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SIMULATING DESIGN FOR PRODUCTION: THE UNIVERSITY OF BOTSWANA EXPERIENCE

S.M. Khumomotse and M.K M'Rithaa

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1. Introduction

Design for Production is a core course at fourth year of the Bachelor of Education (Design & Technology) programme. The inclusion of this industry related course within a Design and Technology (D&T) Education programme was to enable aspiring teachers and design professionals gain an understanding of how *Design for Production* takes place within the real world. Although the programme's prime aim is to produce D&T educators, it is also structured to equip graduates with real life design skills that will enable them to function effectively and efficiently should they choose to move into design practice.

The question that comes to one's mind might be how *Design for Production* could be taught in such a way that it would give students a real life experience. *Design for Production* in industry is driven by competition to satisfy the market. The desire to outdo competitors becomes one of the driving forces behind innovative ideas. The concept of concurrent product development is indispensable in developing brilliant designs. For the design to be manufacturable there must be integration between design and manufacturing during the development of a product (Ettlie, 1990).

This paper discusses how two hypothetical student *companies* developed a product for a client for mass production. It also highlights the effect of fusing the concept of competitive tendering into the project to accelerate learning. It relates the learner's understanding of *Design for Production* at the point in time when the project was launched, and their familiarity with the concept halfway through the duration of the project. Lessons learned from the project at this stage are brought to the reader's attention. In a nutshell the paper shows that simulation of a real life situation coupled with competitive tendering is a potent teaching method for imparting skills, knowledge and attitudes within a short space of time.

2. Project Goals

The goals of the project were to:

- fascilitate learning of *Design for Production* through simulated experience
- facilitate the application of knowledge, skills, values and attitudes in D&T practice

2.1 Project Objectives

The objectives of the project were to:

- introduce students to the dynamics of professional practice in Design and Technology
- compliment the government of Botswana in its efforts to diversify the economy through industrialization as stated in its *Vision 2016* long term goals and objectives.

3. Various Teaching Scenarios

There are various methods which could be adopted in teaching *Design for Production* to ensure that these are beneficial to learners. These however, have limitations that render them unsuitable to bring about desired results. First, guest lectures can be delivered by practicing designers who could also interact with learners. The trouble with this approach is that learners would only acquire theoretical knowledge but not the skills, values and attitudes inherent in design. Further, design practice is not well developed yet in our country. Industrial attachment comes as the next option but there is no guarantee that students would be involved in design for production during such a period. In addition there are no product design firms presently in existence in Botswana, and as a result, learners would be forced to go to companies which have little or no design activities. Another option could include segmented assignments in class. The trouble with this approach is that in real industry design is not performed by one person but by a group of people. This also rules out a self-initiated project option as it lacks both the teamwork and competitiveness dimensions of the real life design.

4. Simulation in Design

Before undertaking the project various forms of simulation were considered. It is plausible at this juncture to define simulation before looking at its various forms. Denton (1994:17) states that *"Simulations as used in training, is a dynamic representation of a system, process or task"*. The same author reiterates that the core of simulation is *'a model (representation)'*. Whereas a model could be discrete and tangible, if a similar model is used to teach people how a system works by allowing them to work directly with it, it becomes simulation (Denton, 1994). Although industrial simulation is difficult to run in academic settings because teachers sometimes have little economic and industrial awareness, the same has been found to be an excellent local solution (Solomon, 1994).

5. Various Simulation Scenarios

Although simulation of the real life situation seems to be the most ideal method, a variety of possible approaches have been explored and both their merits and demerits considered. Each method was judged on the following criteria:

- ability to give learners a real life experience
- appropriateness within the time available
- level of control of dynamics of the project
- ability to motivate students to work hard
- ability to create an innovation environment

5.1 Scenario One

There was a possibility for the whole class to compete with an existing company (locally or abroad) in developing a real life product. Whereas this approach would have given students the feel of designing for industry the hitch however is that a lot of logistics would have had to be put in place. The playing field would not be level between the competitors as some are still learning how to design while others have mastered the practice of product design. At the same time profit oriented companies would see this kind of exercise as a waste of time.

5.2 Scenario Two

The second option was to look for a problem that could be solved through design intervention in local companies then create a suitable solution for production within real life constraints. Students could play roles that are commensurate with multi-disciplinary and cross-functional product development teams. While one cannot ignore the fact that this method would be more realistic, the problem is that the time frame might be a problem and control of factors could become impossible. Given that the two foregoing scenarios did not fulfil the criteria already mentioned, we now move into the approach which was adopted for the project.

