Cabin and passenger environment design for the Airbus A380 – A case study for education

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ABSTRACT

This paper describes the experiences of using the Airbus A380 as a platform for teaching design in a second year B.Sc. Product Design course. The study uses observation and student experience to assess the success of the exercise, and seeks to inform the current debate on "Problem Based Learning" in design tuition. The emphasis is on the way the project-aims, timeliness and real-world relevance and its extended period of study, long enough to explore and integrate alternative ideas, rather than its size, has contributed to a successful learning exercise that has engaged full student commitment over the one year duration of the project.

1. INTRODUCTION

The potential aims in using a project-based problem for teaching "design" were manifold. The key objectives addressed in this course were to:

i) provide students with the experience of the design process,
ii) develop student confidence in tackling a design problem,
iii) provide a platform for students to learn and apply design related techniques,
iv) provide opportunities for students to improve group working abilities.

The traditional emphasis to education within engineering is on the structured study of key analytical techniques. Available time and resources often limit the reality of the exercises and solutions that can be explored. The aim is to provide a problem solving "tool-kit", so the student is capable of handling a range of problems that might be met in a professional career, often in as efficient an educational manner as possible. However, while the relevance of the techniques being presented using this approach may be understood by the lecturer, where the student does not have the experience to place them in a working context, much of this work has to be taken on trust, anyway in the short term, and cumulatively this can make it easy for a student to lose direction, focus and motivation.

Over the past two decades, "Problem Based Learning" has been introduced as a new approach to subject areas like engineering and medicine which demand a high level of technical knowledge: challenging the idea that a corresponding high level of structured teaching is necessary "*before* realistic work can be undertaken". This "new" approach *starts* by addressing an open-ended real-life problem rather than smaller simplified exercises chosen to make particular analytical techniques tractable. Although such an unbounded task quickly generates questions, which need the analytical techniques provided by the traditional courses to answer them fully, they arise in a working context that gives them relevance and a relative importance within an overall understandable framework.

This approach has grown in popularity since its ability to relate knowledge learned in class, to real world problems in health education, was high-lighted by Barrows and Tamblyn (1980); see also Savin-Baden (2000). It has subsequently been shown to be relevant in a variety of educational contexts, for example, the teaching of English Literature in Manchester University, and Entrepreneurship at the University of Brighton. However, it is already a well-established approach to teaching and learning in professions such as Architecture, Civic Design and City and Regional Planning. In a sense it can be regarded as a replacement for some aspects of engineering education traditionally covered by apprenticeship schemes. Where students are training for the profession of Product Design and need to manage the wide range of knowledge required to cover the technical, social and economic issues involved, its adoption at the heart of the curriculum seemed totally appropriate.

2. THE AIRBUS A380

In this example of “problem based learning” the challenge of designing the cabin of the Airbus A380 was given to eleven second-year students. The Airbus A380 shown in Fig. 1 is a multi-billion Euro activity involving design and manufacture across the world. Its specification was defined in close collaboration with major airlines, airports and airworthiness authorities, resulting in a fixed airframe specification. However, the cabin interior was left flexible in the way shown in Fig. 2, to suit the different airline’s perception of their customers’ requirements.

Fig. 1 The Airbus A380 (Courtesy of Airbus)

Cabin design involves the consideration of many issues: emotional aspects such as customers’ perception of aesthetics, personal space, safety and service efficiency; physical aspects such as vibration and sound transmission, heating and air-conditioning, odour control and ventilation, and artificial and natural lighting; spatial aspects such as circulation and access, seating arrangements and the ergonomics of customers’ sitting, sleeping and storage requirements; and constructional aspects such as strength balanced against the need for lightness, and the requirements for flexible layout and maintenance. However, the cabin design is only one concern facing an airline business, which must also cover marketing, booking, check-in and departure facilities, and baggage management and retrieval facilities. The A380 cabin design was selected as a project for the course, while it was still in its design and development stage, the first commercial flights being scheduled for 2006. This gave the exercise an excitement and immediacy resulting from students exploring the same issues being addressed by large multi-disciplinary teams, at the same time that important design and commercial decisions still needed to be made. The challenge facing the students, in its broadest extent, therefore covered the complexity of a multidisciplinary, international design activity. The difficulties the size of this task presented, made clear the need for effective project management techniques from the beginning of the exercise.

