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TikiWiki: A TOOL TO SUPPORT ENGINEERING DESIGN STUDENTS IN CONCEPT GENERATION

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ABSTRACT
For student design engineers, the concept generation stage of the design process is usually one of most creative, but poses problems in handling large amounts of information when developing new ideas. Storing such information digitally potentially makes its retrieval and utilisation quicker and easier - ideal for the inherently spontaneous nature of the concept generation task. There is, however, currently a low use of existing electronic resources amongst undergraduate students. This paper discusses how a group of product design engineering students were encouraged to useTikiWiki, a groupware product, as an integral part of a design project. It was observed that a digital repository has a positive effect on concept generation, despite the logistical problems with moving information into the digital domain. Students were able to better interact with the information, evidenced by hierarchical and well constructed topic information resources, a high number of 'hits' on their Wiki pages, clear references to information used in concept design templates and instances of 'topic-led' designs where the research carried out by a group clearly influenced design direction. Additionally, students showed a strong preference for browsing the structured Wiki pages they had created rather than searching with keywords, in keeping with the open-ended nature of concept generation.

Keywords: Concept generation, information, organisation

1 INTRODUCTION

For student design engineers, the concept generation stage of the design process is usually one of most creative, but poses problems in handling large amounts of information in developing new ideas [1,2]. To create well-substantiated concepts, the designer is required to quickly grasp the pertinent subject matter, and research has shown that creating and sharing relevant documents can help in this [3].

The advantage of storing such information digitally is the ability to retrieve and utilise it quickly and easily, making it ideal for the inherently spontaneous nature of the concept generation task. There is low use of existing electronic resources such as subject gateways (EEVL) and portals (SMETE) amongst undergraduate students [4]. Students find these resources unresponsive when trying to inform their concept design work, as the information is stored in a hierarchical structure and presented in a traditional, multi-layered interface which is not necessarily orientated to the needs of designers [5].

The aim of this research was to examine how a group of students gathered, structured and used information as part of a design project. This involved allowing time at the start of the design process to construct several digital information resources, based around related design topics, which would then be used as part of their concept generation. This then allowed:

- Observation of how students selected and organised information knowing they would have to reuse it.
- Evaluation of the effects on learning and concept generation of access to a searchable repository of design resources.

2 DESCRIPTION OF WORK

A group of 3rd year Product Design Engineering students were asked work in teams of four to rapidly design a can crushing device for domestic kitchen use as a disposal mechanism for soft drink containers. The project was organised and run over six weeks using TikiWiki [6], a web-based piece of groupware, in addition to a weekly studio session. Ten teams of four students were each asked to use TikiWiki as a digital repository and collaborative tool. Each team was provided with a private domain where they could upload images and files, and create Wiki pages (similar to web pages) where they could create hierarchies and links for this information.

The work was split into 3 main areas: information gathering, concept generation and concept development (Figure 1). The teams created ten complete resource sites on topics relating to a can crusher (recycling, market, user environment, mechanisms, aesthetics, ergonomics and safety) during Weeks 1 and 2.

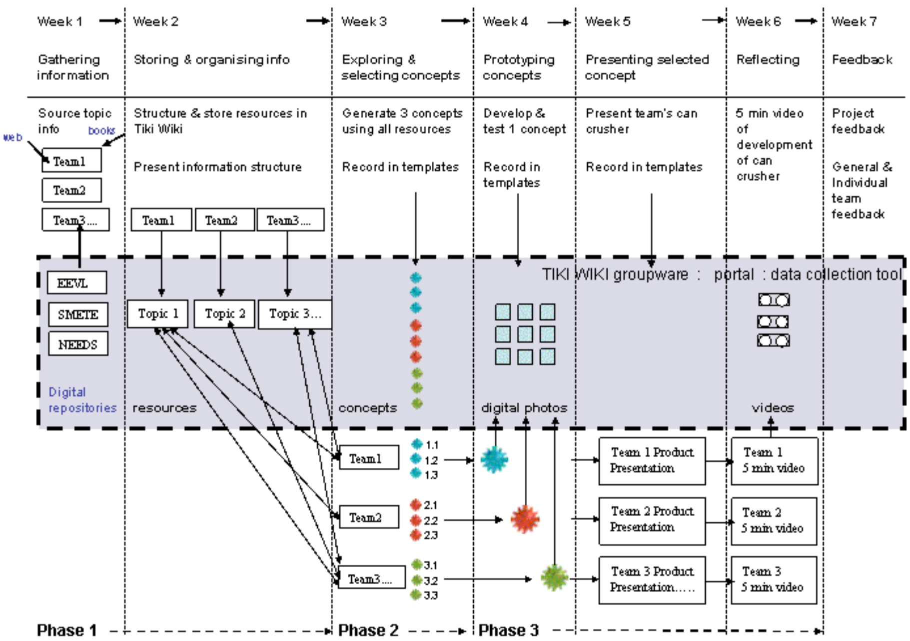

Figure 1. Project overview

On Week 3 the group were given access to the information resources created by the other teams and asked to develop three diverse solutions to the can crushing problem with specific references to the resources. As with all stages of this project, they were asked to document this digitally in a TikiWiki template, and most teams did this by scanning sketchwork and creating hyperlinks within TikiWiki (Figure 2).

