

GRASSROOTS: Social Software in education? Wikipedia to stay ahead in Aircraft Structural Analysis and Design courses

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Abstract

Although digital learning applications have been available to lecturers for several years, they are still hesitant to intensively use these tools due to restrictions in time and budget. To help lecturers overcome this hurdle TU Delft offers its lecturers small grants to implement digital learning in their courses through the GRASSROOTS project[1]. One such project is the development of a dedicated Wikipedia encyclopaedia[2] using course material generated jointly by teachers and students participating in the 2nd year BSc course Aircraft Stress Analysis and Structural Design [3].

Teaching staff at TU Delft generally have a double appointment combining research with lecturing in their area of research. Including their research work as state of the art topical content in courses requires course material to be generated on-the-fly. Publishing of course materials such as lecture notes and books usually lags behind presentation thereof. Also developing course material while aiming for sufficient study results is in the current social environment a cooperative teacher-student activity requiring efficient generation of course material, immediate incorporation of feedback and optimal delivery of course material. Thirdly activating students to assist in developing course material is a strong motivator for participation. Considering the social aspects and continuous on-line availability a Wikipedia encyclopaedia is the social software tool of choice.

This paper describes the experiences and lessons learned whilst developing a Wikipedia encyclopaedia of course material[4]. Conclusions from project development and deployment together with recommendations for future improvement are presented. Also the opinions and responses of the students participating in the project are reported.

Keywords: Grassroots, Wiki, Social Software

1 INTRODUCTION

The course Aircraft Structural Analysis and Design, course code AE2-521N, is taught in the second year of the Bachelor's program of the faculty of Aerospace Engineering, Delft University of Technology, the Netherlands. The course builds on the first year's mechanics and materials courses and extends students' knowledge on structural analysis. The students need this knowledge to study the concept of "design".

The structural elements used in the course are truss members, beams elements and plates, which can be both statically determinate and indeterminate. First the students are introduced to the stress and displacement analysis of the structure. At a later moment these tools are used to parametrically design the structural elements to satisfy certain stress and displacement requirements. Due to the interacting nature of indeterminate structures, the concept of design iterations is taught as well. Apart from the three main structural elements, side issues such as composite cross-sections, stress concentrations and design for multiple versus combined loads are also dealt with.

The course AE2-521N had run for 3 years before the diverse and extensive course content settled. In a lecture period teaching the design concepts is done in a lecture-room setting while students exercise the material by doing challenging design problems. Assessment of students performance is done using a combination of a written examination, mini projects and state-of-art electronic assessment using Blackboard[5].

The course material used during this course consisted of lecture sheets, Mathematica[6] notebooks and Maple worksheets[7] combined with selected reference material. During the lecture period the course is supported by an active online discussion forum where students can post questions and discuss the course content. Because of the ongoing course development a formal reader of course material was planned but had not yet been generated. Because the course content was settling it was decided to develop a reader to formalize the course material. Parallel to the lecture series of this course an evolving document initially written by the teaching staff was piecemeal released. Employing the user forum for active reviewing and continuous adapting was beneficial in fast-tracking development of the reader. Concerning content the reader reflects the course material at a specific time. By its nature a hard copy reader has a significant production time, adapting its content is a time-consuming process and the reader is an additional item for students to carry around.

The TU Delft is implementing policies which increase the use of active learning and the introduction of e-learning facilities. A campus wide wireless network is available and incoming students are expected to make efficient use of the available on-line resources during lectures and such. The university also facilitates a yearly laptop project in which incoming students can obtain state-of-art laptop computers and educational software. In due time it is foreseen that most students will have laptops and all lecture materials will be available on-line for use during lectures and practicals. To stay ahead of this changing teaching environment not only a reader was developed but simultaneously a dedicated Wikipedia encyclopaedia or Wiki for short, was commissioned initially hosting the same content as the reader.

This paper describes the development of the Wiki outlined above. The authors propose a Wiki to be a suitable means of enabling on-line access to course material as required by the university. Being a living document a Wiki is flexible, content can be adapted on-the-fly and access for both teachers and students is easy. First we will look at the technical and operational issues surrounding the Wiki. Next we present the current Wiki as developed by this project. The paper is concluded with a number of conclusions from this project and suggestions for lecturers who are interested in implementing similar technology in their classes.