5.3 Scenario Three

A class of fifteen was divided into two groups with one student and two members of staff playing the role of a client company. The two *companies* were modeled up like design consultancies with manufacturing capabilities. The two groups simulated design in the real world with different members playing different roles including; designer manager, industrial designer, production engineer, electronics engineer, human factors specialist, graphic designer, and legal and standards advisor. The lecturers handling this project played the role of facilitators in the learning process by giving lectures and advising the two *companies*. Various professionals were invited to lecture the students on various topics that were scheduled by the project coordinators as a way of accelerating the learning process.

Students were asked to design and produce an electronic device that would warn members of households that rain was about to fall on their clothes hanging in the line outdoors. In addition a product production system within the design brief constraints had to be designed and made. The product package had to be designed and produced by the team. The product was required to reflect sound consideration of human factors, be environmentally friendly, visually appealing, durable, and affordable. The finished product must be manufacturable in a rural/peri-urban small-scale industry whose employees are mostly unskilled and semi-skilled. It should be technically sound and reflect a deep understanding of contemporary issues in product design. In-depth knowledge of production systems, techniques and methods should be evident in the final outcome.

The prospective company had to prove itself capable of the task given by the client thereby, giving the project a competitive tendering dimension. The two groups developed their own corporate identity, organisational structure and functional units and company name, decoded the design brief from the client who also provided the market information. In summary each company had to adhere to the following checklist:

- design and produce the artifact
- produce the production system and manufacturing plan
- design and produce the product package
- produce a group folio and prepare a tender document

The above also constituted assessable work with the sub-total for group submission being 75% while individual input constituted 25%, adding up to 100%. Concerning individual submission, team members were required at the end of the project to submit an essay not exceeding 2000 words on *Design for Production* with special reference to the functional role one played in the project.

6. The Research Method

At the beginning of the project a questionnaire pertaining to design for production was distributed to design students. The same instrument, with slight modifications, was issued midway through the project to measure the amount of learning that had taken place until then. In the first instance twelve out of fifteen students (80%) answered the questionnaires, while in the second instance ten (67%) from the same group responded. The product, production tools, product package designed and produced were to be evaluated to determine the winner of the tender. In addition, a project evaluation instrument is to be administered at the end of the project to check whether the simulation method (consisting of a competitive tendering) has enhanced the understanding of the aforesaid design concept. To date students have only been able to design the product, produce working electronic circuits on breadboard and mock-ups. They are yet to produce the product, jigs and tools, the product package and the manufacturing plan and write a short essay reflecting on the Design for Production process.

7. Results and Discussions

A data collection instrument (distributed at the beginning of the project) sought to find out the familiarity of students with various design for production concepts, strategies, related issues, and their opinion on various relevant issues. The legend is as follows: *NF=Not Familiar*, *SF=Slightly Familiar*, *F=Familiar*, *VF=Very Familiar*, and *MF=Most Familiar.*

7.1 Responses on Familiarity with Design Concepts

There was a significant change in results concerning student's familiarity with various *Design for Production* concepts. Whereas figure 1 is concentrated on *familiar* and *slightly familiar*, figure 2 shows a gradual move towards *most familiar*. Although one would have expected all respondents to be on the *very familiar* side there still few on the extreme negative. This anomaly is caused by the fact that the project is only halfway through and students did not rotate on their roles during the project, making it impossible to grasp all the concepts.

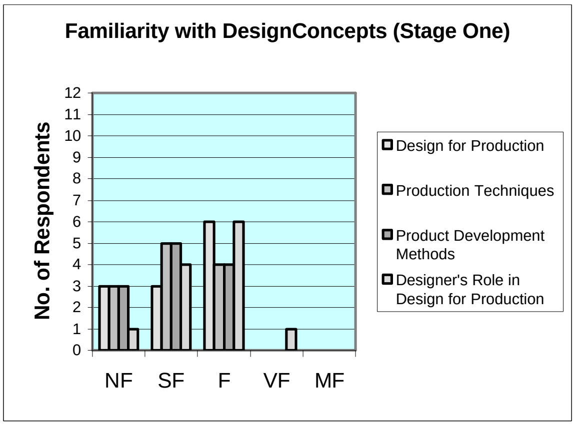

Figure 1.

