

OBSERVATIONS ON STUDENT DESIGN STRATEGIES IN THE CONTEXT OF A COLLABORATIVE TIMBER DESIGN WORKSHOP

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ABSTRACT

Group design projects are ubiquitous in design courses, and the pedagogical benefits of cooperative learning are well established. The workshop entitled '*Geometric deformation of wood*' hosted by Southeast University, Nanjing, provided an unusual setting to observe and reflect on specific aspects of collaborative learning and its influence on design strategies. Of particular interest was the hands-on format of the timber behaviour workshop, the level of education of the engineering and architectural technology students (all post-graduate) in addition to the cross-cultural mix of the individual groups, with students from Denmark, the Netherlands in addition to students from the host institution. The brief was open and the defined outcome was limited to a presentation and discussion. This paper reflects on the various design strategies adopted by the students, examined through the lens of the chosen design methods and the author's observations on the organisation of each group. The reflections are informed by conversations with and observations of the students, the content of their final presentations and photographs. The groups observed varied greatly in their use of convergent and divergent strategies and included a range of design methods including brainstorming, analogy, speculative testing of materials, precedents, form-finding, analysing and prototyping. It was observed that groups who coalesced around concepts early on developed clear outcomes and convergent strategies within the limited time frame, although the authors would suggest, not necessarily high levels of collaboration. The authors also suggest that aspects of the workshop which contributed to the richness of design outcomes included the range of design tools and methods known to the students, the high levels of woodworking skill and the immersive environment.

Keywords: Design strategies, open ended design, collaborative learning, cross-cultural design

1 INTRODUCTION

Open ended design problems present specific challenges for students. This is particularly the case for those who have had a highly structured education, based on the staged acquisition of knowledge, which is typical of, for example, engineering. Without clearly defined favourable outcomes, which in turn imply a linear and converging design process, design strategies need to be evolved. Collaborative learning, through groupwork, is often cited as a fruitful environment for students to construct such strategies [1]. The workshop entitled '*Geometric deformation of wood- a hands on workshop*' hosted by Southeast University in Nanjing, China, provided an excellent opportunity to observe and reflect on how students achieve this in a hands-on workshop environment with limited external guidance.

The workshop, which took place between 6th and 15th November 2025, was cross-cultural and included the participation of masters and PhD level engineering and architectural technology students from Denmark, the Netherlands, in addition to students from the host institution, working in culturally mixed, self-selected groups with limited input from the tutors of the various institutions. Students were required to develop design ideas informed by the structural behaviour of timber by drawing, making, testing and analysing with no specific assessment other than a presentation and discussion at the end. The workshop could be characterised as 'material driven design' with the goal of bridging the 'experiential quality of materials...to their technical properties' [2]. Given that the students were post graduate level, it was implicitly assumed that they had the skills and experience to develop their own design strategies with limited direction from the tutors. The students had access to a timber workshop as well as adjacent break

out meeting spaces, including a café which were used extensively. This paper reflects on the outcomes of the various learning strategies adopted by the 29 students in 6 groups, in response to the workshop framework, based on conversations with the students, student observation, student presentations and extensive photographs. The strategies observed ranged greatly in level of structure and included selecting a range of design methods including brainstorming with sketches, undertaking speculative tests of the various timber and bamboo source materials (by bending/steaming/saturating/scoring/cutting/loading/lacing etc), looking for precedents (already known and searched for), digital parametric models, form-finding, analysing and prototyping.

