MANAGING THE IMPLEMENTATION OF DESIGN EDUCATION IN INDUSTRIAL DESIGN AND TECHNOLOGY WORKSHOPS

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Creation, Invention, Ingenuity, Resourcefulness, Imagination, Dream, Originality…

Design, Plan, Arrangement, Layout, Proposal, Project, Scheme, Map, Proposition, Blueprint, Strategy, Formula, Method, Contrivance, Game Plan……

Management of the design process in the workshop begins with the realisation that design is not invention. The general population are statistically not inventors and to expect students to be able to do what so few of the population are truly capable of is false investment of time and energy. Specific research exists in this field and it has been clearly delineated that creativity is not something that can be taught in three seventy minute sessions at high school.

Design however is a much more tangible endeavour. The process of teaching design is to teach students how to approach given situations and then subsequently set a plan in motion that will articulate in a made product. The design process is often depicted in many forms, many of them linear. The words used to describe steps in the design process are sometimes interchanged to reflect the author or user group but their intention remains the same. The model I prefer to use can be likened to a spoked wheel with evaluation at the hub. This I believe is more attuned with the way that we constantly evaluate and reevaluate throughout the planning process and not as some judgement made at the conclusion of production.

The number of steps in the design cycle is also unimportant for the purpose of adopting a process. Each word describes a signpost that highlights what is considered a critical aspect of the particular design process and this collection of signposts can be changed for each design. Aspects of assessment or their importance in formulating a worthwhile response to the design task at hand will determine their selection. The journey of discovery that the students embark on should be natural for the desired outcome to be achieved. Scaffolding is provided for the students in the way of structure or technique with the purpose of developing or refining skills in the process. Ultimately teachers should be looking at a five-year plan for the roll out of skills so that the depth and the complexity of the design process can reach a culmination in the students' senior year of study.

Traditionally industrial design and technology teachers have been biased towards skill development and projects have been selected on the basis of curriculum benchmarks, availability of tools (class set of 24), skills of the teacher and often on the availability of a drawn solution to the project. Some teachers would make attempts to modernise the curriculum by introducing

projects that the students might find more useful. Often these duplicated the age old skills but sometimes the project would explore new materials such as PVC or acrylic. Little effort was made to reflect the trends in industry and inevitably the justification for expending huge amounts of taxpayer dollars on industrial design centres began to be questioned. The scope of materials and processes that now exist in industry and the skills required to work in the different media are outside the scope of classroom activities. Yet for teachers it is still the mantle to provide a useful general education that will provide students with skills for their future careers. Industry have detailed the skills that they see as important (key competencies) and it is incumbent on us to provide curriculum offerings that support these directions (remember that teachers are public servants).

The advent of the Technology curriculum, the KLA's, subject specific syllabuses and New Basics has for many teachers of industrial design and the classroom environments that they teach in, left them under prepared for the adoption of the new curriculum. While, some staff have made forays and transitional changes into these new curriculums over the past twelve or more years, many more have not. The staff that have tried have success stories to share but these only arrived after many more failures as they experimented with approaches to the new curriculum. The staff and schools that have not done the preparation are going to find that the catalyst for change is going to require them to respond far faster than they can manage. The purpose of this paper is to provide management advice that has been gleaned from experimentation in Queensland schools from the perspective of both a manager and a teacher.

Skill Development vs Design

How critical is it that every student can produce a textbook perfect long and short shouldered haunched and wedged stopped mortise and tenon joint or achieve a filed and scraped edge tolerance of 85% contact with a surface plate? Many would argue that this is what students should be doing and that skills are important. The question is to whom? There is no argument that skill development and instruction when using potentially dangerous equipment is part of the "duty of care" of the industrial design teacher. Which skills and to what depth is really the ongoing issue. The question begs; what use is a highly skilled employee if they have to be told what to do at every juncture? Industry has recognised and dictated that the skills required of students exiting their general education are different and that thinking and problem solving skills are more beneficial to the wealth of the nation than any given set of specific hand skills.

