (Dick)."

7. Deconstructing/reconstructing: blindingly obvious

Date 2.12.96	Day 21	"Having consulted EWLN after my recent client meeting with RA (26/11/96), it has been decided to purchase a commercially-available bowl-back guitar. This way, design effort can be concentrated on exploring the successfulness of different materials and construction techniques for the polymer soundboard, rather than attempting (at this stage) the time-consuming task of building a 'test rig guitar' from scratch. This will be a practical, hands-on way of considering the many facets of materials/construction of a fully-composite/plastic guitar."

8. Drawing: use of an external memory system

Date 27.4.98	Day 143	"I used this left-hand drawing to remind me of how the prototype will be constructed around the neck. It led me on to thinking about the same in the mass-manufactured proposal... the block was providing stability, and rigidity in particular - how could this be achieved in the mass manufactured version, using lay-up/moulding? A web of walls I thought, rather like strengthening ribs in injection moulded components... The idea was then superseded on DS55 main." [with reference to Figure 5]

9. Drawing: development to serve a novel application

Date 7.1.98	Day 95	"This was clearing up, in my mind, how the build-up of components for the final design was going. I was thinking whilst drawing these that I would need to produce CAD models of each." [with reference to Figure 6]

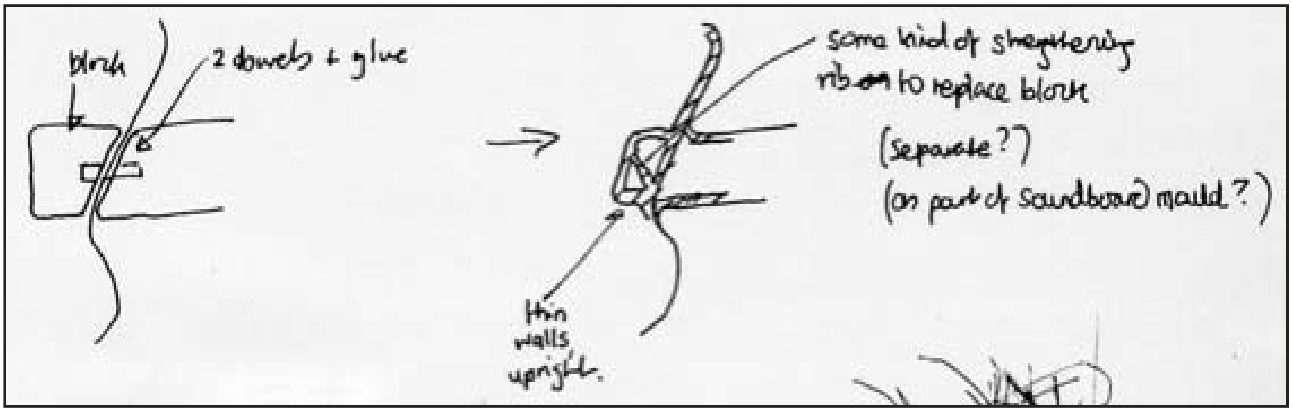

Figure 5: Use of an external memory system (Pedgley, 1999)

