

# The use of Cognitive Style Analysis and the APU Design and Technology assessment strategy as means of clarifying and describing student design work

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## Abstract

A concern for the activity of designing as a fundamental skill in the design and technology repertoire has prompted this investigation into the design project work of undergraduate students. Using two different assessment methods, one from cognitive psychology and one from design and technology education research, the article both clarifies and links the concepts of cognitive style and the individual's design methodology. The article concludes that there are useful implications of this for both students and teachers in the delivery, and the development of designing capability, and the links between 'cognitive style' and 'designing style'.

This research:

- asks what mental processes are involved in designing
- outlines one means to analyse and even measure these processes
- asks whether some mental styles are better than others for designers

Project work as a medium for learning in the design and technology area is a well established tradition. It is recognised as a means to develop skills, knowledge and capabilities.

Of these I am interested in exploring the notion that the most transferable of the activities that is developed by project work is 'designing'. The attempt, with the work described in this article, was to allow undergraduate students to focus on the activity of 'designing' by the application of two different assessment methods, one from design education research and the other from cognitive psychology.

The way of describing the process of 'designing' has changed in the last 20 years from a universal system, to one which is seen as unique to each individual. In order to try to understand and assist in the development of a person's designing, therefore, it is necessary to find ways to look in more detail at the way they

individually operate. The two chosen assessment methods attempt to throw light on this.

My work to date indicates that given the same stimulus, for instance the word 'fish', no two people will have the same mental image from this word. When asked what image they saw, some saw the letters of the word, or gave pictorial, moving picture descriptions. Others imaged food or even fish-like movements. Individuals' view of, and ability to manipulate, their 'world' will be affected by the way they perceive it. The terms 'imaging' and 'thinking' are closely linked and it follows that there should be a connection between people's 'imaging' (the images that they have in their heads) and their 'designing' (the way that images and ideas are manipulated).

The task of this article is therefore to clarify and pursue the links between, 'imaging' and 'designing'. To do this I have chosen to apply the following:

- the analysis of 'cognitive style' as an indicator of 'imaging' taken from *Cognitive Style Analysis*. (Riding 1992)
- the 'APU assessment strategy' as an indicator of 'designing' taken from *The Assessment of Performance in Design and Technology* (Kimbell et al. 1991). (These are both explained in detail below.)

This article is structured under the following headings:

- How has the view of 'how we design' developed? A brief history of the development, from the universal method to an individualised activity.
- What are Cognitive Style Analysis and APU level 1 testing? Why were they chosen as ways of analysing design work?
- How were Cognitive Style Analysis, and a modified APU level 1 testing applied to undergraduate students' work, and what were the findings?
- What are the implications for the development of design capability?



*How has the view of 'how we design developed'? A brief history of the development, from the universal method to an individualised activity.*

Green (1995) says that the late 1960s was when people in the area we now call design and technology started 'designing'. There had always been design as part of the making of objects, but at this point design became the fundamental partner to technology, a visible component of the design and technology teaching in schools. The models of the design process that were available at that time were from studies into what professional designers did. The colleges which produced these professionals had in the 1960s been going through something of a revolution in the development of what they called 'design methods' (Jones 1970.) As the emergent profession of design entered the scientific and accountable world of business it was important to have a message, to be thorough, and above all to have a methodology that could be understood. Piper (1967), in the criteria for the Industrial Design course at Hornsey College of Art, said: "The student will be systematic in his professional decisions (systematically evaluating his decisions against general social criteria." Jones (1970), in his introduction, pointed out that methodology was a tool to be used by the skilled practitioner. From the literature at that time the impression given was that, providing the rules were followed, anyone could be a designer. Design methodology as an idea was very persuasive; it meant that you could identify it, teach it, assess it, and therefore examine it. There was at last a link between the quality of the outcome and the route taken to get to it. Prior to this time designers worked in a very feelings-based domain. This was not only opaque as a methodology but also difficult for anyone other than the designer to intervene in. With the introduction of design methodology, designing as an activity was equated to problem solving. For this there was an established way of working based on an accepted way of solving problems (based on the psychology of problem solving). Provided that they followed the rules, everyone could now solve design problems 'correctly'.

