

## Upgrading Miners Knowledge through Website Learning on Mining Methods for Improved Safety and Productivity

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**ABSTRACT:** Mining Engineering Courses worldwide is in the process of continuing restructuring to meet the challenges and changing demands on mining engineering education. This is particularly pertinent in Australia as mines are highly mechanised as well as being in remote locations and away from educational centres of learning. An on-line interactive student resource on longwall mining has been developed at the University of Wollongong to serve as a supplement to formal teaching of mining engineering students enrolled in the subject of Underground Coal Mining Methods. The website (<http://www.edu.au/enp/current/longwain>) was then circulated to students and to various industrial organisations seeking their comments and advice for the future directions of this type of learning system. There was a general desire by various industry personnel to use this website for industry training, as well as for student learning.

### 1 INTRODUCTION

All mining engineering institutions worldwide including those in Australia teach core mining methods subjects to undergraduate students. The techniques of mining are best demonstrated when formal lectures are supported by field visits and hands-on practical experience. Where active mine sites are in close proximity to tertiary institutions, this is not normally a problem. Unfortunately most mine sites nowadays are remotely located from universities and educational institutions offering mining programs. In recent years large group access to local mines has been less than convenient. This makes the learning of certain mining methods a difficult task for students. Conventional teaching methods are to use static overheads and sometimes videos to explain simple operations to students and concept of equipment sizes and three-dimensional visualisation of unit mining operations are not always easily grasped by students. As a consequence, an on-line student resource on longwall mining has been developed to;

- serve as a supplement to formal teaching of longwall mining to students enrolled in the subject of underground coal mining methods,
- gain a better understanding of longwall mining in each student's own time and own pace,
- allow informal on-line interaction between students and lecturers by incorporation of a self-assessment component into the package,

- keep a breast of latest information and technologies used in Australian mines as the website is maintained dynamic with regular updating, and
- gain access to various statutory mining legislation's and laws as the website is linked to various government organisations and legislative bodies websites.

### 2 PROJECT DEVELOPMENT

A research assistant with mining engineering qualifications was recruited to develop the website. Reliance on a trained mining engineer was necessary in view of the nature of underground mining operations not being easily understood and visualised by others not trained in the discipline. Developing the website in-house provided an opportunity to master skills for future development of other sites as well as regular upgrading of the existing website. The initial introduction is to describe and illustrate the basic elements of longwall mining commencing with a basic definition of longwall mining and expanding to more complex issues related to the operation and problem solving associated with longwall mining. Accordingly, the structure of the developed website on longwall mining falls into the following components;

- a) general introduction to longwall mining
- b) general design and layout of longwall mining

- c) longwall mining machinery and equipment
- d) ventilation and environmental aspects of longwall mining
- e) geomechanics and ground control in longwall mining
- f) longwall change over techniques
- g) punch longwall mining
- h) glossary of longwall mining terms and references, and
- i) student and staff interaction.,

The website was written in the standard html format that is used on the internet. Access to the site is via any internet browser (i.e. Netscape Navigator or Internet Explorer) and the address of the website is <http://www.uow.edu.au/eng/current/longwall/>. One of the aims of this project is to present the information to the students in a user friendly and technically attractive style. The subject area that this website was designed for is a very descriptive subject and students previously undertaking this subject have found it difficult to comprehend and imagine in comparison to a real field situation. The incorporation of various video footage on actual coal mining operations and equipment functioning have contributed significantly to students' better understanding of the subject.

### 3 WEBSITE CONTENT

The technical content of the website is based on class lecture notes of the academics involved in teaching the various longwall mining subject components. This is further supplemented with technical material from industry personnel in the field as well as specialist mining consultants. The reported case studies and the future ones to be incorporated will be supplied from mining personnel and expert industry consultants. Although the website is linked to various national and international websites it will not be used to actively promote any company, product or alike. The website's primary function will be for educational purposes only, both for students and for knowledge upgrading of mining industry personnel. The inclusion of a self-assessment component is vital to the credibility and acceptability of the site. A method of determining the competencies of persons and their knowledge of the topics is becoming more critical in view of the mining legislation direction for future training of mine personnel working at the longwall face in Australia. Another section needs to be developed for the number of instances for the recovery of longwalls from disturbances of ground or inadequate maintenance of equipment or incorrect operation of the equipment. There is a lot of case history in Australia and overseas which has allowed

innovative techniques to be developed and would also save many millions of dollars to the mining industry.