The ability to plan a response to a situation and have the necessary where with all to achieve a level of manufactured quality for the potential market is important. How the quality and manufacturing process are determined is based on price per unit and size of the market for the product. An Architect must have knowledge of building and construction techniques to enable designs to be built, so too do the students of industrial technology and design. The Architect must also have the ability to draw to differing levels of quality determined by the client, size of the project and stage of the design development. Their skill is learnt over many years of university study and more specifically through years of dedicated practice.

The scope of skills required in specific trades and for the range of different processing techniques has become vast. So vast, that it would be absurd to believe that an industrial technology and design teacher could provide students with the skills that might be of any significance to any of the occupations they may pursue. The students will develop the skills through concentrated and dedicated practice upon entering that field of employment. However we can impart the concept of planning, sequencing and quality that are critical to all fields.

Measuring, marking out, separation, joining, finishing, conditioning are now the considerations we need to develop and while we may use timber and a tenon saw as the vehicle the outcome is the ability to mark out accurately, cut on the waste side and cut square and true to the line. Using a coping saw, a hacksaw, a drop saw, a mitre saw or any other cutting device available could as easily demonstrate this skill. The student should be made aware of the range of cutting devices and their uses and accuracy and through their design realisations make the correct selection and produce the required accuracy when making cuts.

The Classroom

Management of the learning environment is as important in the planning of design based courses as the content of the curriculum. The greatest dilemma is the change from teacher directed to student directed learning and the mythical transition of the teacher being the master of all they convey to one of becoming blasé about all that happens in the workshop. The slide from an authoritarian figurehead to permissive apathy is a common error made by teachers when they hear the term student centred learning and results in classroom disaster and lack of student and teacher success. The teacher needs to maintain a supervising presence in the class that allows students the scope to explore individual designs but maintains quality control of the product. Skill development should be factored into the course at such a level that it provides for the quality of product but doesn't crowd the curriculum.

Skill development is better delivered in small discrete blocks and is better if not associated with a tangible project. The primary focus is to provide knowledge, understanding and development of the skill so that it can be applied in other contexts. Making projects has traditionally taken the students attention away from the skill and focused it on what they are making. The result can be seen in practical exams where students are asked to repeat a skill they have performed numerous times and yet are predominantly unable to emulate the skill without the step by step instruction.

The upper year levels may need to have skills integrated into projects but these should be short lived and always focus on the skill being developed and not the project. A lot of material testing and integrated theory about tools, systems and processes can be explored at this time. The key to the successful management of the learning environment for these activities is the word "explored" and presenting content only as theory is a mistake made by many a teacher. Make the curriculum engaging and enjoyable for both the staff and the students and the subject will not be a chore.

Preparation of activities through a variety of instruction sets (video, workbooks, wall charts, work cards, checkpoints, signposts) allows the classroom to become multi-tasking. It is impracticable to have a teacher instruct ten different groups each lesson. Through the careful introduction of initial instruction the class can be provided with starting points for all activities and set to task. The teacher then moves from activity to activity ensuring that the impetus is maintained by providing timely redirection.

Having resources available to the students in the classroom is a substantial part of the management process for the classroom.

Consumables

Possibly the greatest concern to teachers is how to provide materials for a design-based environment. This requires planning at ordering time and should be built on over a number of years. Firstly and most easily accomplished is a greater range of hardware. No longer will you need 10 packets of 11/4" x 8g countersunk wood screws but you may need 1 pkt of each of the range 3/8" to 2" wood screws in pan and countersunk head styles. Working through likely design needs you may also expand your supplies to include a range of springs, o-rings, split pins, strings, ropes, tube, grommets and hinges. The storage of these is best achieved by purchasing a compartmentalised carryall for each staff or a trolley for the room. Minimal stock over a greater range of items has to be carried in each room and excess requirements are able to be sought before students use them.

The problem of materials (timber, metal, plastic, leather, manufactured board) their access and storage in a workshop has always presented a dilemma. How can staff be supervising a class if they are running off to prepare materials for the individual needs of students? This can be resolved by employing a number of strategies. The most obvious and least supportive of student centred learning is to predefine the material used for each project. This is okay for skill development tasks and for closed design activities but should not be used as the dominant constraint. Another method is to cut a range of materials to the same size and allow students to choose their material. This predisposes a particular response to the task and is not conducive to "out of the box" ideation.

