Modelling Industrial Production Methods in Lower Secondary School Design and Technology Projects

CURRICULUM

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Abstract

This article was originally presented as a paper at the 1998 Science and Technology Education Conference held at the Hong Kong Institute of Education. It describes how design and technology students at Sha Tin College are exposed to the manufacturing methods found in industry through two structured, lower-school projects which employ batch and mass production techniques. The projects focus on the need for teamwork, good planning and organisational skills, the value of jigs and fixtures and quality control in manufacturing. Extension work in the areas of graphics, energy and IT is also considered. Sha Tin College is a multi-racial, English speaking international school of 1000 students which broadly follows the UK National Curriculum, modified to reflect the local context.

Introduction

Despite the fact that almost every manufactured product we use today has been mass-produced, in many schools the most common making experience for our students is that of individual production. There are of course sound educational reasons for this. Students personally engage in and experience a wide range of design and practical skills and they are wholly responsible for what they produce. However, by concentrating solely on this type of manufacturing method I believe we are missing out on an important opportunity to expose our students to a wider variety of production methods. Figure 1 shows a chart of the projects/topics undertaken at Key Stage 3 along with the type of production which each project involves.

Group production methods we witnessed on industrial visits and useful trips to local factories and businesses are a vital facet of the design and technology curriculum, but by modelling industrial production methods in school-based projects, our students can experience the techniques first-hand. This article will illustrate and explain two such units of study; one a Year 8 mass production project and the other a Year 9 batch production exercise.

Mass produced band powered buggy (Year 8)

The project is introduced with a short video extract of Charlie Chaplin in the classic movie Modern Times. Chaplin works on a factory production line with hilarious but disastrous results and using this as a stimulus for discussion, the pupils quickly grasp the fundamental principles of the division of labour, moving the work to the worker, interdependence and parallel production lines. A sample vehicle is then displayed (Figure 2)

Figure 1: Key Stage 3 projcects

YEAR	PROJECT/TOPIC	PRODUCTION
7	Electronics	Individual
	CAD Marble Maze	Individual
	Mechanisms: Levers	Individual
	Control: Air-con systems	Single sex 2/3
	Structures: Bridge testing	Mixed pairs
	IDEA: Pencil case evaluation	Mixed groups of 4/5
	CAD Key-tag	Individual
	Graphics	Individual
8	Ergonomics: Sports trophy	Individual
	Control: Alarm systems	Single sex 2/3
	Graphics	Individual
	Electronics: Switching	Individual
	Soma cube	Individual
	Mechanisms: Linkages	Individual
	Band-powered buggy	**Mass production**
	IDEA: Toy evaluation	Individual
9	Graphics: Logo design	Individual
	Machining: Logo stamp	Individual
	Mechanisms: Cams and cranks	Individual
	Electronics: Capacitance	Individual
	3D puzzle	**Batch production**
	Control: robotics	Single sex 2/3
	IDEA: Consumer goods	Mixed groups of 4/5
	Graphics	Individual
	Product design: Mirrors	Individual

and the individual tasks required to produce it are discussed. At this point, depending on the time available and the emphasis required, the production lines can either be established by the students themselves, or the stages can be provided in the form of the worksheet 'Parallel Production Lines for Buggy Manufacture' (Figure 3).

Students then negotiate and sign up for the jobs on offer with any extra workers being assigned the roles of runners, supervisors or quality controllers. The use of prepared jigs and fixtures is explained and their vital role in ensuring that repetitive work is done quickly and accurately, is heavily stressed (Figures 4 and 5). Finally, the jobs are demonstrated, the optimum lay-out of the room is agreed upon and the class are now primed to go into buggy production. Experience has shown that a class of 20 students can make 20 finished and fully operational buggies in under one hour. This compares with about a four-week timescale using individual production for the same task. A graphical element can be added at this point if 'bodywork' in the form of card nets are made, decorated and fitted to the chassis with double-sided tape. This allows for extension work into areas such as airflow, resistance and drag. The practical aspect of the project concludes with the testing of the vehicles and again there are opportunities for extension work into stored energy, wheel-spin, friction, tyres and lubrication. It is also possible to achieve an efficiency rating for the buggy by dividing the distance travelled by the number of turns of the rubber band. This can be calculated manually or by using a spreadsheet if an element of IT is included.