To make it easier for students to use the site a standard/template was developed and this structure was incorporated onto every web page. A general view of the front page of the website can be viewed in Figure 1.

The structure used for this website was as follows;

#### 3.1 Universal navigation system

This system allows the users to move around the web site with ease. The agreed system consists of a simple menu bar that is located in a column on the left-hand side of every page. At the top of the menu bar is the Mining Engineering logo of the University of Wollongong. Below the logo is a list of pages/modules that could be accessed from that particular page. To the left of each of the menu buttons is a mining icon (the well-known hammer and pick crossed) used to indicate the user's current location on the website by making the mining icon turn green. Located at the bottom of the menu bar on every page are four 'global' navigation buttons;

- HOME: Returns the user to the front page of the web site.
- GLOSSARY: Takes the user to a comprehensive list of terms and their definitions that are associated with longwall mining.
- REFERENCES: This button takes the user to a list of references that are associated with longwall mining, enabling the students using the web site to further research longwall mining from these particular references. The students can also check the University of Wollongong's on-line library catalogue to see if the references listed are available at the library.
- TOP: This button allows the user to immediately return to the top of the viewed web page when they have scrolled down to the bottom of it.

#### 3.2 Content

The content of the web page takes up the remaining space left from that used by the navigation system. The content is presented in such a manner as to allow the student to read about a particular topic and then view a graphical diagram of that topic. The lecture material incorporated into the web site is well researched to accurately portray current longwall operations in Australia.

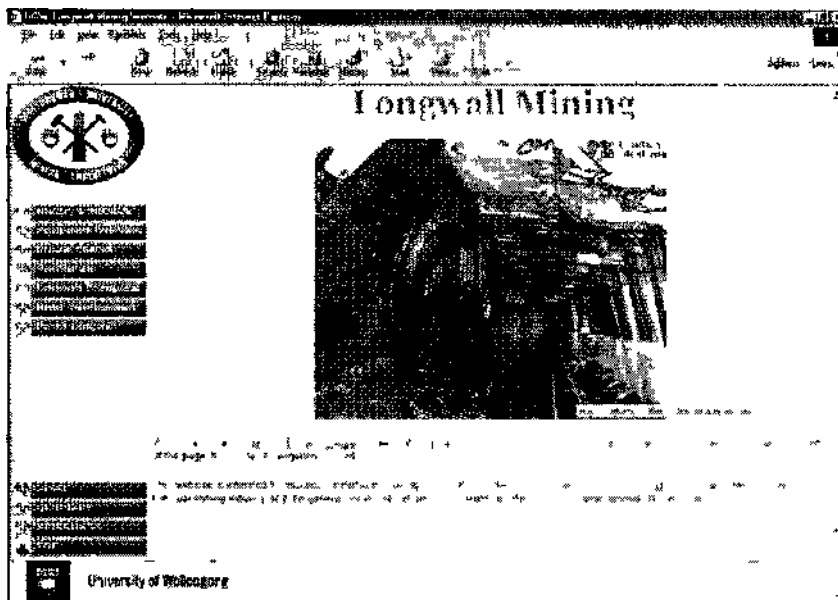


Figure 1 Front Page of the Longwall Mining Web Site

When the user accesses the site the index page in Figure 1 is displayed on their computer screen. A banner is incorporated at the top of the index page that says "Longwall Mining". Beneath the banner is a photograph of a modern longwall face from a current Australian Longwall face operation. In the navigation bar of the index page there is a series of menu buttons for the various learning modules that are available to the viewer. The topics incorporated into this site are:

### 3.2.1 History and methods

This module provides an introduction into longwall mining in Australia and throughout the world. It incorporates a short introduction into the basic concepts of longwall mining and the various methods that can be used to extract coal by longwall mining. A unique feature of this module is that it contains details of every currently operating longwall face in Australia including,