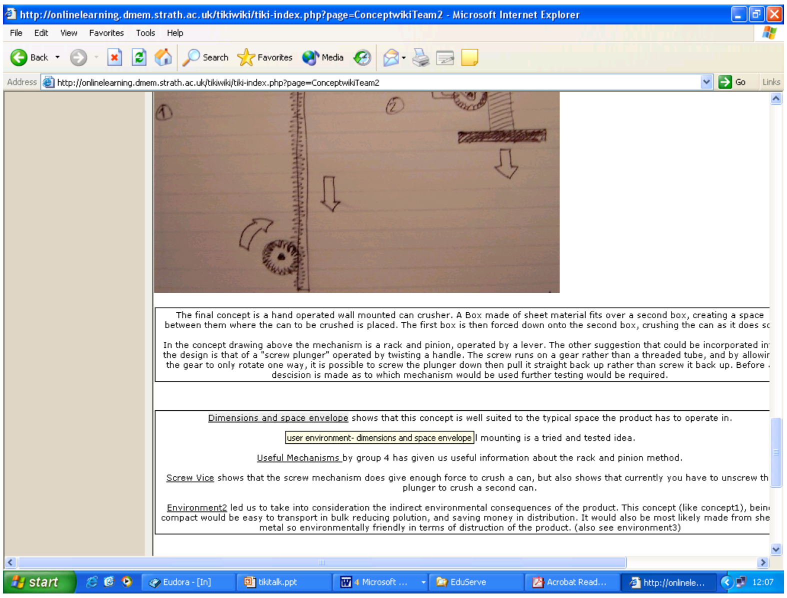

Figure 2. Team 2's concepts page, with sketches and references

The final stage of the project (Weeks 4 and 5) was concept development, when they were required to build a proof-of-concept model and reflect on their design. A TikiWiki template outlining the concept was requested, and a presentation to discuss the merits of their concept using the proof-of-concept model was given by each group. There was then an additional video presentation in the final week of the project when the teams were asked to reflect on their design process.

3 SELECTION AND ORGANISATION OF INFORMATION

The paper considers the two evaluation questions previously mentioned in turn. Firstly, the selection and organisation of information within the TikiWiki environment:

3.1 Creating, structuring and searching for information using Wiki pages

The emphasis of the project was on constructing Wiki pages, which acted as a set of structured links to guide the user through the information rather than just storing it in file galleries. This encouraged students to interact with the resources and made them consider the relationships between the resources they had created. Students showed a strong preference for browsing for information rather than searching using specific terms. This is in keeping with the 'random' nature of idea generation, when the designer is unsure exactly what they are looking for.

TikiWiki has the facility to create a 'Wiki Graph' which illustrates how a set of pages have been linked, and several groups used this function to summarise their information resource structure (Figure 3). This was used in a reflective capacity in Week 3 and proved useful in aiding an understanding of their hierarchies. The Wiki Graph can be used as a navigation page, as each box is an active link to a page, and in future projects it may be useful to ask teams to monitor how this tree 'grows' as their resource develops, making the structure of the repository more transparent. Although most teams commented that the resources provided by others could have been easier to navigate, browsing Wiki pages still proved more popular than doing file searches for information. Since the students were asked to consider their allocated topic and build a set of Wiki pages around it, it was unsurprising that most used this method to access the information of other groups.