2 PROBLEM STATEMENT

To the casual user a Wiki is an Internet version of an encyclopaedia. From the outside a Wiki is a collection of documents containing text and pictures augmented by movies and such. In addition it offers naive navigation through its contents using so-called hyper-links, tabs and menus. A user only needs to point-

and-click on a hyper-link or tab to select and view another document in or even outside the Wiki. In a technical sense such a repository of hyper-documents is stored on one or more computers and upon request i.e. point-and-click, delivered to the user by a web server. The underlying stack of software tools needed to accomplish this easy content delivery is rather complex. Identifying and selecting the most suitable software tools as well as building a stable environment with the software tools is just one of the problems to solve.

In contrast to the rigid content of a hard copy encyclopaedia the content of a Wiki can be changed on-the-fly by anyone with the right permissions. As our Wiki with course material is build exclusively for a specific course of TU Delft unrestricted access is deemed unnecessary and even unwanted. We want the course material in the Wiki to be of high quality and if possible correct. We also want to be able to determine who changed the Wiki content and for what reason. Thus both access management and traceability are important issues.

The dynamic nature of the document repository implies all interested parties i.e. teachers and students, can and if possible should contribute to the Wiki content. Also they are expected to review and when applicable update each others contributions to enhance the quality of the Wiki content. Getting the parties concerned actively involved in Wiki content development is a commutation challenge to be addressed.

The problems are summarised below:

- Identify, select and install a Wiki environment.
- Wiki access management and content traceability.
- Involving teachers and students in Wiki content generation.

3 WIKI DEVELOPMENT

In 2007, an initiative was started at the Delft University of Technology to stimulate lecturers to introduce information and communication technology (ICT) applications in the courses. This initiative is called the Grassroots project. The lecturers are encouraged to implement new ideas into or modify existing items of the course content aided by the use of ICT. To compensate for the time invested by the lecturer, a financial compensation is provided. The development of a Wiki with course material for the Aircraft Structural Analysis and Design course has been selected as one of the Grassroots projects.

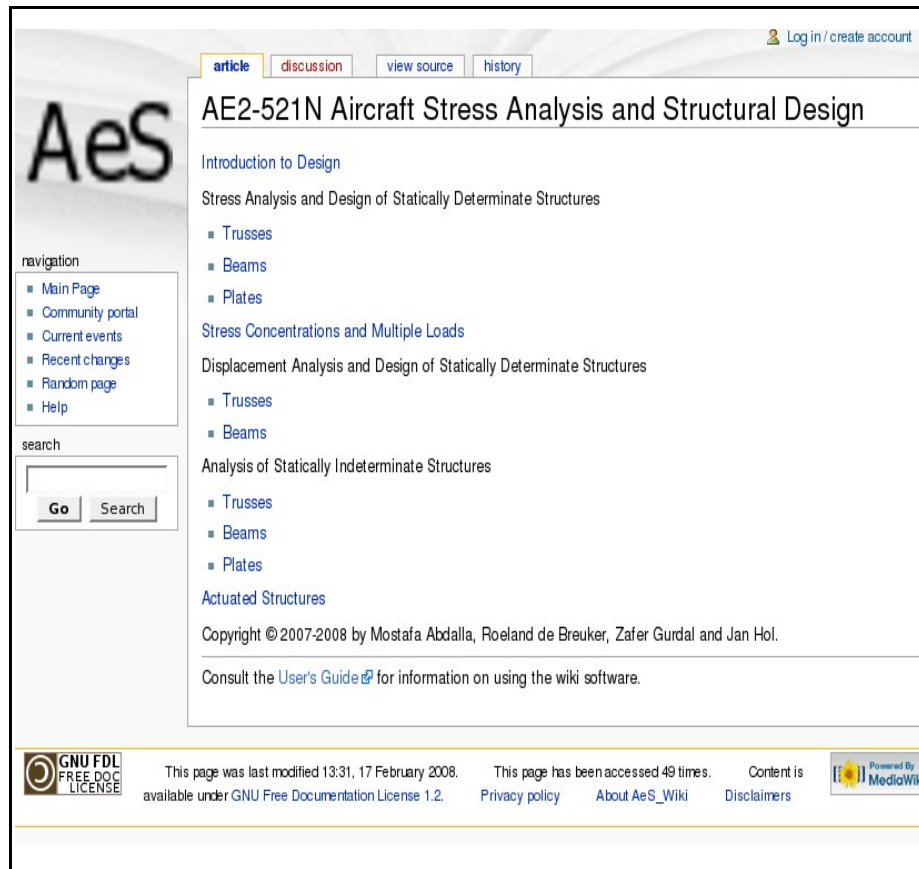
In the following sections, the way the previously summarized problems were handled and our Wiki came to life is described in more detail.