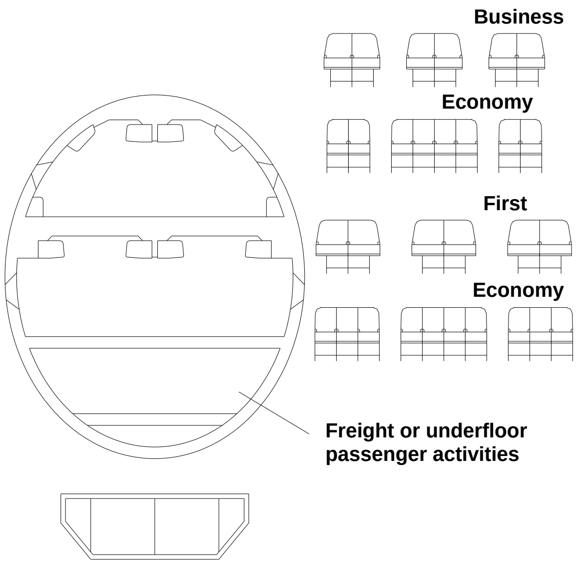

Fig. 2 A380 Cabin layout

3. DELIVERING THE A380 CHALLENGE

While a prerequisite for “problem based learning” is a suitable problem, this approach can also be characterised by the flexibility and the diversity of the different ways in which a problem may be handled. In this case three issues were directly addressed: *group working*, *problem structuring* and *problem framing*.

3.1 Group working

It is an on going educational debate as to whether “problem based learning” should or should not be conducted by groups or by individuals. Where group work is undertaken then group sizes of four or five people are often cited as optimal teams. In this case with eleven students, and with the danger of losing one or two team members, two teams of five and six members gave the only practical arrangement, if each team was to tackle the whole problem.

3.2 Problem structuring

The structuring of the project in terms defined in the syllabus was inflexible. The project ran over three terms in the second year of a B.Sc. in Product Design at the University of Sussex. The project was assessed by means of course work and counted for 30% of the marks for the year. Although the “timing” and “deliverables” of the project work were potentially flexible, it was decided, to provide a semi-rigid framework by providing milestones which student would have to meet. These were presentations of 1) an initial market and technical-research study, 2) a broad concept design study exploring the overall cabin treatment, 3) followed by a detail cabin layout study, then 4) a detailed seat study, finishing with 5) a full scale mock-up of the sitting arrangements in a section of the cabin.

Each of these studies involved finding the most suitable modelling techniques for the design decision-making that was appropriate to the tasks being addressed. These included: schematic, diagrammatic, presentation and technical drawings; scaled, Fig. 3 and 4, and full size physical models, Fig. 5; and computer and related mathematical models, using computer aided design packages. The original layout of the stairs between the A380's decks, initially designed in plan drawings had to be changed when the 1/10th scale models shown in Fig. 3 were built and the three dimensional relationships involved could be perceived and manipulated directly. Similarly the full sized model shown in Fig. 5 allowed design judgements to be made about human-scale effects using rapid construction techniques and relatively crude materials. Although the aim was to solve the design problem as realistically as possible, the success of the exercise to design cabin layouts was decided by the learning objectives defined in an assessment framework, which sought to ensure that a professional design process was being developed.

Fig. 3 Model making

Fig. 4 Quick layout-testing using scaled models of chairs

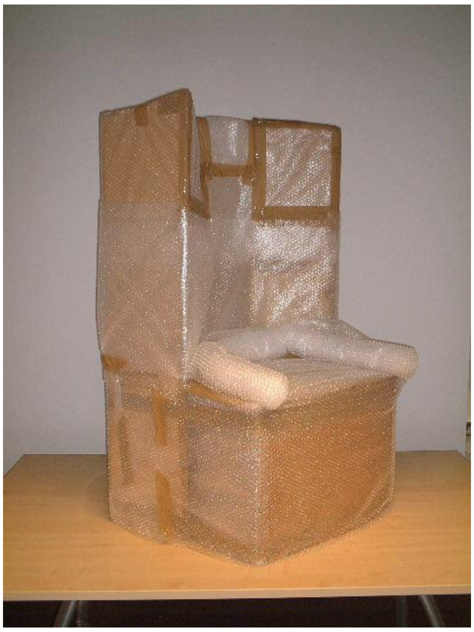

Fig. 5 Rapid seat modelling to judge human scale

3.3 Problem framing

The overall assessment framework was provided by the system based analysis summarised in Fig. 6. The "context" to the cabin design was defined by the economic and market analysis studied in the first term. This work set out target seat counts, which were related to ticket pricing, levels of comfort and the nature of the service. Airframe size, range and speed and therefore likely routes, provided some of the technological constraints.

