Development of An Online User’s and Training Manual for LaModel

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ABSTRACT

Originally developed in 1993, LaModel has aided mining engineers and researchers alike in improving the design and safety of underground single- and multiple-seam mining operations (Heasley, 1998). Through the years (Heasley, 2011), the use and capabilities of the LaModel program have grown immensely while adapting to ground control concerns and problems within the mining industry. Presently, MSHA specifically mentions the use of LaModel for the analysis of, “complex non-typical roof control plans,” defined as either room-and-pillar retreat mining greater than 1000 feet, bump- or bounce-prone mines, or other criteria considered unusual by the District Manager (Stricklin, 2013).

With an ever increasing number of users and an increase in available solution options and complex analyses, there is now a significant demand for better education and training in the practical application and detailed analysis using LaModel. This paper presents the development of an electronic user’s manual and comprehensive online training course created in an open online learning environment in order to better inform and train industry professionals as well as engineering students and new users. The development of both the user’s manual and online training course will ultimately increase the ground control design effectiveness of mining engineers, leading to safer and more productive mine designs.

INTRODUCTION

Over the past 20 years, mining engineers and researchers have used the LaModel program for improving the design and safety of single- and multiple-seam mining operations. LaModel uses a laminated, displacement-discontinuity, boundary-element method which simplifies the overburden into a stack of frictionless homogeneous laminations and limits the detailed analysis to the seam itself. This approach is fundamentally simpler than either finite-element, finite-difference, or discrete-element approaches; and, therefore, the program provides a significant reduction in computational time and efficiently calculates the displacements, stresses, pillar safety factors, multiple-seam interactions, subsidence, etc. for thin-bedded deposits such as coal, salt, potash, limestone, etc. (Heasley and Salamon, 1996; Heasley and Agioutantis, 2001). The laminated overburden model in LaModel is different than previous homogeneous elastic formulations and more realistically represents the natural flexibilities of the stratified sedimentary overburden typically associated with coal seams (Heasley, 2008).

Since its inception in 1993, LaModel’s ability to accurately and reliably determine underground displacements, stresses, and stability has been highlighted in numerous academic publications, research projects, industry designs, and regulatory analyses, most notably the back analysis of the Crandall Canyon mine collapse (MSHA, 2008). While initially developed as a simple research tool, program features have continually expanded to meet the needs of practicing ground control engineers. As mining operations continue to develop reserves at deeper depths and in more complex geological conditions, and with state and federal regulatory agencies requiring mine operators to provide and conduct more detailed engineering investigations of mine stability, there has been an increased interest in the use of LaModel as an underground mine design tool. In fact, MSHA’s Roof Control Plan Approval and Review Procedures explicitly mention LaModel as an approved program for the stability analysis of non-typical mine layouts at depths greater than 1,000 feet, in bump- or bounce-prone seams, or mining conditions considered unusual by the District Manager (Stricklin, 2013). With more widespread use of the program (Gauna and Tyrna, 2010), there is now a large demand for better support and training on the technical details and practical application of LaModel for the evaluation of mine stability.

Problem Statement

Although multiple publications, research projects, industry design, and regulatory reliance on LaModel have helped make the program a popular design tool, there is not a comprehensive user’s manual/help file for users to access when questions about the program arise. With an increasing number of users, there is now a larger demand for better support and training in the application of LaModel. Previously, LaModel has never attained a huge user base within the mining industry, partly because of the industry’s small size, and partly because of the difficulty of learning and using the program without readily accessible documentation and training materials. The limited number of LaModel users is a bit of a “catch22.” Without enough users, it is very difficult and expensive to justify putting too much effort into the development
of comprehensive user support materials, but without providing the user with proper support through a good user’s manual, it is difficult to grow the number of program users. In the past, initial steps were taken to compensate for the lack of a user’s manual by providing access to an online set of slide-based tutorials, and by offering LaModel workshops in 8- to 12-hour sessions at various venues. While the tutorials were useful, they certainly were not up to the present standards of modern comprehensive, multimedia-driven technical documentation. Also, although the workshops were very informative in the application and derivation of LaModel, availability was limited, and did not provide on-demand access to information and training materials when questions arose. Therefore, to meet the needs of the LaModel program’s user base, and to cultivate its expansion, a modern, comprehensive, web-based, multimedia-driven user’s manual and training course has been developed.

Objectives

The Information Age has brought many technological and cultural changes especially in the forms of online communication, and in particular, a new revolution in education as students are beginning to step away from the traditional classroom setting in adoption of the online learning environment (Shah, 2013). The global rise in internet availability, increase in computational capacities, and reduction in technology costs have amplified claims that new mobile and streaming technologies can provide accessible, quality education to the public (Alexander and Boud, 2001). Currently, both public and private educational institutions have become more accepting of the online environment as a means of educating diverse student populations. With enrollment estimated at 10 million users and courses available from over 200 universities around the world, The New York Times officially deemed 2012 the “Year of the MOOC,” or Massive Open Online Course (Pappano, 2012).