The flaw with this universal method (a linear route from start to finish) was that there proved to be as many exceptions as there were good examples. Several attempts at alternative and more flexible models followed, but all with the same problem that there did not seem to be a universal procedure. In the late 1970s and early 1980s, the idea re-emerged that designing was more to do with attitude than universal methodology. This was in some ways a return to the way that craftsmen and artists had traditionally worked. Lawson (1980) illustrates a more heuristic approach in architects compared with that of mathematicians. Schön (1990) advocated that the feeling for the activity was fundamental to developing professional expertise. His phrase 'reflection in action' encompassed the idea that it was more valuable to think like an architect than to concentrate on a system or procedure of working given by someone else. (Both Lawson and Schön have used architects as their subjects for the study of 'designing'). A switch in emphasis from a system which dictated a way of working to one which depended on the act of 'reflection' throughout the work, meant a more fluid and pragmatic approach. Thinking, evaluating the progress of the work from a base of experience, and a heuristic approach to proceeding were promoted as qualities of the proficient professional. They reinforced that there was not a universal method, but that by thinking like a 'designer', practitioners would develop their own methodology to suit themselves and the particular situation. The process of designing was seen as not universal but individualised in approach.

The way that students are expected to design in their design and technology in schools has mirrored these movements. It has changed from a linear and content driven model, towards a more fluid and individualised idea of 'wearing a designer's hat'. Reflecting on the context and the interplay between the varying needs of the situation are what drives the designing and enhances capability. This is the position described by the APU report (Kimbrell et al 1991) where the process is described as being a path from the vague towards the real with some parts taking place inside the head and some being realised in various



forms outside the head. The path that an individual takes will depend on their personal view of the activity at any particular moment (*Diagram 1*). (This is described in greater detail in the next section.)

*What are Cognitive Style Analysis, and APU assessment strategy? Why were they chosen as ways of analysing design work?*

What I was trying to explore was the links between the way people 'design' and the way that they 'image'. These two instruments were chosen as starting points. Cognitive Style Analysis sets out to determine an individual's fundamental style of thinking and 'imaging'. APU testing was devised as a means of assessing the details of design capability, and thus gives some pointers to the person's style of 'designing'.

#### Cognitive style analysis

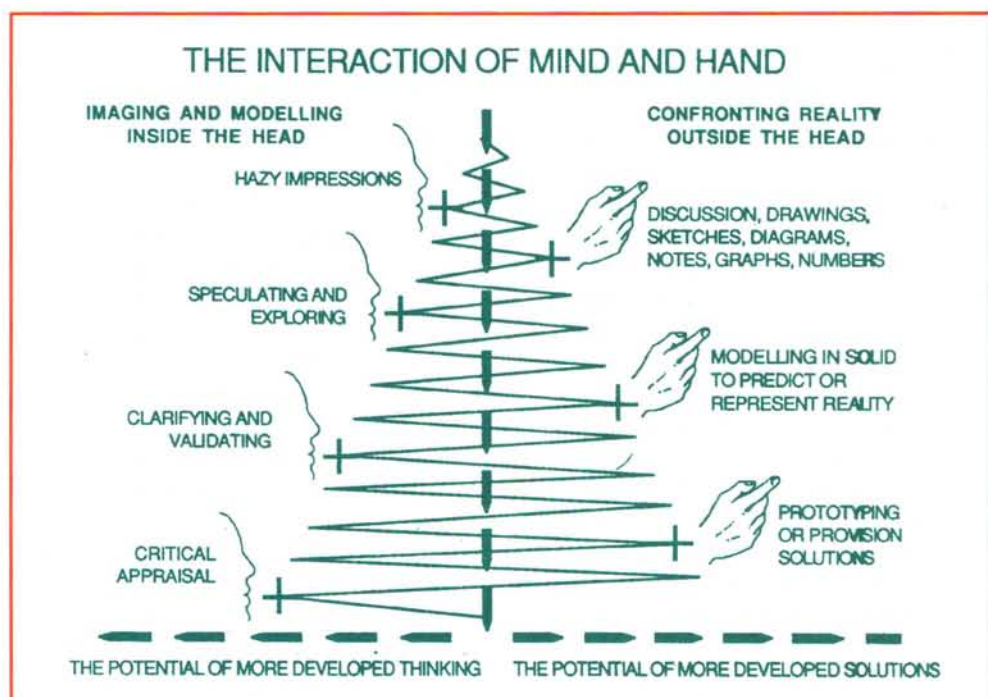
This identifies the basis from which peoples thinking derives. Riding (1991) has evaluated the work in the area of cognitive style and determined that the many existing categories in the interpretation of cognitive style can be summarised by the two indicators, Verbaliser/Imager and Analytical/Wholist (*Diagram 2*). All subjects can be placed within these two continua, and this will give an indication of their 'fundamental' cognitive style. If they are