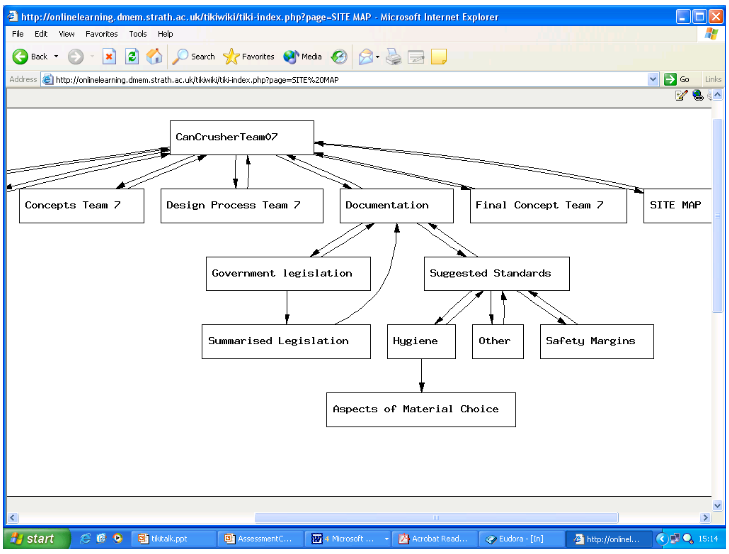

Figure 3. Team 7's site map

The better teams selected, filtered and presented information in a clear and simple layout which allowed other students to quickly access key information. Teams subdivided their topics into 3 to 8 sub-categories; and their resources had between 2 and 6 levels of information, with more detail at lower levels. Forcing the students to think about this organisation of information added to their understanding of their respective topics and how they related to the can crushing device. For example, the Team 8 (ergonomics) had a 'history of ergonomics' at the top of their front page. It was suggested that key anthropometric data, which was hidden elsewhere in their resource, should have been presented further 'up-front'. This tends to indicate that the students in teams were thinking in 'story' or 'report' mode rather than analytically about use of information within a product design context. When other teams commented on their use of the ergonomics site, they described it as useful, but difficult to get to the important information. In turn, Team 8 was forced to acknowledge what were the key aspects of their research with respect to engineering design. It was found that for the other topics, a similar process took place. Poorer teams tended to simply paste up large amounts of text-based documents in shallow Wiki structures that proved unhelpful to others.

3.2 Creating, structuring and searching for information using keywords and descriptions

On uploading files to TikiWiki students had to attach metadata to each file (filename, author, keywords, description). Students showed a strong resistance to inputting large amounts of metadata. Ultimately, keyword searches proved unsuccessful since the metadata attached to each file by the students was inadequate, misleading or incomplete. This was mainly due to the students not having a clear understanding of the purpose of metadata and it is hoped to run future sessions with more emphasis on this. The ease of inputting large amounts of metadata, however, is another problem that is under consideration: it is time consuming and not perceived as a core design activity. Other methods such as 'drag and drop' and the potential role of a librarian are under consideration to integrate the use of a digital repository more with the design process.

3.3 Storing work in templates

Each team was provided with a template in TikiWiki and asked to develop three diverse concepts, and to provide an images, summary and links to the relevant information they utilised in each. Although digital photography and scanning facilities were provided, the process of recording the process digitally was found to be onerous, especially the scanning of hand-drawn sketches, and this raises the issue of inhibiting the free-flowing nature of concept generation. The template was intended to minimise the work required in transferring information into the digital domain. The benefit for the students was that they could then create a document where all information relating to their design was stored, and could link directly to relevant information.

When it came to choosing one of the three concepts most teams relied on a controlled convergence matrix [7], despite the fact that this was an inappropriate tool for concepts of a modest level of detail. In the space of one week, most teams had produced a couple of rough sketches and some description and link information, but not enough to justify a formal matrix evaluation. In the future, it may be possible to directly link weighting factors to information links within a digital domain like TikiWiki. This would formalize the link between the information which has been collected, identified, rated and then used for a number of different concepts, providing continuity in the design process.

4 EFFECTS ON LEARNING AND CONCEPT GENERATION

The paper now considers the second evaluation question- the effects of the TikiWiki environment on student learning and concept generation:

4.1 Patterns of use of TikiWiki

After a few initial problems when the students were familiarising themselves with the system, TikiWiki was generally regarded as a useful tool. Figure 4 illustrates the level of activity in the TikiWiki environment during the course of the project. Peaks can be seen as the weekly deadlines approached, but the tallest is during the 3rd week and this indicates that TikiWiki was being used most heavily for the concept generation stage of the project. Unfortunately, this output doesn't show what type of activity was going on, i.e. whether students were uploading, downloading or browsing information, but does illustrate the level of interaction with information at various stages of the project. The final, proof-of-concept phase, for example, shows a significant drop-off in activity.

There were two ways of searching Wiki pages to find resources but students preferred to browse rather than search using keywords. It seemed they were more familiar with this method of searching on-line due to browsing the Internet, and there was the additional suggestion that browsing suited the spontaneous and open-ended nature of idea generation. Searching and reflection was in any case inhibited by poor use of keywords and descriptions at the file upload stage. In future projects, more support and better preparation is needed in terms of keyword and description use as this is a skill students are generally unfamiliar with.