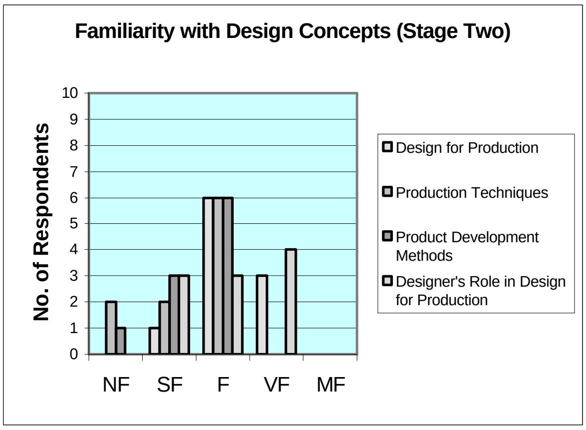

Figure 2.

7.2 Responses on Familiarity with Design for Product Issues

There has been considerable change in students' familiarity with design for production related issues. Figure 3 shows the majority of respondents concentrated on the *slightly familiar* and *not familiar* side while figure 4 shows a gradual move towards *familiar* and *very familiar*.

7.3 Definition of Relevant Terms

At the beginning of the project students could not define *Design for Production*. They were also confusing *product development* with concept refinement, which is usually called 'development of idea' in D&T literature. At the current stage the students were able to correctly define both terms in their own words. In the second instrument students were asked to define the concept of *competitive tendering*. Almost all of them were able to define concisely this process showing that effective learning had taken place.

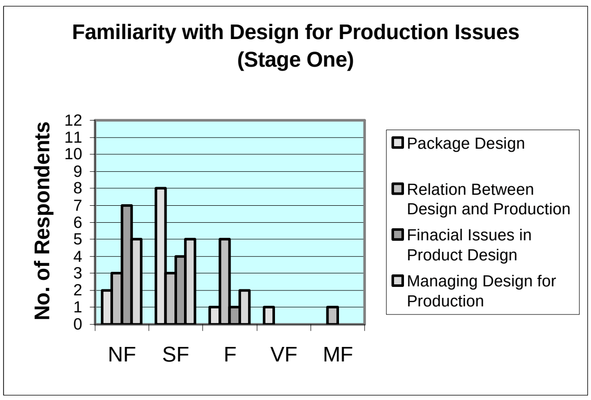

Figure 3.

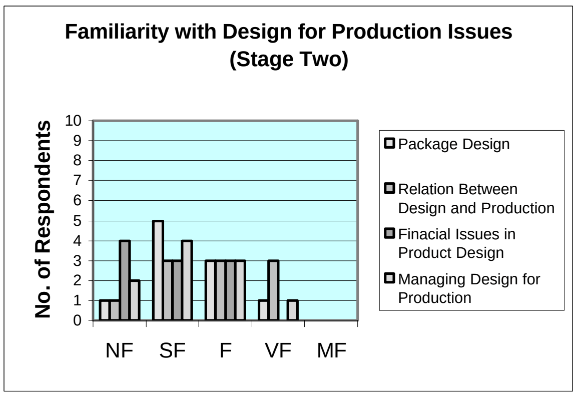

Figure 4.

7.4 Managing the Design for Production Process

When asked whether they were confident to effectively manage the design for production process in their own company, student responses did not vary much at the beginning of the project or halfway through it. It is however interesting to note that the number of respondents who said they could not do a good job if they won the tender reduced significantly indicating a gradual move towards the affirmative as shown in figure 6.

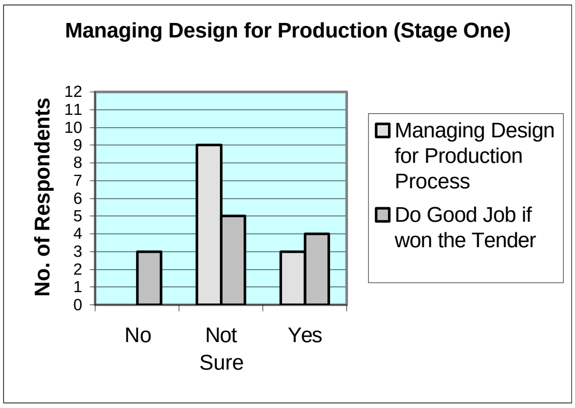

Figure 5.

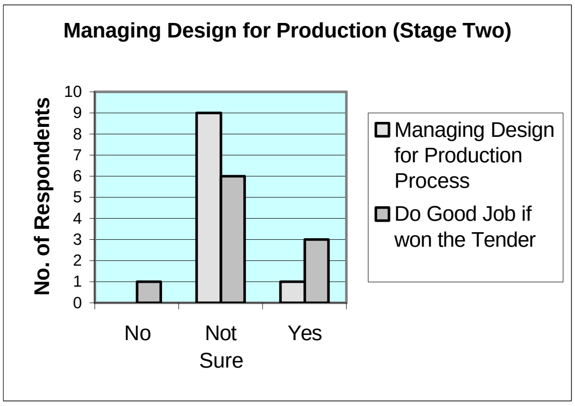

Figure 6.