assessed as, for instance, an analytical/visualiser, this means that they will 'tend' to operate in a fundamentally step by step manner, and will 'primarily' image as mental pictures. This is not to say that this is the only way that they can operate, but that they will have learnt their other attributes, both social and intellectual through their individual framework. It is this individual framework that the test for cognitive style identifies. (*Diagram 2, Riding 1991 pp7 CSA Guide.*)

These two continua are seen as discriminators of the following commonly occurring terms within the framework of cognitive styles (*Diagram 3, Riding 1991 pp10 CSA Guide.*)

The actual Cognitive Style Analysis test is in the form of a computer programme, which involves a series of questions, half diagrammatic and half verbal. Based on the accuracy and speed of the yes/no answers, the cognitive style of the subjects is assessed. The cognitive style is expressed as the raw headings and numerically. The number indicates the position on the two axes of the subject.

Diagram 1





### APU Design and Technology assessment strategy

The work of the APU team on assessing performance in design and technology (Kimbell et al. 1991) was centred on finding a way to not only define capability, but to reconcile the 'method of working', with 'quality of outcome'. They had to establish a scheme of operation where what was not a linear process could be evaluated, and conclusions drawn from it. The project team recognised that capability was complex and not just based on the end result but needed to take into account the route taken to get there. They established a model which took account of 'reflective' and 'active' stages in the work (Kimbell et al. 1991 pp155) (Diagram 1). 'Active' was stated as "allows us to take action in response to the task resulting in the development of proposals for new artifacts systems and environments", and 'Reflective' as "allows us to think around the task, seeing and considering the issues that bear on it. It helps us to solve the real problem, rather than the one that seems most appealing at the time". Ideas are transformed and 'pushed' towards reality by their exposure to "outside the head" examination/scrutiny. The process of designing is seen as the way that the individual "moves from the vague and indistinct towards the real". The testing and assessment framework was devised to 'evidence' these two aspects of students' activity. The subjects in the study were 10,000 15 year olds and they were assessed by their activities in one of a series of contextualised design tests.

The focus on the assessment of both intentions and outcomes as a way of assessing the designing was not new, but its use in the assessment of school students was. The definition of excellence in design and technology was a fluid combination of

