

# **KNOWLEDGE EXCHANGE AND KNOWLEDGE TRANSFER PARTNERSHIPS: A LIVE CASE STUDY APPROACH FOR UNDERGRADUATE DESIGN PROJECTS**

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## **ABSTRACT**

This paper draws on experience gained from a Knowledge Transfer Partnership currently being undertaken by the authors, and how it has been used to provide case studies for undergraduate design projects. It will highlight the good practice that has been identified, and also discusses the experiences of the adoption and implementation of this type of learning activity. Gaining feedback from students, staff and industrial partners is also reviewed. We have found the case-based approach through a knowledge exchange model to be a useful method to develop key transferable skills such as group working and individual study skills, information gathering and analysis, time management, presentation and practical skills. It is also hoped that the projects carried out will equip students with the skills to bring together the different elements of creativity, technology and business, enabling students from different backgrounds and with varying levels of experience to work together, a key outcome of the Cox Review 2005. Examples of student project work outcomes are shown alongside the commercial work from the KTP associate.

*Keywords: Knowledge exchange, knowledge transfer partnerships, cross disciplinary, case study*

## **1 INTRODUCTION**

Teaching and learning styles are, by their very nature, constantly changing and evolving and in recent years there has been a noticeable move in a number of UK undergraduate Product Design courses from lecture-based activities towards more student-centred activities [1]. Case studies are an increasingly popular form of pedagogical tool and learning vehicle and can have an important role both in engaging students and in developing their skills and knowledge [2].

Case studies have long proven to be successful in stressing developmental factors in relation to context, but they tend to be retrospective, with criteria established using historical data. A longitudinal live case study approach provides a systematic way of looking at events as they happen, collecting data, analysing information, and reporting results. As a result the researcher, staff and students may gain a sharpened understanding of why the project evolved as it did, and what might become important to focus on more extensively in future research or projects. They may also feel more closely linked with the project, and therefore more “ownership” [3].

“The case study is a research approach, situated between concrete data taking techniques and methodologic paradigms” [4]. For design students, a case study approach is a useful way to learn more formal design process models while embedding them in live industrial situations, maintaining interest while allowing them to benefit from an in-depth study of a design problem, enabling them to compare and contrast methods and approaches. Case studies have also been closely linked with increased student motivation and interest in a subject [5].

## **2 THE PROJECT: A KNOWLEDGE TRANSFER PARTNERSHIP (KTP)**

Buckinghamshire New University (Bucks) were awarded a two year KTP with The Pure H2O Company Ltd in 2010. KTP is a UK government funded programme enabling organisations to improve their competitiveness, productivity and performance by accessing the expertise, technology and skills of the UK’s knowledge base, notably within universities. As they are part-funded by

government, there is less risk to the company. KTPs address short term, tactical issues requiring expertise not currently available within the organisation [6].

Pure H2O produce water systems for domestic, industrial and commercial applications. They have pioneered patented developments in environmentally sound and technologically efficient treatment of water. The company have a significant share of the UK water purification market and their goal is to grow the business and become more profitable by expanding their operations in multi-function taps to supply pure, chilled, sparkling and boiling water (Figure 9). However:

- Pure H2O do not have research and development capacity to shorten supply chains and source sustainable materials locally, or to expand their networks and realise their wider market capacity. They recognise a need for a greater design and engineering input.
- They have identified a need for more detailed design and technological development to apply existing and emerging technologies through their next generation products.

This paper draws on lessons learnt and experience gained from the KTP. While it is understood that it is often difficult to summarise and develop general propositions and theories on the basis of specific case studies, a model of good practice has been identified and developed. Experiences of the adoption and implementation of this type of learning activity is discussed. Gaining feedback from students, staff and industrial partners has been an important aspect of the research. We have found the case-based approach through a knowledge exchange model to be a useful method to develop transferable skills such as group working and individual study skills, information gathering and analysis, time management, presentation and practical skills. It is hoped that the projects carried out during this work will equip students with the skills to bring together elements of creativity, technology and business, enabling students from different backgrounds and with varying levels of experience to work together, a key outcome of the Cox Review (2005) [7].