- longwall production figures for the last calendar year,
- equipment used at each longwall mine site,
- layout plan of each longwall site,
- coal seam mined,
- coal transportation,
- method of underground access,
- contact details of the sites,
- geographical location,
- commencement date of longwall mining operations

### 3.2.2 Equipment overview

A thorough description of longwall face equipment is described throughout longwall faces. These include,

- coal shearer
- coal plough
- powered supports
- armoured face conveyor
- pantechicon
- beam stage loader
- communications
- environmental

### 3.2.3 Ground control

An important aspect of longwall mine design is to understand how the surrounding ground stratification reacts when a tunnel is driven through it. The general stress build up around a longwall panel is described and demonstrated graphically as shown in Figure 2.

### 3.2.4 Ventilation

The design of a ventilation system for a longwall mine is dependent upon the geological and atmospheric conditions found at each individual mine site. Many factors have to be considered to determine the most suitable system of ventilation.

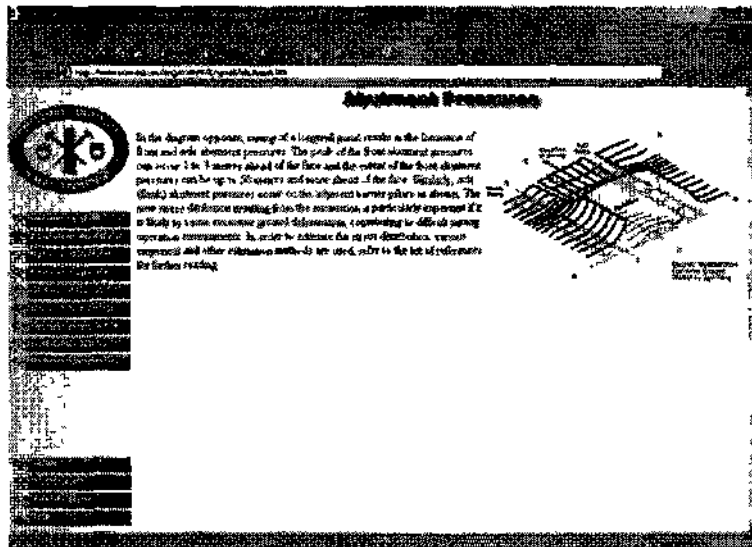
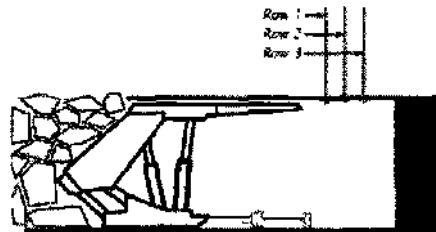


Figure 2 Longwall panel abutment stresses.

### 3.2.5 Longwall Changeover

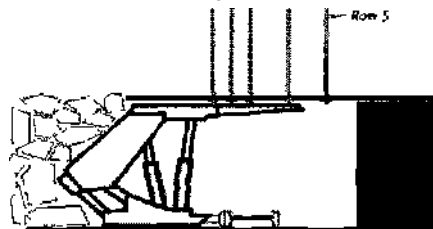
Once a longwall panel has been fully extracted the longwall equipment is dismantled and moved to a new panel. This operation is called a longwall changeover. The sequence of face preparation for equipment salvage is shown in Figure 3.

#### Bolt Up Sequence Stage 1



Cut from the tailgate in 20' chock sections. Place 1 "w" strap over the top of the chock (ie perpendicular to the face) anchored with 2 bolts set at 6.8 metres. Set rows 1 & 3 after row 2 at 7.3 metres & 6.3 metres

#### Bolt Up Sequence Stage 3

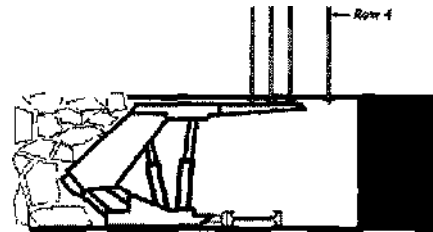


Advance the pans and cut from tailgate to maingate and back to tailgate and advance the chocks. Set row 5 at 4.3 metres.