Ideally free access to the range of materials in your store would allow for open slather design. Reality is that students do not always look for the most cost effective way to get their material and will often cut a new length when a shorter piece is available. Here arises the problem of the roll of wire with fifty ends because students simply cut from where they want. If student design tasks are designed appropriately for the expertise and time available and this is analysed it should be seen that the majority of projects will never go over a certain size range. It has been found that material can be prepared to a length appropriate for end on storage in a classroom cupboard and that this will accommodate most students. Timber can be ordered in lengths equal to the depth of the cupboard and stored in cross sectional sizes. Steel and plastic rod, tube and bar can be docked to the same length. Sheet materials can be docked to length and ripped to a range of widths (25, 50, 75, 100, 150, 200, 300). In the room boxes for the storage of shorter offcuts will need to be made and stored. Under the cupboards or benches with wheels and rope handles works well. Labeling the boxes with sections sizes or material names will divide the material.

Managing the material requires all teaching staff to use the same approach. Students are directed to search the offcut boxes for appropriate material. If no suitable material exists in the boxes they seek partners among the students to use a full length out of the cupboard. They then approach the teacher who gives them permission to access the cupboard. In cases where no partner is available the waste material is placed in the appropriate box. This system will cater for the majority of student needs, in the rare situation where a larger piece is needed it can be organised outside of class time by the teacher.

Projects

Projects should be simplified to make them manageable within the classroom and within the scope of skill development. Where a coffee table was made under direct instruction techniques, the task may now have to limit the design to a coffee mug tree. Why? The scope of a student's experience has to be drawn on and to plan a project and have the necessary skills to identify sequence, processes, quality of production and safe working habits to produce a project as complex as a coffee table is too broad. Ultimately we want to develop in the student the skills to be able to respond to any given task but the skills to investigate, plan and judge are considered to be critical during the early stage of development. If students cannot perform the skill they can certainly access someone who can and this reflects much of what we see in industry today. Typically due to the large expense of production tooling, many designers and manufacturers sublet aspects of their design to specialist production outlets.

Costing

Costing design activities is always a tough one and over time you will note that the students tend to use similar amounts of material due to the nature of the design tasks. If you consider the range of makes and models of a family car and their size you would determine that although the designers of these vehicles come up with different responses to the brief, the basic material quantities remain the same. It is recommended the user cost is formulated on the average price and that through give and take over a number of projects individual costs will balance out. To ensure that the Industrial Design Department remains solvent erring on the side of extravagance should be an objective of the first couple of budgets.

Students can of course be charged for direct use but few departments can absorb the initial outlay for purchase of stock without parent contribution. Students can be charged for surplus materials used. This is often done with senior technology studies classes but creates a cash collection issue. Students could bring extra materials in for themselves. This works well for the motivated student but often creates behaviour management problems for those students who are disorganised.

A credit card system could also be introduced particularly in schools where swipe card technology exists for student ID's. Parents contribute an amount for the setup of the card and as students use materials it is deducted. When the students run out of credit the parents are given the opportunity of topping up. This can be done with manual or electronic methods. A downside to this technique is the administrative burden created for the teacher or office personnel.

Tools and Equipment

The expansion of the curriculum to include opportunities for the students to plan activities should not be limited by the traditional material specific workshop. The students should be able to use the best and most appropriate tool for the task and consider their work as prototypes based on hand and machine tool construction. These techniques would normally differ when manufactured through faster more accurate processes for production.

There are two aspects to consider when modifying workshop environments. The transition period while a course works its way through the year levels will make the movement of tools between workshops a necessity and secondly, the subsequent mixed or combination workshops that exist after transition is complete. The subjects of Shop A and B are usually designed to cater for a sole task being performed in unison by the class subsequently requiring 24 sets of tooling and requires at least one of each type of workshop to remain established while the course runs in the school. This will obviously be influenced by the school population and workshop facilities available. Management of this transition process may mean making some tools portable or establishing class passes where students move to the necessary area to complete the task.