## 2.1 The Case Study Approach

In order to disseminate the key project stages a series of five lectures, seminars and practical sessions were delivered by the authors to a group of level five BSc Product Design students at Bucks. These were aligned to key performance indicators (KPIs) in the KTP document, therefore these had been formally agreed to happen at defined points within the development programme. The lectures culminated in a project brief which enables the students to apply the knowledge and skills learned through a six week structured design project. Each session was used to contrast the academic approach (Bucks) to that used by the company (Pure). The topics were:

- Reverse (value) engineering & Design Efficiency (Bucks) or *Applied Ideation (Pure)*
- Design for Manufacture and Assembly (Bucks) or *Reducing Legacy Part Cost (Pure)*
- Design for Mass Production (Bucks) or *Design for Value (Pure)*
- Rapid Prototyping (Bucks) or *Additive Manufacturing (Pure)*
- Supply change management (Bucks) or *Greening Supply Chains (Pure)*

## 2.2 Stage 1 – Value Engineering or *Applied Ideation*

Undergraduate design projects at Bucks typically follow a relatively prescribed path from a paper concept to a physical reality via package drawings and theoretical reverse engineering studies. The use of onsite workshops, technician support and relatively considered and refined briefs ensure that a student has the ability to learn and apply the prototyping process with relative ease. At Pure however taking a sketch to a prototype, which not only shows form/fit, ergonomics, usability and proof of concept is a slow process as they have never had to employ resource in this manner and have few facilities. Resources must be employed across the supply chain to allow the designer to produce prototypes which utilise new and existing parts in an efficient and improved way. With the Hydrocell, the below counter part of the Quatreau Tap System, fitting all of the components in to one case relied on supplier co-operation to ensure that when moving from own products to an OEM design the system would still function as intended. There then needed to be dialogue between the OEM manufacturer and the designer before a prototyping. This compromise within the design phase is lacking in many student projects, and this was a useful vehicle for showing it. Figure 1 shows student response to the packaging brief and initial company response.

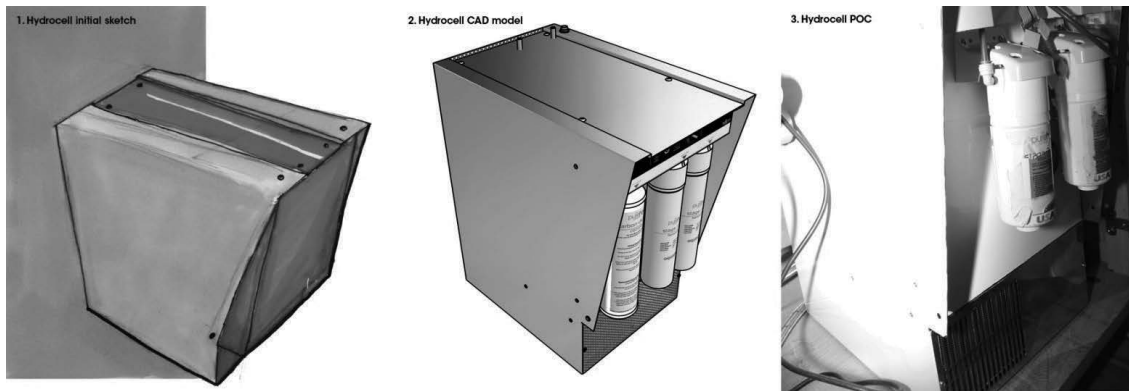


Figure 1. Package sketches and drawings lead to a final CAD model and form/fit prototype