### 3.2.6 Punch Longwall

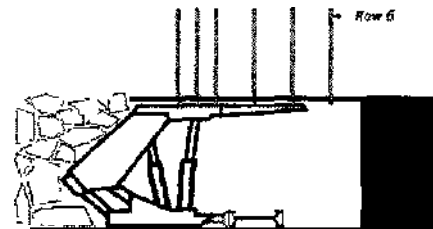
A method of longwall mining from the highwall of an open cut operation, in which the stripping ratio far outweighs the production cost of coal mined as shown in Figure 4.

#### Bolt Up Sequence Stage 2



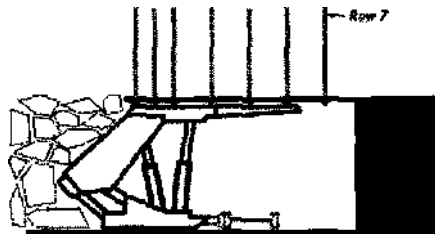
Take the shearer to the tailgate. Advance the pans and cut from tailgate to maingate and back to tailgate, then advance the chocks. Set row 4 at 5.3 metres.

#### Bolt Up Sequence Stage 4



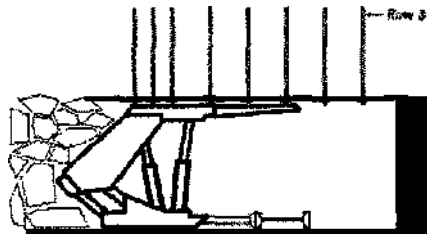
Advance the pans and cut from tailgate to maingate and back to tailgate and advance the chocks. Set row 6 at 3.3 metres.

#### Bolt Up Sequence Stage 5



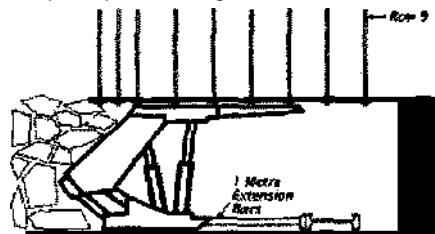
Advance the pans and cut from tailgate to maingate and back to tailgate and advance the chocks. Set row 7 at 2.3 metres. The chocks have now reached their final position. The next 2 shears that are to follow will provide face for the chocks to be removed.

#### Bolt Up Sequence Stage 6



Advance the pans and cut from tailgate to maingate and back to the tailgate. Set row 8 at 1.3 metres.

#### Bolt Up Sequence Stage 7



Install the relay extension bars. These allow the pans to be pushed a further 1.0 metre without the chocks needing to move. Advance the pans and cut from the tailgate to the maingate and back to the tailgate. Set row 9 at 0.3 metres. Set an extra bolt every 2nd chock for mesh at an angle over the coal face.

#### Final Bolt Up Sequence Stage

The face is meshed using angled bolts from stage 7 and bolts where needed to hold the mesh onto the face. A rib strap is installed along the bottom of the mesh and bolted every 1 metre.

This now completes the bolt up cycle. The bolts that were used at this mine were 2.1 metre mild steel bolts. A mild steel bolt was used rather than a high tensile bolt because it is able to bend more.

The conditions at South Bulli did not require support to be installed at the maingate or tailgate. Some other mines in the Illawarra region do provide support to the gate roads. This support is in the form of either:

- Polyurethane Resin injections into the tailgate, maingate and face areas
- Cable Bolts

#### Bolt Up Final Plan View

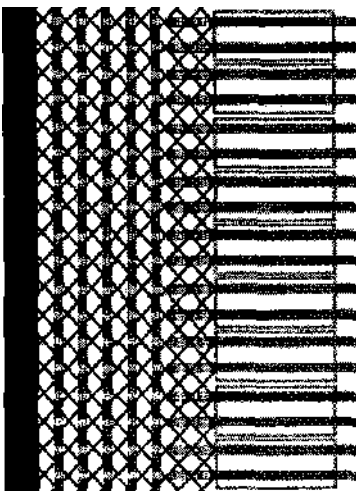


Figure 3. Sequence of longwall face preparation for equipment salvage.

