DRAWING CONCLUSIONS

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ABSTRACT

This paper will discuss the three areas of concern namely: -

- Poor basic knowledge of drawing practice and convention
- Poor sketching ability
- Lack of CAD tuition

The paper will suggest that by replacing hand draughting of engineering drawings by CAD techniques time will be freed up for more rigorous tuition in drawing conventions and the practice of sketching. This augmented by lectures and phase tests for the knowledge elements and the use CAD as the primary tool for the teaching and learning engineering drawing should lead to an improvement in standards and better engagement of the students with the material.

This aligns with McMahon's postulation in [4] that the revolution in ICT could and perhaps should change the approaches to teaching used by universities. This in turn could free up some time to allow more actual design and project work to take place [5]. It has also been suggested by some of the author's design colleagues that the increased use of computer software for engineering analysis could further release time for design and perhaps more CAD tuition. This view is not, of course, generally accepted by engineering scientists.

Keywords: Design Education, Engineering Drawing, Computer Aided Design, Sketching, Curriculum Design

1 INTRODUCTION

The problem facing tutors was highlighted a short time ago by a colleague who returned to teaching level one design after a lay-off of some years. He commented that the students' ability to draw anything had significantly worsened in the intervening years and that now it was a painful exercise to try to have them produce half-way decent hand sketches, let alone reasonable hand-drawn formal engineering drawings. He also has changed his view from one that regarded pencil and paper drawing as an essential skill that must be learnt, to one that embraces the use of CAD packages and other IT techniques to enhance students' learning.

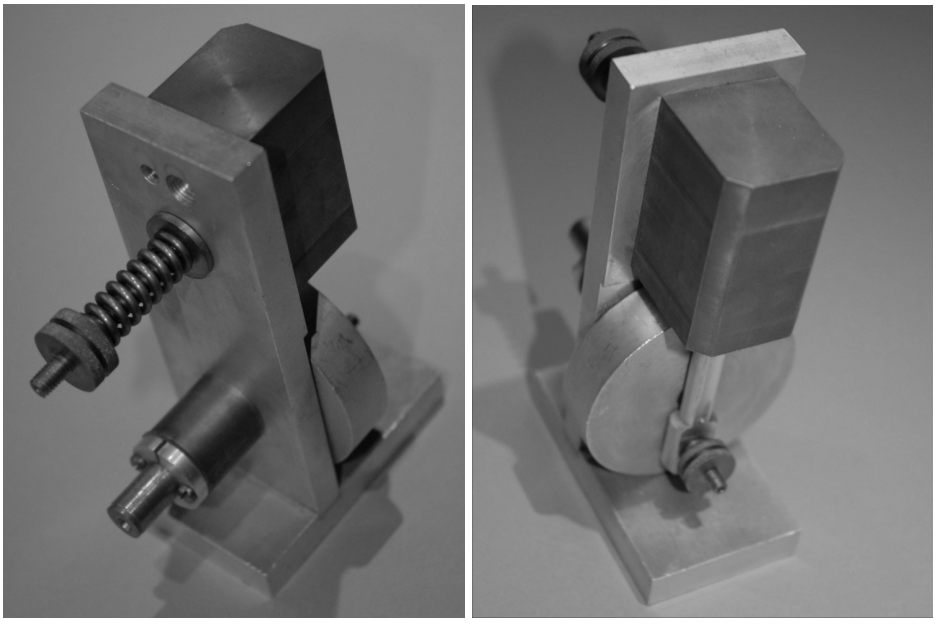
It has, for many years, been custom and practice to teach engineering drawing skills to practically all the students on Level One engineering courses. This has met with varying degrees of success. The students pass their first level assignments but in subsequent years fail to produce properly laid out drawings using standard conventions. It is not only that they regress rather than expand their ability to hand craft an engineering

drawing but also that even when using a CAD package many fail to use proper projections and conventions.

In an attempt to address some of these problems in-class tests have been introduced to assess the knowledge base of the topic. Typically the students are asked to complete a short phase test or perhaps to check a print for draughting errors. However, although this appears to correct some of the gaps in basic knowledge, the areas of poor sketching and draughting remain un-addressed. It is also clear that in most curricula there is little time for much CAD tuition. Students are now arriving CAD literate in most cases, so to be made to produce formal drawings on paper is alien to them and may contribute to lack of engagement and poor standards of execution. It would also seem appropriate to introduce 3D modelling packages from the outset rather than retain the 2D basic CAD introduction.

With the current review and re-approval of all courses in the Faculty of Engineering & Computing at Coventry University it is timely to review the way that sketching and engineering drawing is taught across the newly formed Faculty.