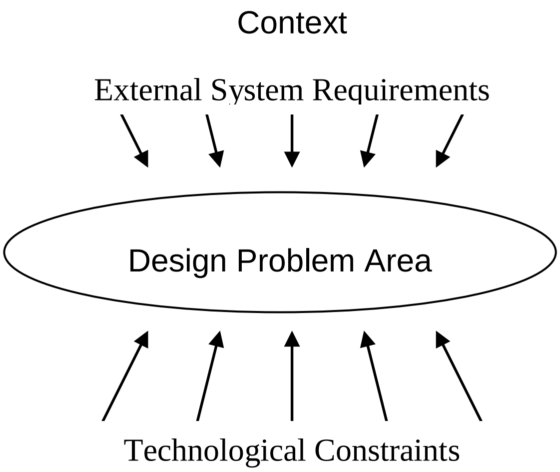

Fig. 6 Design system analysis

The decisions made about cabin layout provided the "context" for the more detailed study of the aircraft seat design. Enumerating all the activities that would be carried out in the cabin and the functional demands they made on the seats, set up the context, which established the specification and design requirements for "a seat", studied in the second term. This "context" also included: space constraints for ergonomic design, safety requirements, aesthetic issues, and environmental controls for heating, lighting and ventilation. Constructional requirements for adjustable layout, lightness of build and ease of maintenance, represented some of the technological constraints that applied. Some of these issues could be analysed by the students based on their existing knowledge, some required knowledge they did not have. Acquiring this missing knowledge or information could be tackled in two ways, the first requiring further personal study and research to provide the necessary answers, the second commissioning expert help. The latter case would be handled in real life by specialist consultants, or from cooperating specialist teams. The subdivision of the overall work within the student teams, allowed the task of cooperation between specialist groups to be explored, because the work load was partitioned and distributed to team members to work up and then report back and integrate into a working whole.

Two inputs from “expert consultants” were arranged from faculty engineers, the first offering structural advice the second giving the basic relationships which would control the layout of the ventilation and air-conditioning ducting. In both cases the support was only offered when demanded by the students’ study needs. An interesting outcome from this arrangement was the totally different perception of problems as seen by the students and that initially assumed by the experts. The experts’ initial response to the students’ request for help was that there was not time to teach them how to solve their design problem properly, whereas, all that the students wanted, in the first instance, were ways of bounding the solution within viable size ranges and into practical layouts, either by using simplified formulae or reasonable rules of thumb. The need to explore and service the communication needs set up by the interface between different specialist engineering design groups, as part of this courses content, was clearly highlighted by this experience.

Once independent partial studies were complete there followed the task of bringing together all the requirements into a single integrated design solution. This was where this approach diverged from merely analytical engineering teaching methods. Solutions for sub systems and sub-assemblies had to be compatible with each other. This meant exploring alternatives, both as simple and complex solutions, to bring together a working design, which usually involved compromises, and priority choices being made. Where the two teams made different design choices, it provided very useful discussions for all concerned.

4. OUTCOMES

In addition to tutor observation, students were asked to provide qualitative and quantitative feedback to help determine if the A380 challenge met the teaching aims, Table 1. The outcomes of this are summarised below.

i) *To provide students with the experience of the design process*

Most students benefited in some way from the exercise, though differences were noted depending on the background and previous experience of the particular student.

Typically:-

“Designing a product intended for a particular market I always thought took more effort than one would first think. I didn’t realise however, until completing this course [module] just how much is done behind the scenes for the generation of concepts and final design development. The course [module] has provided me with an incredibly detailed insight into the stages a product goes through before it is available for purchase, and in an engaging and captivating manner”. [Chris Davies]

ii) *To develop student confidence in tackling a design problem*

At the time students undertook customer related research, the airline industry was split between a high value, business approach (British Airways, Virgin) and a low cost approach (EasyJet, Go). Industry and marketing experts would have predicted the decline of the high cost arrangement but neither student group had the expertise or the courage to adopt this approach. The approaches adopted by the students were either a mix of low cost and high value seating, or a mid range option with low cost seats with high value extras. During the course of the project, the high value airlines began to publish poor trading figures compared to the profitable low cost airlines and even British Airways began to remove high value seats on some of its routes. Students were able to reflect that they could have been bolder with their own design decisions based on the facts that were originally available. Students were also able to reflect on the diametrically opposed design concepts that emerged. One group developed a strongly branded, bold concept whilst the other developed one that was neutral and flexible.