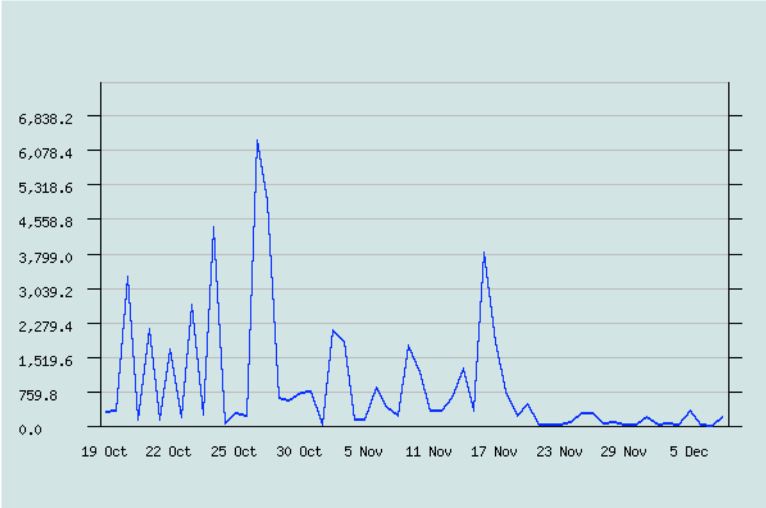

Figure 4. TikiWiki usage statistics

4.2 Effect on design work

Using the digital repository allowed for reflection on the information gathered and it was observed that the best concepts were those produced by teams that had interacted more with the stored resources. This is illustrated by Figure 5 which shows the better teams had the most hits on their pages: Teams 1, 5 and 9 were 1st, 3rd and 5th in the class respectively. These teams also had a greater number of references to the information sources utilised in their concept templates. This suggests that reflection improves learning through the accessing and interacting with information. Additionally, to organise and structure the information it was necessary to think about relationship (hierarchy and priority) and the Wiki page format allowed the students to do this. It could also be argued, however, that as good students they had spent more time creating an information resource and the high number of hits was a result of this.

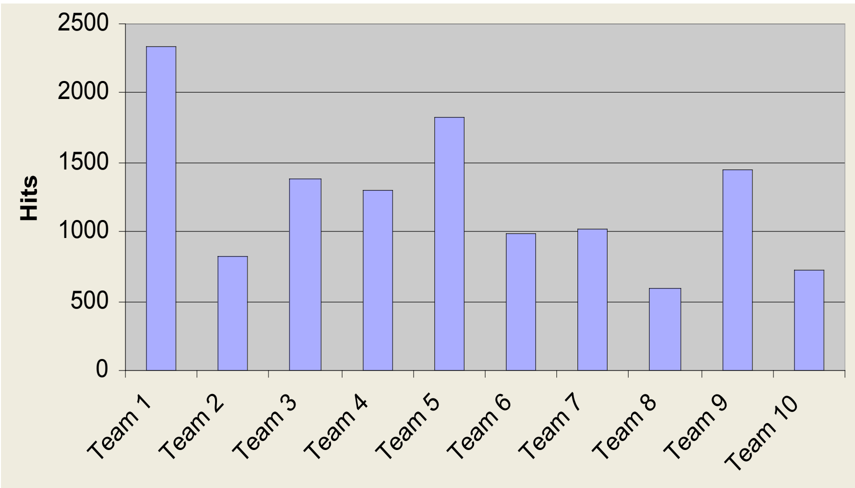

Figure 5. Hits on Wiki pages by team

It was hoped that asking teams to reflect on their information resource topics would result in more considered concepts. The assigned topics did not overtly affect the concepts produced, but there was some evidence of topic-led designs: Team 7 (safety) produced an enclosed, motor-driven concept, and Team 4 (mechanisms) had a highly developed mechanical crushing design. However, the resources of other teams didn't make a similar impact, and therefore it seems that the level of reflection on the information resources made the difference.

5 CONCLUDING REMARKS

A digital repository seems to have a positive effect on concept generation, despite the logistical problems with moving information into the digital domain. By integrating the information search and organization element into the design project, students were able to better interact with the information they would be using. This was evidenced by the improved concept generation work of teams which had: created hierarchical and well constructed topic information resources; a high number of 'hits' on their Wiki pages; clear references to information used in concept design templates; and instances of 'topic-led' designs where the research carried out by a group clearly influenced design direction. Additionally, students showed a strong preference for browsing the structured Wiki pages they had created rather than searching with keywords, in keeping with the open-ended nature of concept generation.

The results of the project were, however, limited by the tight project timescales during which the students had to spend time learningTikiWiki, understand why they were creating information resources and build a proof-of-concept model. It would therefore be desirable to try a similar session with the group over a longer period of time.

Since TikiWiki is an open source program, there is scope to add or enhance features, and it is anticipated that significant changes will be incorporated as the research continues.

As the next stage of the investigation, it is hoped to establish the suitability of these resources for re-use with cohorts in later years. Additionally, there is the intention to run information literacy workshops to assist with the understanding of information retrieval, evaluation, use, management and organisation before running a longer-term project.

ACKNOWLEDGEMENTS

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