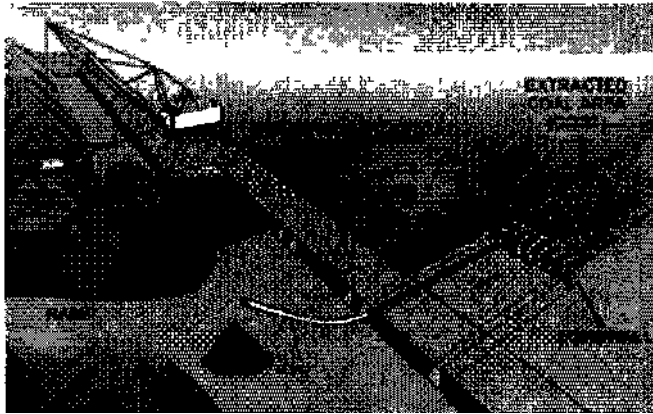


Figure 4 Punch longwall mining

#### 4 WEBSITE SURVEY

In designing any computer interactive system, which requires user participation the friendliness of the system, needs to be evaluated to determine how useful the information portrayed, together with learning retention time, the speed of performance and rate of errors etc. In web interface design, the time required by the browser to load the material together with the navigation controls being developed to prevent loss in hyperspace needs also to be assessed. These concepts are important factors of Human Computer Interaction (HCI), in determining user friendliness usually referred to as 'usability' [Shneiderman 1992]. In assessing usability, information can be collated in a number of ways from observations, interviews, keystroke capture and questionnaires of the users ability to become proficient with the system. There are several leading authors in the design of user interfaces including Nielsen, a leading guru of web interfaces. Nielsen uses a technique of 10 heuristics for assessing usability for assessing web site interface design [Dumas 1988, Shneiderman 1992, Nielsen 1994, Tilson et al 1998, Bevan 1998]. In terms of evaluating the web site a survey of users was devised using some of the heuristics concepts together with a functionality evaluation. Initially the survey was conducted using students which have had exposure to the subject of longwall mining. The aim was to gather their input and ideas for further development on the website. The students navigated through the website for approximately half an hour and were then asked a series of question at the conclusion of the session. Some of their responses are given below

*"It is great because you actually get coloured pictures, movies etc right where your information is so you visualise what your reading"*

*"Yes, very helpful. I wish we had it for our sessions work "*

*"It helped my understanding of longwall mining by a great deal due to the videos and diagrams. "*

*"It helped a lot, doing a 2<sup>nd</sup> year subject it is the V time you are exposed to anything mining related and the concepts can sometimes be confusing but here they are set out logically. "*

#### 5 INDUSTRY RESPONSE

The following comments were received from different industry quarters;

- *"As a non-engineer I found it a very easy site to navigate, with easily accessible links. The quality of writing is excellent, and I was able to easily understand the concepts involved. "*
- *"I would like to congratulate you on the new website, it is very good and extremely comprehensive. The website is a good general introduction to the areas of longwalls. It would be enhanced by the addition of two areas. (i) There needs to be a method of determining the competencies of persons and their knowledge of the topics, this is becoming more critical with the way mining legislation is going for all training in the future. Each of the sections needs an assessment module attached if this is intended for industry training, (ii) Another section needs to be developed for the number of instances for the recovery of longwalls from disturbances of ground or inadequate maintenance of equipment or incorrect operation of the equipment. There is a lot of case history in Australia which has allowed innovative techniques to be developed and would also save many millions of dollars to the industry. The case histories would have*

*to be sought from the various mines who have had longwail failures due to those criteria I gave you and extended delays. "*

## 6 CONCLUSION

The website on longwail mining is developed primarily as a tool for effective teaching in tertiary education. The website has been placed into the public domain to assist in upgrading and training of mining industry personnel as well as raising awareness of the mining operation to the public in general. The website would be a valuable source and a useful library for those interested bodies in remote regions and rural areas of Australia and also any interested persons throughout the world. Although the website is interlinked to various national and international websites. It is purely an educational website that in due course will also be a website for advanced training in various aspects of mining engineering which will cover more complex issues for improved safety in mining operations.

## ACKNOWLEDGMENTS

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