LaModel’s diverse user base, ranging from high school-educated technicians to engineering specialists with doctoral degrees, necessitates instantaneous access to current and comprehensive reference materials designed to accommodate users from multiple occupational backgrounds. Therefore, a comprehensive, electronic reference source/user’s manual for the LaModel program is desired. This online user’s manual should decrease the barriers to initial adoption of the program, reduce training costs, and increase the speed of user acquisition of program knowledge, thereby increasing overall productivity. It is desired that the online manual incorporate written technical documentation, hands-on software demonstrations, narrated slide presentations, and related academic publications. It should enable users to quickly access information on the installation, operation, and troubleshooting procedures of the LaModel program. Further, it is desired that some information from the user’s manual and supplemental material to be arranged into self-paced online training modules. These training modules are intended to be primarily composed of voice-over and captioned slide presentations and hands-on LaModel software demonstrations, which are then further supported by the technical documentation and academic articles within the user’s manual. It is the intention of this project to better educate the public on the application of the LaModel program through the creation and online distribution of a LaModel user’s manual and training modules.

LAMODEL USER’S MANUAL

The LaModel user’s manual is composed of five main sections:
1) Welcome to LaModel, 2) LamPre, 3) LaModel, 4) LamPlt and 5) Stability Mapping (see Table 1). Section 1, “Welcome to LaModel,” introduces the history and technical background of the LaModel Program. Section 2, “LamPre,” describes the parameters, input processes and calculation procedures for the forms, wizards, and graphical grid editor in LamPre. Section 3, “LaModel,” explains the application of the single-form LaModel program including details of the progress messages that appear during a run and details of the various input and output files used by LaModel. The LamPlt section (#4) describes the various stress items output by LaModel and the available plots and associated options for illustrating the stress items. Finally, Section 5, “Stability Mapping,” explains the specific functions in the stability mapping program that apply to LaModel including: automatic seam and topography grid generation, transfer of LaModel results into grids, grid utility functions and grid plotting in AutoCAD. These five sections introduce the new user to LamPre, LaModel, LamPlt and Stability Mapping and provide the experienced user with all the technical specifics on program features, parameter ranges, mathematical limitations, as well as calibration and analysis.

The five sections in the user’s manual are composed of core technical documentation (see Figure 1) along with supporting slide presentations, software simulations, and academic publications. The technical documentation provides users with written details on the definition, use, typical ranges, etc. of critical parameters. The slide presentations are narrated and captioned PowerPoint presentations that provide additional background and mathematical details on the derivation and practical application of the program. The software simulations are produced in the Captivate program, which allows the developer to produce videos of LaModel screen captures that include on-screen events such as: mouse movements, menu selections, keyboard inputs, etc. These simulations provide step-by-step hands-on demonstrations of parameter input and operating procedures for every facet of the LaModel program. Finally, all of the core technical documentation, narrated slide presentations, and hands-on software simulations are supported with copies of academic publications which include professional papers, project reports, and student dissertations. These technical publications provide very in-depth mathematical details of LaModel, along with examples of practical applications. The electronic user’s manual can be considered as an encyclopedia or companion guide to LaModel that provides users with detailed information and hands-on learning activities demonstrating each feature of the program application and operational control. More than just defining the input parameters, the user’s manual strives to provide comprehensive details and interactive demonstrations of the practical application of LaModel in order to better train a proficient end user.

The actual LaModel user’s manual “document” is created using Adobe’s help file creation software, RoboHelp. Using RoboHelp, the bulk of the user’s manual is compiled into a MS Windows HTML help file. The Windows help file format (.chm) is very familiar to computer users (see Figure 1), with the presented material organized using a “Table of Contents” style navigation pane on the left and specific topic details to the right. With this format, users are able to quickly navigate through the manual, exploring more intricate details of LaModel from slide
Table 1. Preliminary Summary of LaModel User’s Manual.