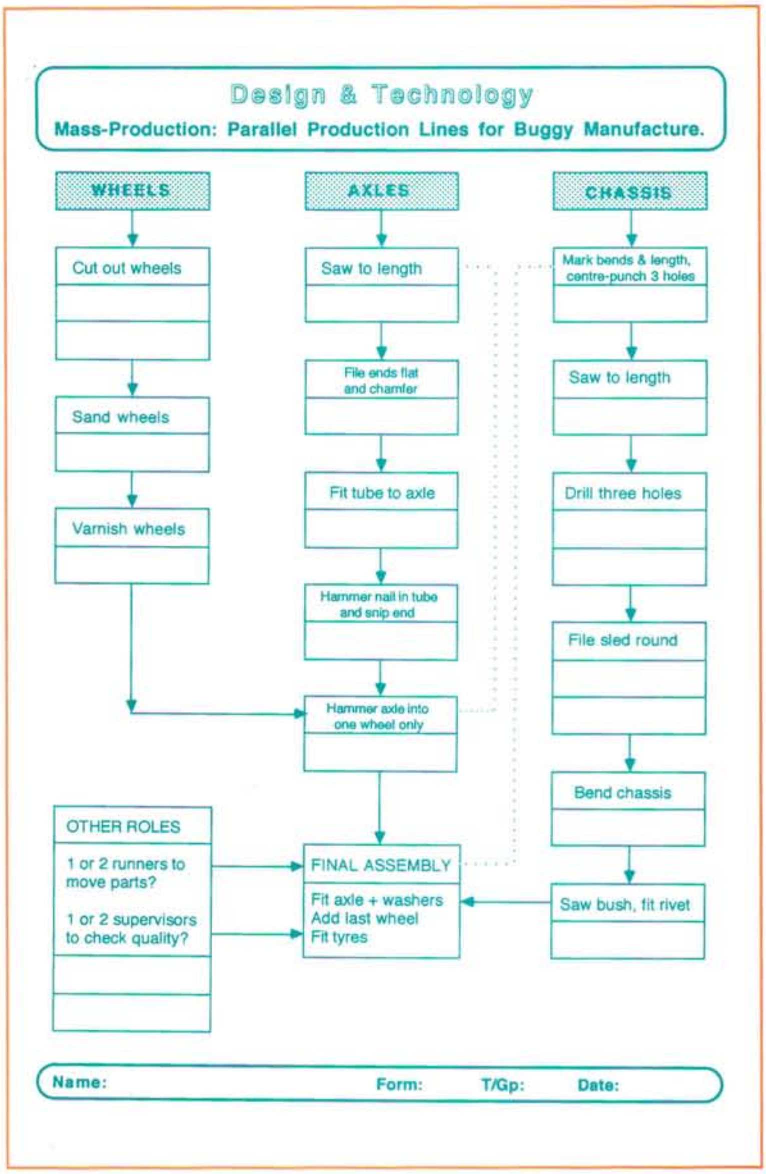


Figure 3: Parallel production lines for buggy manufacture

Batch produced 3D puzzle (Year 9)

The second project involved making a 3D wooden puzzle (Figure 6). The students are split into production units of four or five, based loosely on friendship groupings in the hope that this will promote team co-operation. Each group has to make a 'batch' of four or five puzzles. The starting point is a consideration of the differences between individual, batch and mass production and the work on buggies from the previous year proves useful here. Again, the use of jigs to ensure accuracy and speed is heavily stressed (Figure 7). Working in groups, the students then plan out their order of production. The second stage is to translate this chronological sequence into four or five 'parallel production' lines for each member of the group, to show specifically what he or she will do. Finally a dedicated work area for each group is set up and production begins. We have found that the groups can produce their quota of puzzles in one double lesson and once again this is much faster than if the same work were undertaken using individual production.