"This has been a valuable experience and my favourite course [module] so far." [Lawrence Weyman-Jones]

iii) *To provide a platform for students to learn and apply design related techniques*

55% of students expressed the value of learning to communicate through presentations, 44% singled out creativity and 44% also singled out other design techniques. Typically:-

"I think this project has been a great experience to me. It makes you learn so much, so many different design skills, stages – using programs, working in teams, getting things organised. It is really the most enjoyable project in my degree at the moment." [Annie Li]

iv) *To provide opportunities for students to improve group working abilities*

The value of the group working experience was acknowledged by 88% of the students. "We met in the library three times a week, We even met up four times on Sundays which must show the dedication of the group". [Chris Davies].

Table 1. Student feedback

Learning experience issue raised by students	Percentage of students raising the issue
Group dynamic	88
Presentation	55
Creativity	44
Design techniques	44
Hands on	33
Customer needs	22
Technical research	11

5. CONCLUSIONS

Discrete independent design studies are not as demanding as finding solutions in studies targeting an overall design objective, because in the second case the partial results have to be compatible with each other. This project illustrated this in many ways. Although the importance of providing an overall goal was recognised, the size of this project made it unrealistic to expect all the design-exercise goals to be reached. By providing a structured approach with milestones for presentations, it was possible to satisfy the four key aims to develop design experience, self-confidence, design support skills, and team working strategies. The subject was chosen to ensure multi-faceted, multi-disciplinary design issues had to be addressed, so techniques to handle them could be explored. As a first run it was felt that the course had been successful in meeting its teaching objectives.

Success has to be placed in context with the degree programme that surrounds the project. For example, if students had not experienced group working before, they might naturally place a higher emphasis on the experience of group working gained in the project, than otherwise. It did seem however, that students enjoyed and valued the experience, where they were able to support and be supported by colleagues in mutually beneficial ways through a highly demanding exercise. One result was that they were able to recognise the merits of a concurrent engineering approach as they explored the many different inter dependent aspects of a complex design task. There is also the question of how the course was delivered. Was the project well conceived as a teaching experience, or have we been lucky? It is hoped that the degree of tutor preparation and expertise indicates more than a lucky outcome, however only experience gained over a range of projects, over time, will answer this question. There was a conscious effort to keep the project successful by making the design experience as real as possible. This was achieved by making the student teams compete against each other in their presentations, and by continually updating the project with live, relevant and topical issues introduced by guest speakers, invited from the aircraft industry.

Finally the most interesting "emergent" benefit of the course arrangements was a consequence of the amount of time allocated to it. It was not the size of the exercise that was important, but because of its duration through the whole year, there was time to explore alternative concepts, to revisit ideas from various points of view, and most importantly time to "refactor" and "refine" design solutions as understanding of the problems deepened. However, the extent and nature of the project did mean that this process of reworking appeared less artificial, and was easier to manage without boredom and loss of motivation setting in. The experience gained working through the early stages in a design, when results seemed to be poor and disconnected, to the point when *"things started to gel and come together",* is perhaps one of most important learning experiences needed for any design student! This experience is important in developing a student's confidence: to keep going through many false trials without abandoning an idea. The lesson that good design is more often the result of a systematic problem-space search, than simply inspiration, can be a hard one to learn. At the same time the ability to release an idea when it ultimately proves inappropriate especially after a lot of work is equally necessary. The selection process inherent in the contents of the film editor's cutting room floor is an important aspect of the design process. In this respect the importance of debriefing each student after each presentation, to help unravel their responses at each stage of the work and maintain courage and motivation until successful results started to give their own rewards and motivation, was vital.

REFERENCES

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Savin-Baden, M. (2000) Problem-based learning in higher education: Untold stories. SRHE/Open University Press.