3.1 Identify, select and install a Wiki environment

At the time the Wiki project was conceived central ICT services of the TU Delft indicated they could provide a basic environment into allowing us to focus on the Wiki content. When push came to shove ICT services could not deliver except promising a Wiki module in our central Blackboard system *real soon now*. As we wanted to develop the reader and Wiki in parallel with the lecture series it was decided to step up to the challenge and build our own experimental Wiki environment.

Searching Internet for information on Wiki environments and consulting with colleagues and various knowledgeable ICT experts resulted in settling on a LAMP-environment. A LAMP-environment combines the Linux operating system[8] as foundation for an Apache web server[9] to deliver content to users, a MySQL database management system[10] to store content and the PHP computer scripting language[11] to dynamically generate web pages. All of these components are available as part of most current Linux distributions. Because of previous good experience we selected the Fedora 7 distribution of the Fedora project[12] as the LAMP-environment of choice.

Topping of our software environment is MediaWiki the software which also powers the Wikipedia websites[13]. Written in PHP and able to use MySQL its a preferred solution for a Wiki environment. MediaWiki provides a rich environment where textual content and static graphics can be enhanced by technical formulae using LaTeX[14] and streaming audio and video content. Also given the widespread use of MediaWiki and its open architecture, a large number of plug-in modules are available. Added to our Wiki environment were modules for user access management and content traceability.



Front page of AE2-521N Wiki.

3.2 Wiki access management and content traceability

The Wiki content being the reference description of the course material implies controlling who can do what concerning content needs to be enforced. An open environment as is customary for general purpose Wikipedia can easily be modified resulting in loss of coherence and integrity of the course material. Besides affecting the content quality or destruction of content this might potentially result in legal issues if the actual content becomes part of a dispute and course manager(s) are asked to guarantee the course material. Therefore it was decided to restrict access for adding and modifying content to only formally enrolled teachers and students. Other Wiki readers have readonly access but are not allowed editing privileges. A user enrolment confirmation module was added to the software environment. Enrolment request by new Wiki users or bulk enrolment of all students in a course is handled by the course manager(s).

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Analysis of Statically Indeterminate Plates

Introduction

The analysis of plates is rather intricate, as already indicated in the chapter on statically determinate plates. Only in exceptional cases of uniaxial or biaxial stress states, analytical methods can offer a way out. In this chapter, it is explained how internal stresses in plates can be calculated for indeterminate plates. Again, just as in the case of trusses and beams, displacement compatibility is the key to solving the stress state.

As a start, we consider a statically determinate plate. If a square plate of length L and thickness t is loaded in x -direction with a force P , the resulting stress in that direction is $\sigma_x = \frac{P}{Lt}$, and according to Hooke's law, the strain is $\epsilon_x = \frac{P}{ELt}$. Due to the Poisson effect, which accounts for the fact that a plate shrinks in a direction perpendicular to the loading direction, the strain in the transverse direction is $\epsilon_y = \nu \epsilon_x$, ν is the Poisson ratio, with has a typical value of around 0.3 for metals. Note that the stress in the transverse direction remains zero.

Biaxial Stress State

Let us first consider a simple biaxial stress state plate, which is given in [the following figure](#).

Biaxial stress state plate

Obviously there is a stress in x -direction due to the applied force P , but because of both side restraints on the plate, there is normal stress in y -direction as well due to the constraint force R_y . The displacement in x -direction is defined as:

Content page of AE2-521N Wiki.