7.5 Confidence to Practice Design

Students were asked if their current year of study was their last one, whether they had confidence to work as free-lance, in-house and consultant designers. Figure 7 shows the majority of respondents were not sure and had no confidence at all to venture into design practice. There is however, a significant shift from the negative towards the affirmative, though the majority is piled at the *not sure* category as indicated by figure 8. The interesting point is that in both stages no respondent is confident enough to work as a consultant designer.

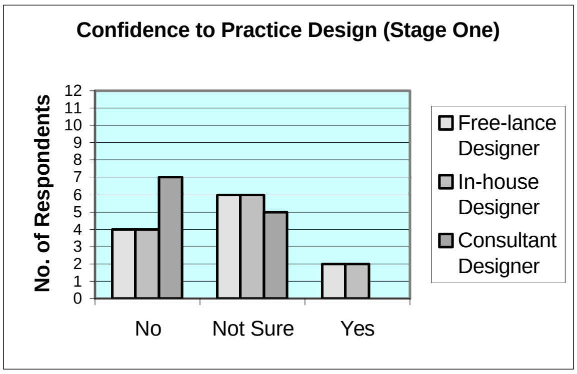

Figure 7.

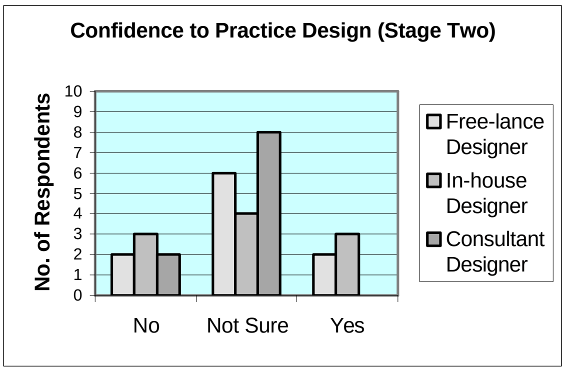

Figure 8.

7.6 Respondents Feelings about the Project

An overwhelming majority of respondents (that is 80%) said they enjoyed the project, while 10% were not sure and the remaining 10% said they did not. Furthermore 90% of respondents felt the way the project was structured gave them a real-life experience, while 10% were not sure. Respondents outlined five major reasons that made the project interesting viz it was challenging, interactive, taught them to communicate, work as a team, and encouraged cross-functionalism. They further pointed out that the project gave them the ability to take responsibility for a specific aspect of the project and yet function as a unit.

8. Lessons Learned and the Way Forward

Respondents felt the time frame was too short to grasp requisite knowledge and experience. The lectures that were given as part of the briefing and debriefing process were in a serial/sequential order, thus consuming a lot of time. In the future the coordinators of the project will have to organize a full day of seminars for the students with different presenters giving lectures on various design for production topics. Furthermore, students reported that playing one role throughout the project inhibited them from getting a wide scope of the concept. They suggested that they be allowed to rotate by way of playing different roles during the project.

9. Conclusion

Botswana and Africa's unique socio-cultural mileu calls for innovative teaching strategies. Simulating design for production within an academic setting has been vindicated by the results as a potent method of imparting knowledge, skills, attitudes and values inherent in design. Fusing the concept of competitive tendering into the project added some dynamism and real-world dimension resulting in accelerated learning. Teaching design concepts requires one to be imaginative; to have an awareness of cultural, social, economic, political, and industrial contexts of design and to transfer those settings into the classroom by way of simulation. This has proved to be ideal for teaching several concepts within a short space of time as student use the information acquired for competitive advantage. The more responsive to the world of work our teaching methods are, the more the students will be prepared to be efficient and effective design practitioners. Grasping first world Design and Technology concepts, and applying them appropriately to challenges and realities of our hopes and aspirations for industrial transformation and economic sustainability is the ultimate goal, and justification of this approach to pedagogy.

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Khumomotse S.M. (Mr)
Lecturer (Design and Technology)
Faculty of Engineering and Technology
University of Botswana
P/Bag 0061, Gaborone
Botswana
Tel: +(267) 355 4316
Fax: +(267) 352 309
Email: Khumosm@mopipi.ub.bw