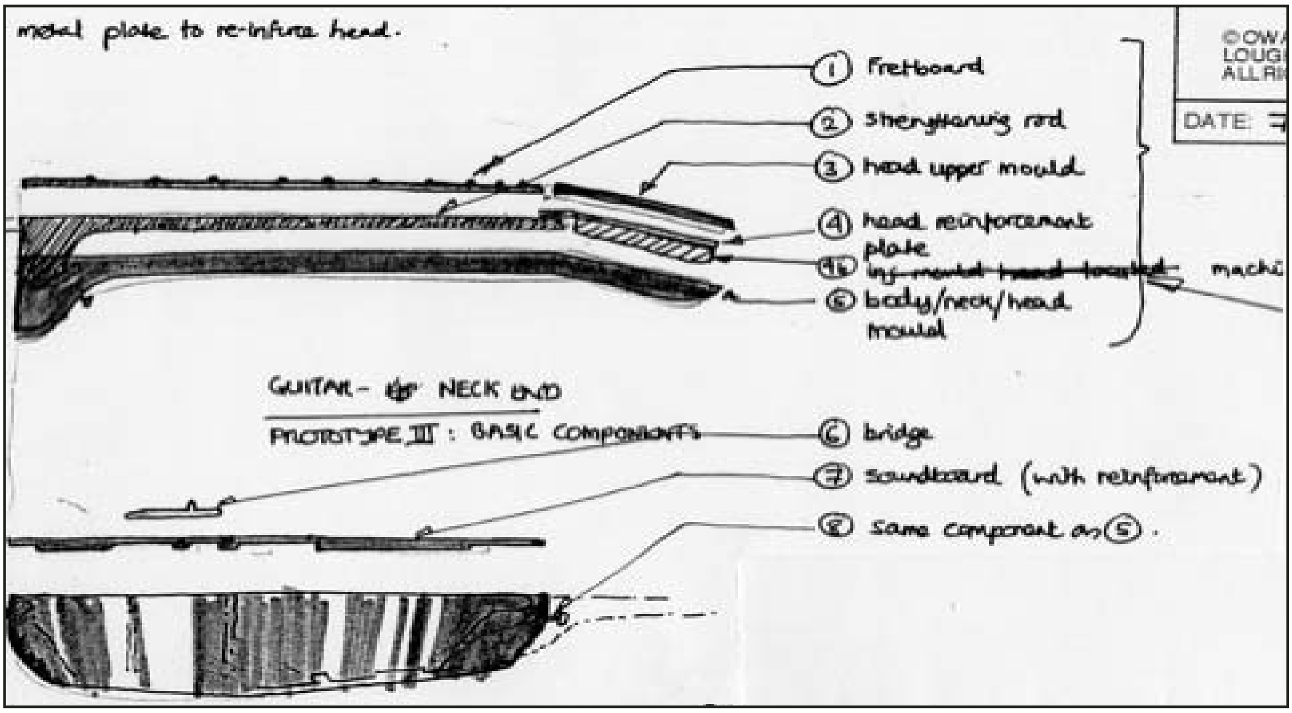

Figure 6: Development to serve a novel application (Pedgley, 1999)

10. Drawing: use of drawing instruments

Date 13.2.98	Day 114	"The bridge has been detailed up, including precise points for the bridge-to-soundboard location lugs and, with the aid of the section drawing showing where the string holes need to go, I was able to determine the distance back from the saddle where the strings should terminate... I was thinking of machining considerations as I was detailing-up, making sure the tooling could cope." [with reference to Figure 7]