3.3 Involving teachers and students in Wiki content generation

E-learning and the development of the Internet has provided a new entrance point for students to knowledge [15]. Before world-wide access to Internet became fashionable students used books and lecture notes for their studies. Similar to using Internet to access information by point-and-click students have adopted the same approach to acquiring knowledge. Also knowledge and information in general is perceived to be a shared commodity and no longer perceived as being someone's intellectual property.

Expecting teachers to be involved in content generation assumes them to be convinced of the added benefit of a Wiki with course material especially in comparison with more traditional forms of course material such as books and lecture notes. Introducing E-learning concepts and demonstrating their practical use in a Wiki environment is a strong motivator for teachers. Course managers need to provide active assistance, hands-on workshops and a good and stable Wiki environment to convince teachers to step in. What is ultimately needed is for them to be able to focus not on the tools but on the course material they teach to students. For this project course managers and teachers were introduced to E-learning in general and Wiki environments in particular by presentations, workshops, self-study and simply trying it.

The easiest way to get students to participate in content development is by requiring it as part of the course assessment. Although participation is guaranteed this also is prone to produce bad results as their motivation is not intrinsic. If good course material is to be developed, students need to feel they have ownership of the course material and are intrinsically motivated to contribute. Due to the fast-paced lecture series and the somewhat delayed availability of the Wiki environment this issue was not sufficiently addressed. For this project student participation was not solicited beforehand nor was a means of grade compensation devised.

4 RESULTS

The result of the Grassroots project reported in this paper is a Wiki environment containing the same course material as the reader. A figure displaying the front page of the course material Wiki is shown on page 4. The Wiki front page is similar to the table of contents of the course reader which was developed in parallel.

The figure on page 5 displays one of the Wiki pages with course material. On a par with regular course material the Wiki page contains besides text also technical formulae and pictures.

Richer streaming audio and video content although enabled in the Wiki environment has not been used. Similarly downloadable course material such as homework assignments and example problems was not incorporated. As the project called for course material equivalent to the course reader enriched content was not required. However experiments were done in which the use of enriched content was successfully demonstrated.

Use of the Wiki with course material following the final lecture and before the written examination soared as a large number of students accessed the Wiki while preparing for the examination. Also in the subsequent teaching period students enrolled in related courses and lab work incidentally accessed the Wiki for reference use.

5 CONCLUSIONS AND RECOMMENDATIONS

This Grassroots project for a Wiki with course material resulted in a Wiki environment hosting the course material of the Aircraft Stress Analysis and Structural Design course equivalent to the course reader. During and following this project the following observations and conclusions were reached:

- A Wiki environment is equivalent or better than the traditional course reader. Besides the course material usually covered in a course reader a Wiki environment enables rich content. The varied and richer content potential allows creation of modern and flexible content. Also access to the course material is not restricted to availability of hard copy material but only requires Internet access.
- The Wiki content being a live document enables teachers to keep course material synchronized with evolving lecture content.
- A Wiki environment upgrades teaching from a teacher driven activity to a cooperative teacher and student activity. Cooperation being two-way communication ensures that easier transfer and more persistent delivery of lecture material.
- Due to lack of a student involvement policy and delayed availability of the Wiki environment student participation was less than expected.
- Debriefing students who participated in developing Wiki content learned that ownership by students of the Wiki content is essential to keep them motivated.
- Generally available open source software is of sufficient quality to host a stable and rich Wiki environment. Operational use by teachers, students and course managers is straightforward.
- A limited amount of training in E-learning and Wiki development suffices to get teachers and students involved and establish a functional course material Wiki.
- Easy access to the Wiki with course material helps students in follow-on coursework.

Based on these findings and the lessons learned a new Grassroots project was proposed and granted. This successor project aims to develop on-the-fly course material for a MSc course in which students study topics unique to their graduation project in a cooperative setting. Preparing course material in a classical manner is too time-consuming and only useful for a limited number of students. Using a flexible Wiki environment with a group of MSc students working on a variety of graduation projects and stimulating cooperative development of a shared Wiki gives students ownership of the material and commits them to the project. Teachers contribute by guiding the students on content and in establishing reusable Wiki

content for the next generation of MSc students. In time this will result in a varied and continuously updated Wiki containing study and reference material relevant to the graduation projects of our MSc students.

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