2 A LITTLE HISTORY



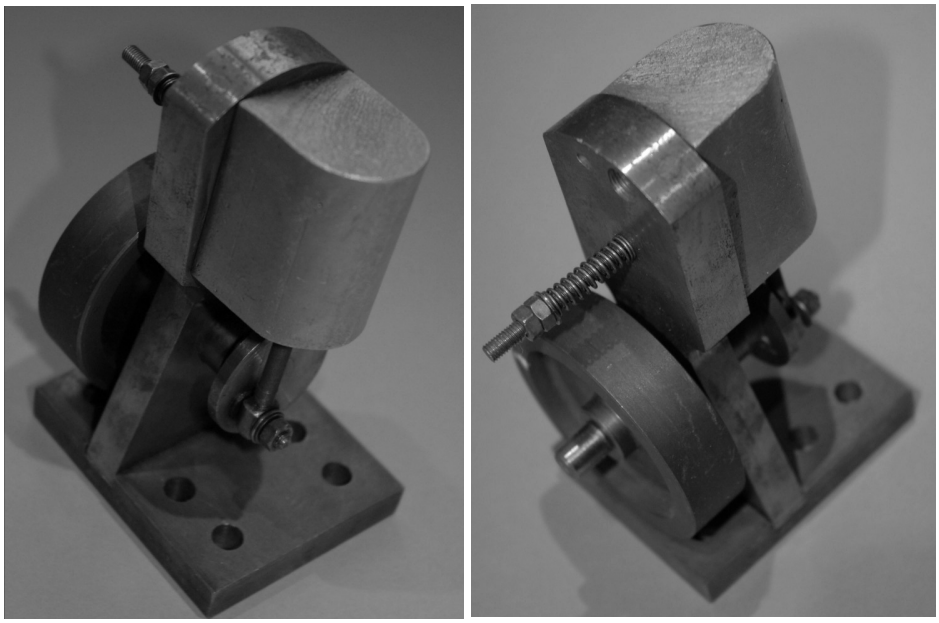
Figures 1 & 2. Example of student generated design

Some 15 years ago engineering drawing practice at Coventry University was taught as part of an integrated package of activities carried out in conjunction with a local further education college. First year engineering students spent one day a week on this activity - half the time being spent on engineering drawing practice and half on 'hands on' design, make and test projects.

The main focus of this experience was the design, make and test of a pneumatic swing-cylinder motor.

With regard to engineering drawing practice the diet consisted of an introduction to engineering drawing conventions, projections, dimensioning, tolerancing, drawing hierarchy, parts lists, material specifications etc. Also covered were electrical circuit diagrams, engineering geometry and a good deal of 2D and 3D sketching of engineering artefacts.

However, the main component of the draughting activity was to produce a complete set of fully dimensioned and toleranced working drawings for the pneumatic motor which the student could use to manufacture the components.



Figures 3 & 4. Example of prescribed generic pneumatic motor

On completion of the machining exercise the student would check and comment upon compliance with the drawing, bench fit the assembly and test for maximum RPM using an electronic counter made in a parallel exercise. The student would then be able to modify the motor in an attempt to improve performance.

The hands-on practical sessions included casting and pattern making, sheet metal construction, electrical circuit board manufacture and machining (turning, milling, drilling, grinding etc.).

Students, in the main, entering the course at this time had quite reasonable sketching skills and had probably studied technical drawing: many had some machining experience.

The main benefit of this scheme was that the students were able to make their design of pneumatic motor to their own drawings. There was much diversity with cast rather than

fully machined components and a number of different configurations including vertical and horizontal single cylinder versions as well as horizontally opposed and 'vee' twin creations. The motors were attached to a standard industrial air supply and the speeds obtained varied between 850 - 6000 RPM. Figures 1 & 2 are examples from this period

A subsequent course review reduced the class contact hours and financial constraints imposed on workshop time forced a decoupling of the draughting element and the construction element of the pneumatic motor project. Increasingly the reduction in workshop time meant an increasing number of components had to be produced from a standard drawing using machining jigs and fixtures and pre-machined blanks. This meant that although students were able to produce a set of drawings for the motor they were severely constrained in the design decisions that they could make. Figures 3&4 show this severely constrained version. At this stage the class contact part of the module still covered the majority of the engineering drawing elements mentioned above together with the introduction of cardboard engineering and an introduction to 2D CAD in the form of AutoCAD.

Some five years later the next course review reduced the design module by 50% for most of the engineering course allowing time only for the some basic sketching, an introduction to engineering drawing and its conventions and the production of a set of hand drawn pneumatic motor drawings, before making a standardized motor. This proved to still be a worthwhile exercise although considerably watered down from the original scheme. Over the intervening years until the present a further reduction in the skill levels of students entering the course has been noted. A further diminution of sketching and draughting ability is apparent although students do tend to have an increased facility with basic CAD packages. Indeed it has now become painful to watch students attempting to produce neat, clean, accurate drawings on the drawing board.