### 2.3 Stage 2 – Design for Manufacture or Reducing Legacy Part Cost

This was the company's first time dealing with legacy components, which needed to be updated and improved. As the product is niche and high end most parts are machined from solid and require much machine time. Removing complexity and looking at material choice reduced machine time and material cost for components, and component cost as processes are removed. The hardest part for the Pure designer was keeping the spirit of the original parts but making them suitable for production. Most design courses start a design process with a blank slate and do not focus on improvements to products. If they do they tend to be complete redesigns rather than refinements. The iterative nature of this exercise was particularly useful for the students as they managed to reduce part cost by 40%; part count was down by 20% and material costs by 50% (Figures 2, 3 and 4). A move from brass to aluminium also produced a useful discussion on material cost against machining time, and why the anticipated cost savings didn't always occur, due to factors such as machine time, tool changes etc.



Figures 2, 3, 4. Design Studies in machined brass, aluminium, and ABS

### 2.4 Stage 3 – Design for Mass Production or Design for Value

Adding value to the design was undertaken through a systemised approach to the design for manufacture of current parts, such as the substitution of materials, lean manufacturing techniques, and robust design. Two strategies were employed to ensure that value was created and retained through new product designs. Firstly, economies of scale were applied to the most difficult part in the current design by modularisation to allow its use across a range of products. Using DFMA methods allowed the designer to reduce the cost of the part, and utilising it in further designs the batch quantity could be increased and further savings made. Secondly a systematic approach to analysing user trials data and customer feedback allowed some parts and features to be removed, such as an adjustment ratchet on the touch screen control panel which was deemed unnecessary by users. These techniques were applied throughout the company at all stages of the product life so as to improve stock control, parts ordering and assembly, installation and maintenance, and removal and subsequent remanufacture, upcycling and disposal. A case study studying a time and motion study on tap assembly using basic DfMA and Poka Yoke techniques reduced assembly time by 60% whilst reducing handling errors.

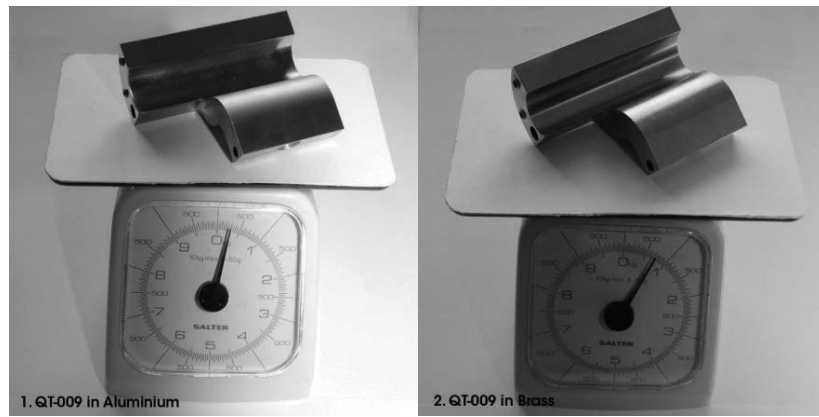


Figure 5. Weight savings from material substitution, with associated material cost savings

## 2.5 Stage 4 – Rapid Prototyping or Additive Manufacturing

Rapid prototyping facilities are undergoing a transition from prototype and concept manufacture to replacing some model making techniques. The ability to check parts for form/fit and usability becomes an important stage in the development process. Commercial prints are often used at early stages of development, after initial ideation and initial CAD drawings. They can be used to quickly test an idea with current components, such as the concept in Figure 6. Alternatively they can be used to quickly prove a concept plastic part such as the water distributors and touch screen panel snap fits in the bottom right of the image, not be easily replicated with machining. Rapid prototypes are important in ensuring that products can be produced on time and budget and often come in cost neutral or with a cost benefit over outsourced traditional prototyping. Selective Laser Sintering (SLS) and Fused Deposition Modelling (FDM) processes were used to establish form/fit test pieces for teaching tolerancing and materials properties, they allowed trials of the touch screen placement and also provided useful exercises for simulated CNC machining trials.