The ultimate workshop has unlimited access to tools for all materials and processes and their exists no management considerations. Twenty-four drill presses, twenty-four wood lathes…… Reality is that buying multiple tools and machines is expensive and totally unnecessary. Having a single scriber and tenon saw doesn't work either. There exists a state of compromise between the sublime and ridiculous that allows for prudent expenditure of funds while carrying a range of tools in such quantity that a class can be actively engaged in learning while in the workshop. The design of the projects and the number of student tasks being conducted in the classroom simultaneously influence the determination of quantity. Classroom management skills may need to be analysed and adjusted to cater for fewer tools to perform a single task. Even during skill development tasks this will be an issue and appropriate management will mean multi-tasking is inevitable in the successful workshop environment.

As a general guide you only need 24 steel rules, 12 each of tenon saw, hacksaw and coping saw, 8 marking out and measuring tools, 4-6 of the range of percussion and punching tools and fewer of the tools that you currently have racked and rarely use. At schools where successful transition has taken place the purchase of new tooling is minimal and usually limited to coping saws. Machines can be moved and rewired and so can the benches. Buffing machines are probably the critical item for addition. Mobile injection moulders and centralised storage of portable power tools and clamps works very well particularly if racked well and all the staff manage student access.

Assessment

Assessment techniques and the strategies used to map the student outcomes are primarily determined by the system being used (outcomes, criteria, competencies) whichever system is used the students should be assessed against their ability to satisfy benchmarks. The evidence is collected through observing student classroom practice, the content of their design folios, the product and any public presentation of their work. Groups and individuals alike should be assessed using the same strategies. Self and peer assessment is very useful particularly for group work.

Holistic assessment is typically the best method to adopt and is achieved by determining the outcomes a student will satisfy by completing aspects of the task. If the task is completed to the level expected it would be determined that the student has demonstrated all of the characteristics that map to that level. Classroom observation logs can be used for the collection of anecdotal data related to safe working habits and industry. These can be used when moving around the class and if designed well need not be onerous for the teacher.

Student skill level will predominantly be determined by the outcomes of their design tasks. Practical assessment tests although redundant can still be used as a useful measure of skill but may also be used to assess aspects of design. Theory tests are still a crucial method of assessing a students learnt knowledge and can be used as entry and exit tasks associated with class activities which in a multi-tasking environment is probably the best approach. Tests could now be structured in easily identified sets associated with topics such as tools, materials, design, safety, processes and systems so that the assessment can be focused and determination of student assessment of particular outcomes can be made and justified.

New Technology

Sintered ceramics and metals, composite materials, biodegradable polymers and spider web silk technology are just a few of the material fields that are emerging and schools are unlikely to be able to provide resources for their use. Stereolithography, laser cutting, pressure casting, and CNC routing are processes due to safety and cost that schools are typically not going to be able to provide access to. The issue with existing curriculum is that we have been insular in the delivery of content to that which we can provide within the structure of the school environment. This was okay when technology in society was not much further advanced but it is detrimental to our students if we continue to do the same in light of the technologies that currently exist. While students may not use the process or materials the knowledge of their existence and determination of the best method or material for a design is considered to be appropriate. Some schools or individuals may be able to access the technology through local area networks or parents and friends.

Professional Development

Teachers should be engaged in lifelong learning and be looking for currency in their knowledge and understanding of industrial processes and materials. Inservice opportunities should be provided when staff are required to teach processes that are outside of the scope of exposure over the course of their career. Staff need to be independent in gaining new knowledge and this begins with professional reading and research. Staff could quite reasonably be expected to self educate about a new material and its properties but are unlikely to be able to teach pneumatics without some appropriate training. In-house training is great if expertise exists on staff to do so, local interest groups might play a part, accessing funds through various projects may assist but this does not always mean that there is a provider available. Experts from industry cost a lot of money and may not be able to guide you in the best way of teaching the content so expending the money needs to have tangible improvements as an end product.

As a rule of thumb curriculum should be set to the skills currently held by staff and modified as staff expertise is developed. That is not to say that you wait until staff have mastery because to do so is to deny students opportunities which they themselves can take further than the teacher is prepared to take them.