2 LITERATURE REVIEW

2.1 Cooperative learning

Cooperative learning is an established pedagogical approach with the potential to promote positive outcomes [3]. Of particular interest in the development of design ideas are the observed outcomes including students' ability to 'influence other's efforts to achieve goals,' 'provide groupmates with feedback,' 'challenge other's reasoning and conclusions' and 'take the perspectives of others more accurately' [3,4]. The group dynamic aligns closely with industrial design practice as it is identified that whilst ideas come from individuals, 'concept selection and enhancement is best performed in groups' [5,6]. Cooperative learning promotes tacit learning and accessible language, aspects appropriate for an inter-cultural workshop [7]. It also provides a suitable framework for design processes based on material investigations which promote hands-on activities including 'tinkering' [8]. Cooperative investigations have been identified as a suitable format for students to hone their leadership skills, particularly where the model is to promote 'authentic leadership, mentorship, collaboration and personal growth' [7].

2.2 Design strategies with convergent and divergent elements

Design strategies can generally be defined in terms of the balance between deliberate divergent and convergent design activities, in the development of a design [2,5,6]. This characterisation of the design process maps closely to neurological evidence suggesting that creative thinking is characterised by continual shifts between convergent and divergent thought processes [9]. Design strategies in engineering have evolved from strongly defined convergent processes, to incorporating design tools which foster divergent thinking [10]. The success of a range of tools and activities to encourage divergent thinking include brainstorming, 'tinkering' with materials, morphological analysis, using function trees, tools incorporating deliberate search for analogy, sketching and study of precedent have been demonstrated [11]. It is also recognised that groups with a strong range of skills and strong domain knowledge, which they can access with ease, can assist divergent design processes as does deliberate prompts to 'think out of the box' with reward for quality rather than quantity of ideas [12].

2.3 Design environment and intercultural setting

Practical aspects of the quality of the working environment including the space, equipment and facilities available can impact the design process [5]. Equally the more abstract aspects of the environment including the organisational culture within which the design is taking place can influence creativity and innovation [13]. The authors are not aware of any comprehensive models which map how receptive different world cultures are to cooperative learning. However, evidence suggests that most students across cultures are open to such learning techniques with the pedagogical basis of their schooling, a key influence. Furthermore, with increasing if sporadic information and cultural convergence the situation is evolving [14,15].

3 METHODOLOGIES

This paper examines the various design strategies adopted by the individual groups in response to the workshop framework. The specific design methods chosen by the groups, which form part of their design strategies, have been identified by the authors from conversations with the students, student observation, student presentations and extensive photographs taken by the authors and other participants in the workshop. To structure the discussion of the paper, design methods used are identified and categorised regarding their purpose as problem research or '*discover methods*', problem definition and direction '*define methods*' and design solution generation and assessment '*develop methods*' following the framework defined in 'The Delft Design Guide' although it is recognised that many design methods cross these boundaries. Also, some methods noted do not appear in the guide itself so are categorised

based on the judgement of the authors [2]. This guide is referred to for the range of design tools presented. It is noted that this publication has its origins in an industrial design school although the target audience includes the wider design community. The authors acknowledge that following further discussion with the students more design methods might emerge, and that the categorisations are subject to interpretation. Reflections by the authors on the mode of organisation of each group is based on observations of, and interaction with, each group and can be seen as subjective. The identification of the six groups as A-F is for the purpose of differentiation in this paper.

Discover Methods Problem search	Exploring form Exploring material Design drawings to discover Sourcing precedent
Define Methods Problem definition and direction	Categorise and test samples Design drawings to define Concept model
Develop methods Design solution generation and assessment	Brainstorming/writing/drawing Form finding Analogies and medium transfer Paper (form) mock ups Analysis Modelling (A+D).virtual prototyping Design by drawing to develop Testing models Verificaiton Recording

Figure 1. Design Methods Observed

4 OBSERVATIONS AND DISCUSSION

4.1 Design strategies and chosen design methods

Although there was clearly common knowledge of design processes, skill sets and tools, across the groups, it was interesting that the overall strategies of the groups were quite distinct. Group D settled early on with the objective of exploring a pre-existing designed form by substituting the original material for timber, following a clearly defined convergent process. Group E developed a set of behavioural rules or ‘syntax’ for combining thin timber elements with an array of strand tension elements, systematically examining the form and structural possibilities. Group F had a multiplicity of directions, including one particularly interesting exploration of origami and kirigami shapes using thin timber veneer elements, formed with curved and hinged edges. By contrast, Group A followed a clearly defined convergent structural form finding approach shaping a lattice using loads and steam to modify properties in real time.