Figure 2: Sample buggy

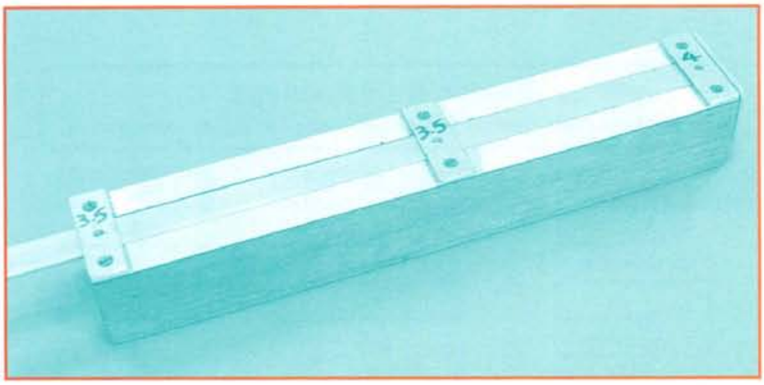
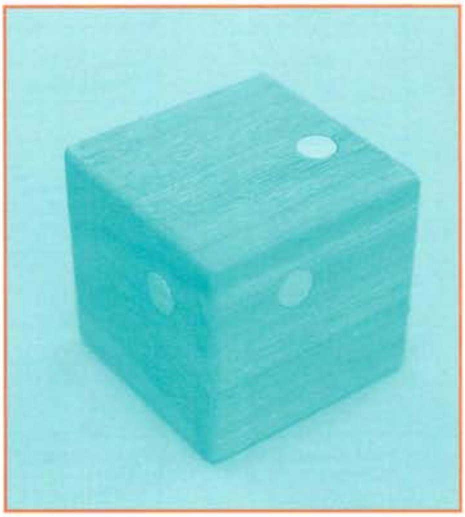


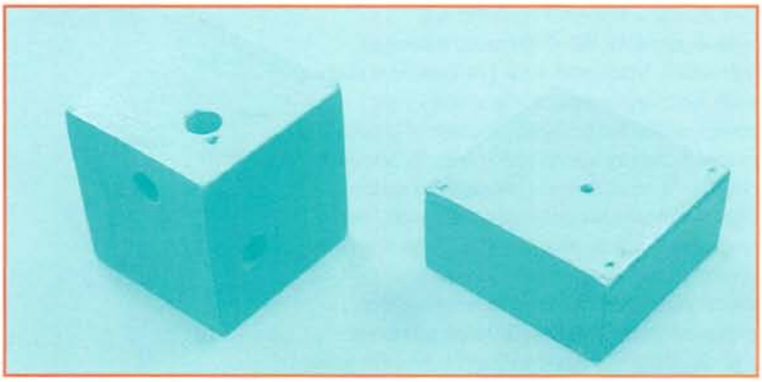
Figure 4: Jig for marking and drilling chassis



left: Figure 5 Jig for locating plug in centre of axle

Above: Figure 6 Sample of 3D puzzle

Below: Figure 7 Colour-coded jigs for making centres on puzzles



Conclusion

As with most design and technology projects, the final stage of both these units is to produce an evaluation. This time, however it is the production method which is evaluated, not the artefacts which are produced as these should be fairly standardised products. A study of student evaluations shows that as a result of their first-hand experience, all are able to identify at least some strengths and weaknesses of the system. The more perceptive students have, in the past, suggested some very sophisticated solutions to the inevitable problems of worker boredom, such as re-training, job rotation and team production (of a type used by Volvo and other major manufacturers). They were also able to identify the organisational faults which sometimes caused smooth production to be disrupted. Secondly, enjoyment of the work was abundantly apparent and undoubtedly a key factor in the high levels of motivation exhibited by the students. Finally, because of the methods involved and the use of effective jigs, every student was able to take home an accurate, working quality product. The value of this should never be underestimated when producing design and technology outcomes.

Our experiences with these popular projects suggest that the approach is a worthwhile and meaningful adjunct to our regular industrial visits. The variety of teaching and learning styles which they inject into the design and technology curriculum is also felt to be highly beneficial.