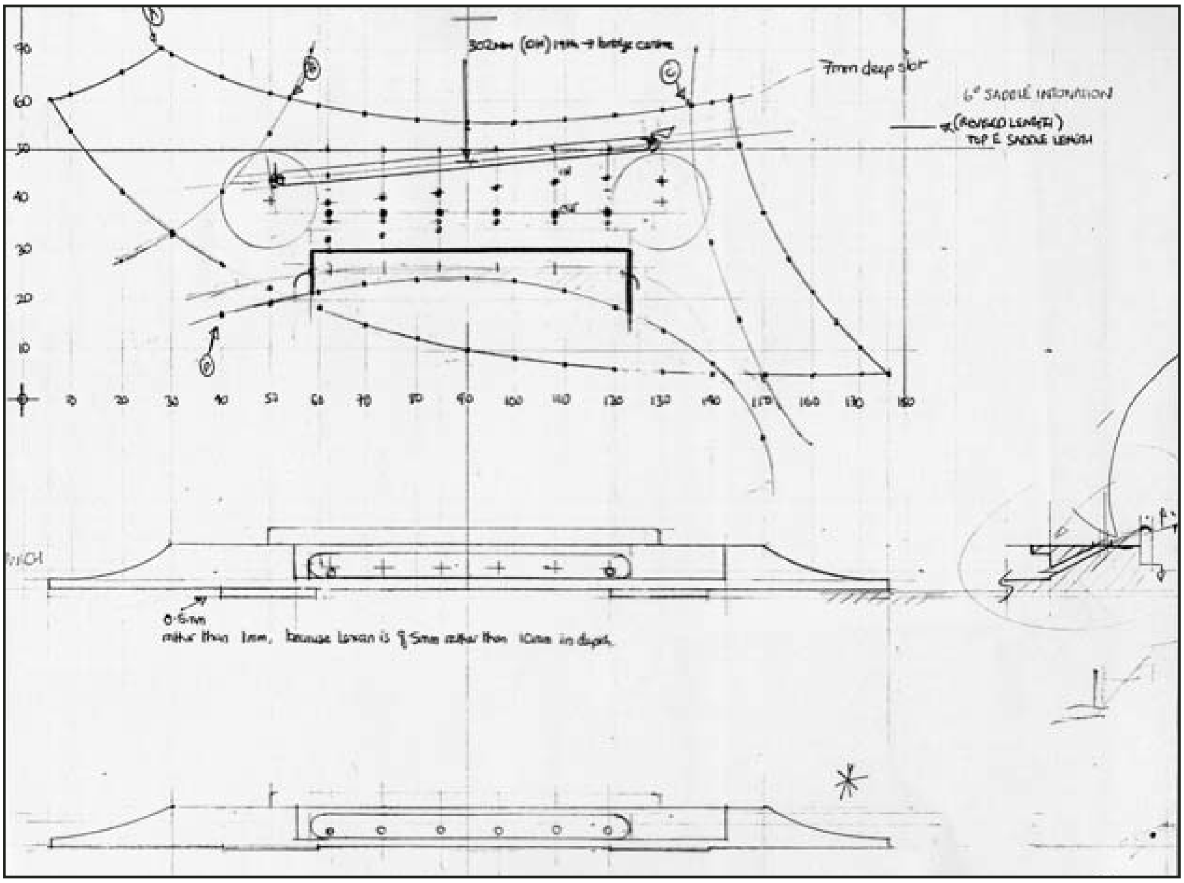

Figure 7: Use of drawing instruments (Pedgley, 1999)

Beginning a reappraisal

The fundamental nature of designing has, of course, been analysed before. Archer (1979) discussed designing as a third culture of comparable significance to science and the humanities. Also that year, Fores and Rey (1979) published their discussion of 'technik', which has the same origins and much the same meaning as Doyle's technicity. These ideas from the 1970s underpin, whether consciously or unconsciously, aspects of current thinking about design and technology education. However, Doyle's analysis marshals recent research evidence from studies of human evolution and casts these conceptions in a new light. Table 2 shows some curriculum review questions derived from Doyle's concept of technicity against which aspects of existing design curricula might be gauged.

Grouping	Technicity characteristic	Some curriculum review questions
Language	an organ of social cohesion	Is sufficient emphasis placed on the importance of language in bringing stakeholders together?
	intentionality	Are activities such as writing a product design specification or creating a product use scenario, given sufficient weight in defining intentions?
	shared memories	Is sufficient emphasis placed on activities which can provide the foundations of a vocabulary when designing? e.g. product analysis, museum studies
Deconstructing and reconstructing	identifying different making strategies	Is enough weight placed on exploring different technologies?
	rehearsing alternative scenarios	Are students encouraged to explore different ways of achieving their design goals?
	a secure cultural foundation	Do the students' cultural surroundings support them in taking risks?
	blindingly obvious	Are students rewarded for doing the obvious?
Drawing	use as an external memory system	Are students encouraged to use drawing (or 2D and 3D modelling media) as an external memory system?
	development to serve a novel application	Are students taught to understand and develop drawing (modelling) strategies suited to their purposes?
	use of drawing instruments	Are students taught how to draw (model) appropriately using 'instruments'?

Table 2: Some curriculum review questions relating to the ten characteristics of technicity

Conclusion

Is it plausible to take the view that to be human is to be innovative and, if humans engage in activities of this nature, then innovation is inevitable? Human decision-making is an expression of the art of making judgements based on incomplete information about existing factors and future consequences. This is the essence of design activity, and hence then of the existence of products and their associated technology (given that the existence of the artefacts or systems preceded the explanation of their performance, empirically or otherwise). In the same way that each game of chess is highly likely to be different, so with product design dependent on a multitude of sequential decisions, the designs will inevitably be different. So, in some respect, every resolution of a design problem could be seen as innovative, in the sense that with respect to some factors it is a 'better fit' for the design intentions than its predecessors. It is a matter of judgement as to whether the better fit is of more value than other better fits. So, on the view that technicity can be understood as the capability underlying human decision-making in the face of uncertainties, perhaps innovation can be interpreted as inevitable and product evolution considered the survival of the most valued.

Perhaps rather than adopting process models of designing, there would be merit in considering the characteristics of technicity as the analytical framework for alternative design and technology curricula.

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