The design methods chosen by the various groups provide a useful point of reference to examine their design strategies. Some methods were used by many groups and others were unique to a particular group. The authors found that the range was surprisingly rich (see Figures 1 and 2).

‘Discover methods’ which were used by several groups included exploring materials in the workshop and sourcing precedents (C, D and F), prompted perhaps by precedents being used heavily in the introductory lecture. Drawings to discover and exploration of form were identified only in the work of group F.

The range of ‘define methods’ used was more restricted. Groups A and C systematically categorised and tested the various timber and bamboo materials supplied and specific concepts defined by drawing and modelling were evident in groups A, B, E and F. There was little evidence of systematic problem definition as part of ‘define methods,’ to develop a framework to assess ideas, which is perhaps understandable given the open-ended nature of the workshop.

By contrast, there were a wide range of ‘develop methods’ observed across the teams in the latter stages of the workshop. These included brainstorming (in reality a direction selection approach), digital form finding, medium transfer, paper mock-ups, 3D CAD and layout drawing, analysis of both analogue and

digital models (virtual prototyping); developing design by drawing, particularly at a detail level; testing, verification and recording of model behaviour under load.

It was observed that groups tended to either undertake open ended domain research using '*discover methods*' (groups C, D and F) or rapidly progressed to a process of problem refinement using '*define methods*,' leading to a concept design, (groups A, B and E). This was followed in all cases by extensive use of a variety of '*develop methods*,' with the exception of group F.

There were both divergent and convergent outcomes at the end of the workshop, with convergent outcomes tending to correspond to groups which had used '*define methods*.' Groups A and B could be categorised in this way. Group D is an important exception to this observation, as a highly convergent process was established without any recognisable '*define methods*' being used. The group recognised a good idea and followed it. Some groups had identifiable divergent stages, prompted by deliberately choosing design methods which promoted divergence, most notable brainstorming. For example, group E returned to search for possible forms based on the syntax they had established early on. In groups C and F, which did not have a convergent process, it is difficult to identify deliberate attempts at divergence.

4.2 Design strategies and group organisation

As cooperative learning is seen as a forum for the development of authentic leadership, it was interesting to observe that group organisation played a role in the direction of various groups [7]. Some teams seemed to operate with less obvious design and organisational leadership. By contrast groups A and B appeared to have emergent leaders. These groups coalesced around a single idea and adopted highly structured convergent strategies. They developed specific outcomes within the limited time frame and had specific measurable outcomes. In both cases the emergent leader promoted a concept around which the design process was organised, so there was a close alignment between the emergent leader, the originator of the idea (assumed to be the same or at least an early champion), the choice of design methods and as a consequence the design strategy [6].

It is interesting to compare groups A and B to D with regard to group organisation. The members of group D also coalesced around a single idea early on which resulted in the choice of specific design tools being used as part of a highly convergent strategy. But in contrast to groups A and B, although group D had a clear originator of the idea, there was no clearly identifiable leader. Group D consciously presented themselves as collaborative, (including mentioning their group badminton session in their presentation), but perhaps, despite outward appearances didn't have a substantially different design process to groups A and B.

Group E provides an interesting contrast to D, as a group which also operated on a collaborative basis. Group E had a clearly defined design strategy based on a process rather than a specific physical outcome, which involved exploring a design space or syntax where bent timber pieces and tensioned strands were combined to form a family of structural variations. Common understanding within the group defined a design process with convergent and divergent stages where interaction between group members created possibilities. Importantly, the individuals of this group, although of various nationalities, came from the same institution. Perhaps this reflects that authentic collaboration, which has recognisable impact on design strategies needs to be nurtured over time and is difficult to foster in a short workshop.