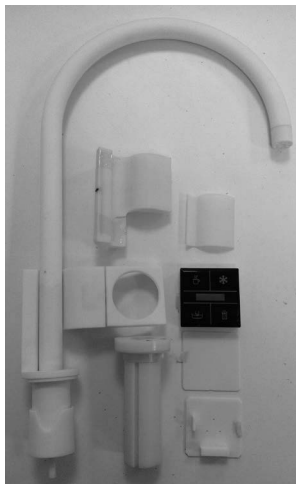


Figure 6. SLS tap



Figure 7. Brass tap for user trials



Figure 8. Chromed FDM tap

## 2.6 Stage 5 – Supply Chain Management or Greening Supply Chains

Supply chain management is a tool that is rarely taught to design undergraduates but is an important one for designers. Sourcing parts for theoretical designs or one-offs is an easy process but ensuring that the design is able to be produced in quantity at the right quality and price is crucial for ensuring that a design makes it to market and stays there. Sustainable sourcing is important for Pure H<sub>2</sub>O, as well as compliance with RoHS, WEEE and ISO 14006 requirements. Sourcing and manufacturing as many of the parts as possible locally or regionally was also a key requirement of the KTP. Due to the purity of the water used in the taps there are additional demands on the materials used in the taps and therefore on the supply chain. During the course of the project a large order enquiry necessitated a complete restructuring of the order and supply chain, and this provided the ideal opportunity for a

seminar on the importance of the supply chain. Students performed a series of exercises in order to help streamline the stock control and ordering systems using techniques such as Poka-Yoke, Critical Path Analysis, Kanban and Six Sigma. These methods all require real world examples for them to be seen as relevant and useful for the students, and their work was of great benefit to the company in making these methods seem useful and approachable. Errors in ordering and stock control were significantly reduced by using these methods, along with a clearly labelled set of 3D CAD models and drawings of parts with a readily accessible colour coding, naming and numbering system for all parts. Part variations were avoided wherever possible, while still allowing some user customisation, for example in the layout and colours of the touch screen controls (Figure 10), angle of fitment for the control panel, final finish, and spout size and layout. Of all the five stages identified it appears that supply chain management has the most potential to help the company grow, or potentially hold them back. One customer enquiring if the product contains tantalum (a Conflict mineral) can take up many months of trawling through supplier's files and catalogues, which can cause delays and cancelled orders. Good supply chain management would help to avoid this scenario [8].



Figure 9. Quatreau tap in chrome



Figure 10. Touch screen layout for user trials

### 3 CONCLUSIONS

A live case study approach poses many potential problems for design education, with issues of access to potentially sensitive or confidential information, geographic location, and different expectations of timescale and quality of outcome all providing potential pitfalls. By using a KTP programme to provide a series of defined case study examples, the likelihood of problems relating to timings and expected outcomes are reduced. There are also more closely defined links between the students and the company due to the pre-existing formal arrangements for sharing of IP and development costs that usually occur around KTP projects. The outcomes of this project have been very beneficial for all parties, with the most notable achievements being:

- Stage 1: 50% reduction in Hydrocell size; 40% reduction in part count and cost
- Stage 2: 50% reduction in material cost; 50% reduction in part weight
- Stage 3: Reduction in part count and complexity resulting in reduced assembly time
- Stage 4: New range of tap designs prototyped and user tested well under specified time
- Stage 5: Supply chain mapped and all stakeholders involved in constant updating

The work could not have been carried out without close collaboration between the authors and the CEO and staff of Pure H2O, and the students themselves, for which we are very grateful.

### 3.1 Further Work

The five stages of the lecture programme are now complete and the students have completed their case study work reports. The final sixth phase involves setting the students a longer design and make project to allow them to apply their knowledge and skills to a more detailed brief set by the management and design team at Pure H2O. The results of this project showing new parts and designs will be presented at E&PDE12, along with the updated designs for the new range of taps from Pure H2O incorporating the work from these case study stages, as a culmination of the KTP.

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