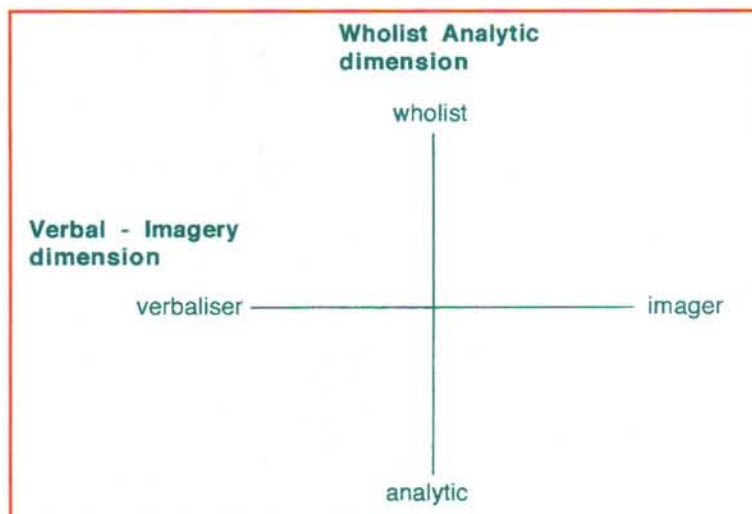


Diagram 2

the reflective and the active capabilities, in moving ideas from the vague towards reality. Assessment at level 1 was of the holistic level of excellence and the characteristics of this in terms of the students' ability at handling *issues*, making *proposals* and *appraising* the one against the other. The components of processes, communication, and conceptual understanding were assessed separately. The combination of these two assessments gave a view of the holistic capability and the components of the performance that made up that capability. These were different for each candidate but there was reliable agreement on the assessment of level and components. Diagram 4 is a modified version of the APU assessment strategy used on the ESRC Understanding Practice in Design and Technology Project. (Kimbell, R.A, Stables, K. and Green, R. 1996)

It shows a modified approach with the processes category broken into three and the balance of emphasis in the work indicated between technical, aesthetic and people.<sup>1</sup>

1. The spelling of the words wholistic and holistic relates to the two sources, Cognitive Style Analysis and APU in Design and Technology, respectively

### Cognitive Styles

Wholist	Analytic
Field dependent	Field-independent
Holist	Serialist
Impulsive	Reflective
Levellers	Sharpeners
Surface	Deep
Divergers	Convergers
Lumpers	Splitters

Verbaliser	Imager
Extrovert	Introvert
Verbaliser	Visualiser

Diagram 3: The relationship of the Cognitive Styles to other styles



*How were they applied to Undergraduate students' work, and what were the findings?*

Students on the undergraduate BA Ed (primary and secondary) Design and Technology course at Goldsmiths University of London are encouraged to keep a 'Process Diary' for recording and reflecting on their planning and designing. In their work on the reflective process, Rogers and Clare (1994) developed the 'process diary' as a tool for enhancing the learning of design and technological capability. The contents of the students' diaries along with the made outcomes of the design and make project work are the means by which their work is assessed. The form that this recording, reflecting and designing takes is the choice of the individual student. An advantage in this case over the tests used in the APU report, as a means of providing evidence, is that the process diary gives a powerfully individualised view of the way a student works.

The process diary and the made outcomes were used for this study. Four students were chosen, the criteria for their choice being that they were of a high standard, and that all had very different designing styles. They are in the second and third years of the course, and a mixture of male and female, with a variety of experience prior to their entry onto the BA Ed. course. They all took the Cognitive Style Analysis test and a piece of their recent project work was assessed using the format outlined as the modified

APU assessment. The application of the APU assessment was done by one of the original assessment team. Because the students were chosen for their high standard of performance, the holistic level was expressed qualitatively. The components of this level were assessed using the form shown in diagram 4.

Examples of the work assessed and the comparative results of the two assessment instruments are shown below.

#### Student 1

- Cognitive style is *Intermediate Verbaliser*, i.e. deals equally analytic and wholistic but from a verbal 'imaging' basis.
- APU assessed as being holistically a high level, which indicates an integration of action and reflection, dealing with issues proposals and appraisals fluently and effectively.
- Indicated strengths in dealing with issues, and particularly with appraisal of progress and decisions to move ideas forward. Focused on a combination of technical and aesthetic areas.
- Communication was high in clarity and confidence. Dealing with concepts was high particularly in the areas of materials, energy systems and aesthetics.

Diagram 4

**Name**

holistic	0	1	2	3	4	5
issues						(T A I)
proposals						(T A I)
appraisal						(T A I)

**procedures**

used to record the focus of activity  
technical T.aesthetic A.  
people I.