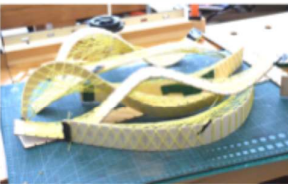
Group	No. Students	No. Nationalities	Main concept/approach	Methods Observed	Image of Project
A	6	2	Physical form finding of a timber gridshell by modifying properties under load.	Define Methods: categorising and testing samples, design by drawing to define. Develop Methods: brainstorming, digital form finding, analysis modelling, design by drawing to detail, testing model, verification, recording.	
B	5	1	Wave profile bracing formed by steaming timber.	Define Methods: drawing to define (concept), concept model. Develop Methods: drawing to detail, testing model, verification.	
C	4	2	Developing meshed forms from steamed and cut bamboo sections.	Discover Methods: exploring material, sourcing precedent. Define Methods: Categorise and test samples.	
D	4	2	Exploring a previously defined kirigami form in timber.	Discover methods: exploring material, sourcing precedents. Develop methods: brainstorming, medium transfer, mock ups, analysis modelling, testing model.	
E	3	3	Developing a 'syntax' for combining bent timber pieces with tensioned strands.	Define methods: concept model. Develop methods: brainstorming, physical form finding, analysis modelling, model testing.	
F	5	3	Folding and bending timber sections and veneers following origami patterns.	Discover methods: exploring form, exploring material, drawings to discover, precedent. Define methods: drawings to define. Develop methods: medium transfer, paper mock ups, drawings to detail, model testing.	

Figure 2. Group outputs

4.3 Reflections on the cultural and physical environment

With the exception of group B, the groups had students from at least two of the institutions or countries of origin. It was observed that the individuals generally worked professionally together. It was not possible to discern differences in how the designs were developed between the groups based on cultural backgrounds or discipline, when considering what types of design methods or strategies were used in each of the groups. It is noted that participation was voluntary, so students chose to take part in this open-ended workshop. The authors feel that this perhaps resulted in a degree of self-selection by the students at each institution, resulting in a cohort with a high degree of common purpose and eagerness to work together and overcome cultural differences. To explore this issue interviews with the individual students might have yielded more inciteful and revealing findings.

The students clearly took advantage of the range of spaces to find a suitable working environment. They were given access to a traditional classroom with rows of seating 10 minutes' walk from the workshop, in addition to a café close to the workshop and a small table just outside the workshop. The groups used

all the facilities, with the exception of the more remote traditionally laid out classroom. The workshop was very heavily used, as was the café.

All the groups did something unique. Perhaps this was due to the particularly rich knowledge of 'develop methods,' in making, analysing, and drawing which the various institutions and backgrounds brought together but there seemed to be something else at work. Bringing together students with excellent making skills, provided a common forum and language to communicate and mix ideas in the context of an open-ended explorative workshop which crossed global cultural boundaries. Equally the working environment, (the combination of a well-lit, organised and equipped timber workshop with congenial spill out spaces within a leafy campus university) set the scene for a culture of engagement, thoughtfulness and enjoyment of design. Perhaps a celebration.

5 CONCLUSIONS

The opportunity to observe significant numbers of post-graduate level students of engineering and architectural technology from Europe, studying in Europe, interacting with their peers in China, on site in China, in an open-ended workshop, based on materials, provided an unusual opportunity to study collaborative learning and its influence on design strategies. The importance of common skills and knowledge of design methods, particularly those involving making or 'tinkering' with material were observed to provide a language to supplement verbal communication and strengthen the design process. More fundamentally the authors would argue that bringing together a diverse group of students with a depth of design process knowledge and high degree of model building skill, in an enabling environment, ensured thought provoking and unpredictable design outcomes but perhaps also demonstrating that collaborative working benefits from more sustained periods of interaction and short term workshops favour convergent strategies.

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