The author in [2] remarked that the gradual reduction in hand drawing skills observed amongst the last five cohorts of students enrolling on Product Design and Engineering Courses at Coventry University may well just be the tip of an iceberg. It is undoubtedly the case that just as good observation skills form the basis for good drawing skills they also form the basis for good 3D modelling skills. In fact it is the complete range of 3D visualisation skills that is in danger of being lost.

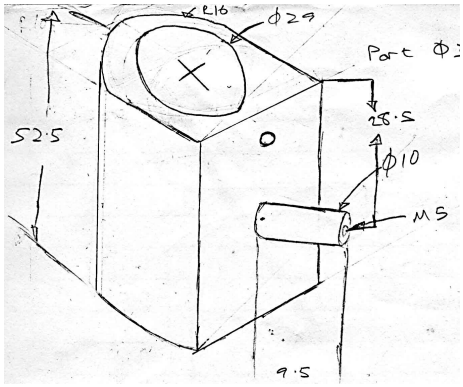


Figure 5. Example of naïve sketching

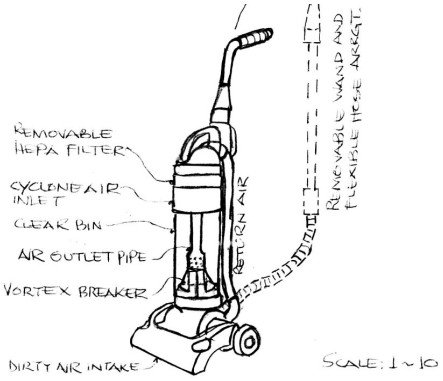


Figure 6. Example of laboured sketching

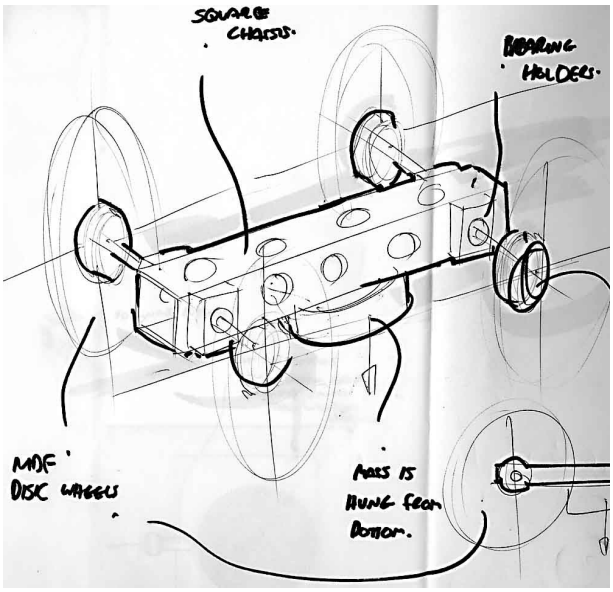


Figure 7. Example of glitzy sketching

Three inappropriate types or styles of sketches are commonly seen: -

1. the naïve (Figure 5)

This is typified by the lack of proper perspective or projection.

2. the laboured (Figure 6)

This is usually hard edged and overworked.

3. the glitzy (Figure 7)

These usually exhibit a bit of style but lack content and are probably produced quite quickly.

3 WHAT NEXT

The decision to repackage all courses into a six modules a year format for September 2006 start has given the course teams an opportunity to revisit modules and their content with respect to drawing and CAD provision.

Over the past few years students have been eager to learn and use 3D Solid Modelling CAD packages such as Catia and Solid Works, in fact the most popular modules in years two and three of the course are option modules covering the application of Catia.

Under the new scheme it is difficult to include modules of CAD or CAE in their own right as on courses accredited at CEng level engineering science knowledge and application is of paramount concern with the computer based tools being seen as just that – 'tools to aid engineering'. It has therefore been decided that at Level One there should be a module of Design Principles and Practice which will be something of a portmanteau module encompassing design theory, tools and techniques, an introduction to CAD solid modelling and an introduction to draughting conventions, BS8888 etc.,

together with design based project work. The engineering practice assignment of 'making a pneumatic motor' will still be present will the Level One laboratory rota but hand drawing will disappear and students will be encouraged to draw a selection of components as solid models in CAD. Additional CAD workshops will also be included in the Level One laboratory rota.

4 CONCLUDING REMARKS

This new scheme should allow more time for students to practise and hone their sketching skills and to absorb the conventions of good draughting practice. The latter topic being presented as a series of lectures outlining BS8888 etc., with assessment being part of the project assignments. Students are required to produce 'drawing plans' in the same way that one creates an essay plan for a piece of creative writing.

This should ensure that students understand how to interpret a formal engineering drawing and are able to check that the CAD package of their choice has produced orthographic projections correctly. It should also give students the confidence to sketch with authority.

Is the banishing of the drawing board and draughting machine the right approach which reflects modern industrial practice? Or is it too bold a move - only time will tell.

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