clarity	1	2	3	4
complexity				
confidence				
skill				

**communication**

materials	1	2	3	4
energy systems				
aesthetics				
people				

**concepts**

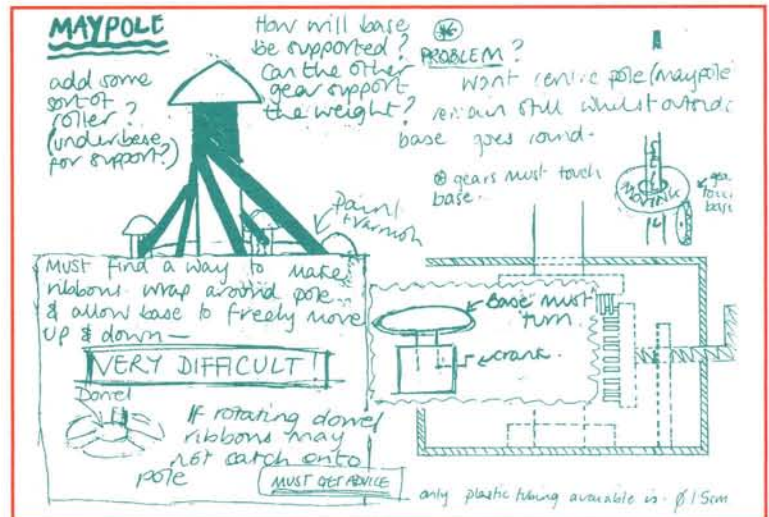


This student was concerned at all times to keep to the time scale required for this project and that the end result was suitable. They were approaching the end result in a very analytic (step by step) way but all the time keeping a wholistic view of the end result. This is typical of all of this subject's work. Interesting in their approach was the way that the writing drives the drawing and designing. Comments such as "I must find a way to..." followed by very fluent sketching are seen throughout the work. The fluency of the reflection from issues to outcomes and the ability to solve the particular problems are very evident. This style of presentation would be seen as typical of that expected within school design and technology work.

#### Student 2

- Cognitive style *Wholist Bimodal*, i.e. tends to view the whole of the activity, and is fundamentally able to deal with images and words equally.
- APU assessed as being holistically a high level holistically, good with issues and with appraisal in the technical area.
- A high level of communication, clear, dealing with complexity, skilfully and with confidence.
- Deals with concepts best in materials and energy systems.

Interesting in the approach of this student is the degree to which all of the steps in the work are 'tied' mentally before they are put on paper. There is a very clear picture from the start of not only the design project that is being developed but also the 'process diary' that is part of that outcome and its assessment. Whilst less fluent visually the ideas are confidently expressed. The work is extremely well organised with a determined grip on outcomes and deadlines. There is a greater strength in verbal rather than visual communication, and the work exhibits less of the fluency between action and reflection aspects of the analytically assessed cognitive style students. The grip on the whole project is shown to be very strong. This style of work would be seen as suitable within school design and



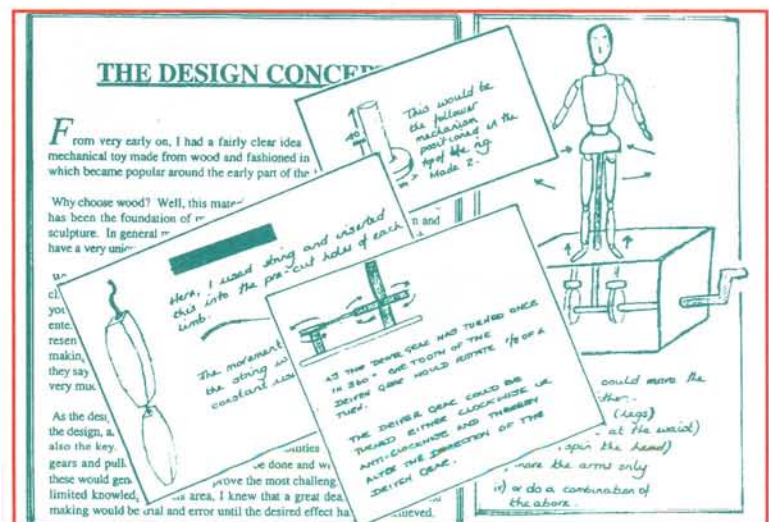
technology, but tends to evidence decisions and conclusions rather than thoughts and reflections. The impression that it gives is that this is the report of the designing, rather than the designing itself.

Example 1:  
Student 1's work

#### Student 3

- Cognitive style *Wholist Imager*, i.e. tends to view the whole of the project at a time, and from a visual basis.
- APU assessed as being a very high level, good at proposals, and appraisal and less good with issues.
- Communication is confident, clear and skilful but with less clarity than the others, there is evidence of reflection, but of little desire to make this public.
- Concepts are assessed as high within the energy systems and materials areas.

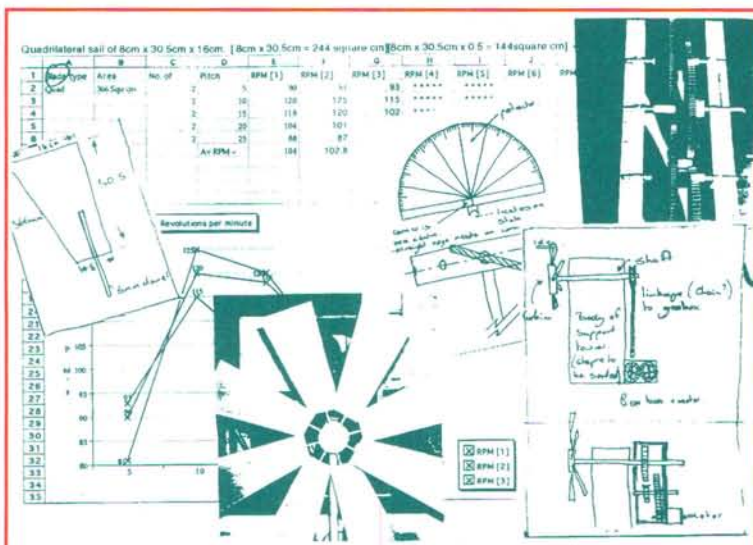
Example 2:  
Student 2's work







This work exhibits many of the qualities Riding describes as typical of wholists. There is at all times a strong grip on the whole project, but the work shows little sequence. For instance, the gearbox was



- Cognitive style *Analytical Imager*, i.e. works in a step by step fashion using fundamentally visual images.
- APU assessed as high level holistically, with strongest the ability to appraise and move forward.
- Less good at dealing with issues and proposals.
- Considerations are focused in the technical and aesthetic areas and the communication is clear, confident and skilful, but lacking in the explanation of complexity
- Concepts show strength within the materials and aesthetics areas with less emphasis on energy systems and people.

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*What are the implications for the development of design capability?*

As I was part of the original APU assessment team, the ideas embodied in the team's report had become assimilated into my own practice. What the extra dimension of cognitive style has done has allowed a more informed dialogue between the student and the assessor in several ways; first *it has allowed discussion to focus on 'how' the designing was done as well as 'what' was done*; second it has given credibility to an individual's approach, and allowed students to take ownership of the process of their working.

The subjects of this study were chosen because they had very different ways of working. I was not concerned to establish that there was a preferred cognitive style for design and technology students as might have been more feasible for linguists or mathematicians. What was interesting was the similarity in approach, in the case of wholist/imagers, to the work of Atkinson (1995). She found that wholist/imagers were less likely to complete project work at GCSE than analytic/verbalisers. In my case I was dealing with a mature student, who had a strong grip on the outcomes that they wanted. Perhaps the influence of cognitive style is greater in younger students, for whom the mismatch between the way that they want to work and what the examination and teacher requires leads to a lack of motivation.

What this study has done is to focus on the reflective act and the means by which the individual moves their ideas forward. At first sight it is difficult to conceptualise reflection and decision making without the use of words. This will put verbalisers at some advantage. However, does the conventional, art-based, sketch book rely on a kind of 'visual reflection', or is this in fact a 'projection'? Is it the pushing of ideas forward, rather than looking back and learning? This work was of a very exploratory nature but it has already been valuable in my discussions with students concerning the development of their design work.

There is some evidence that a vocabulary which not only relates design intent to finished artefact, but is also aware of cognitive style, can be used to help understand and develop designing capability. Amongst my sample there was not a single 'designer' cognitive style. The major possibility from this work gives a clue that the nature of the reflective process may be different for individuals. Should not the strategies used by design educators relate to an individual's starting point, cognitive style, and designing style, in order to move students towards capability? The possibility that both of the instruments, plus others could be used in the enhancement of the development of an individual's design capability, is very exciting. There is clearly more to be uncovered in this fundamental area of design and technological activity.

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