<table>
<thead>
<tr>
<th>Section Title</th>
<th>Manual Text</th>
<th>PowerPoint Presentations</th>
<th>Captivate Videos</th>
<th>Captioned Dialog</th>
<th>Recorded Audio</th>
<th>Papers</th>
<th>Theses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>words</td>
<td>slides</td>
<td>frames</td>
<td>words</td>
<td>hours</td>
<td></td>
<td></td>
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<tr>
<td>1.0 Welcome to LaModel</td>
<td>924</td>
<td>56</td>
<td>0</td>
<td>3758</td>
<td>0.41</td>
<td>0</td>
<td>0</td>
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<td>2.0 LamPre</td>
<td>&gt; 17184</td>
<td>&gt; 72</td>
<td>&gt; 428</td>
<td>&gt; 18,628</td>
<td>&gt; 2.05</td>
<td>&gt; 6</td>
<td>&gt; 3</td>
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<td>3.0 LaModel</td>
<td>2,071</td>
<td>-</td>
<td>~ 34</td>
<td>~ 1,442</td>
<td>~ 0.16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.0 LamPlt</td>
<td>5,213</td>
<td>&gt; 50</td>
<td>&gt; 308</td>
<td>&gt; 11,078</td>
<td>&gt; 1.22</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5.0 Stability Mapping</td>
<td>7,811</td>
<td>~ 20</td>
<td>~ 205</td>
<td>~ 7,352</td>
<td>~ 0.81</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Preliminary Manual Totals</td>
<td>&gt; 32,609</td>
<td>&gt; 198</td>
<td>&gt; 1,437</td>
<td>&gt; 42,258</td>
<td>&gt; 4.65</td>
<td>&gt; 8</td>
<td>&gt; 5</td>
</tr>
</tbody>
</table>

At the time this paper was written, the LaModel user’s manual remains in its development stage as the recorded audio is being finalized. The latest topics that are under construction for the soon to be released LaModel 3.1 update include: the new strain-softening coal wizard, the local mine stiffness form, and the new solution algorithm. The current version of the user’s manual discusses all topics concerning LaModel 3.0 with over 32,000 words of technical documentation providing users with written details on the definitions, application, typical ranges, etc. of critical parameters. The written documentation of the LaModel program is further supplemented by over 190 PowerPoint presentation slides and over 1,400 Captivate video frames with about 42,000 words of narrated dialog and an estimated 4.65 hours of hands-on demonstrations. Users are also able to enhance their understanding of the LaModel program by accessing 13 academic publications, which provide mathematical details and examples of the practical application of LaModel and are attached to the help file. In utilizing this diverse set of multimedia formats (text documentation, slide presentations, video simulations, and technical publications) the LaModel user’s manual provides an engaging presentation of all of the program features to better educate the public on the application and detailed analysis of underground mine works using LaModel.

User’s Manual Example

In order to provide the reader with an in-depth understanding of the structure and design of the materials within the LaModel User’s Manual, an example of using the user’s manual to investigating one of the many topic pages, the Lamination Thickness Wizard page, is presented here. To investigate this topic, the user would access the topic page through the “Table of Contents” navigation pane on the left of the main User’s Manual window. First, the user would expand the “LamPre 3.0.2” section folder, then expand the “LamPre Input Parameters” section folder, followed by the “Overburden/Rock Mass Parameters” folder, and finally open the “Lamination Thickness Wizard” page, as shown in Figure 2.

Within the “Lamination Thickness Wizard” topic page, the user is first presented with a short description on how to access the wizard within LamPre (see Figure 2). Following this introductory description, the topic page has been organized by the main parameter sections (Rock Mass Parameters, Seam Parameters, Abutment Extent Parameters, and Yield Zone Parameters) used in the LamPre Lamination Thickness Wizard form (see Figure 3). By scrolling through the topic page, users are able to peruse detailed descriptions of each form section and the associated parameters. All of the descriptions contain basic definitions, while the descriptions for the more complex parameters include an explanation of the mathematical derivation and suggested parameter ranges.
In addition to the core technical documentation of the Lamination Thickness Wizard, if the user continues deeper into the table of contents under the thickness wizard (see Figure 3), they are presented with three different sets of supplementary material: a narrated PowerPoint slide presentation describing the mathematical details behind the thickness wizard, a hands-on demonstration video on using the wizard with a “Tutorial 1” example and an academic publication detailing the derivation of the calibration equations used in the wizard. All of this material can be accessed through the table of contents, or by selecting in-text hyperlinks in the topic page.

In the supplemental slide presentation, users are introduced to the lamination thickness wizard form through descriptive slide, mathematical equations and graphical depictions of the underlying program principles. Then, the user can practice using the form by following along with the hands-on video demonstration. Finally, if the user desires more information about the Lamination Thickness and associated wizard, the related academic publication, “Calibrating the LaModel Program for Site Specific Conditions” (Heasley, 2008) may be opened.

The LaModel User’s Manual has been developed to provide comprehensive support on the technical knowledge and practical experience needed to proficiently use LaModel. By developing the manual in an HTML format, users are able to quickly access and review the detailed information about the program from many locations, on many devices, and at the time and speed they desire. Ultimately, it is anticipated that this user’s manual will lead to an increase in LaModel’s effectiveness in the hands of practicing mining engineers to enable the design of safer and more productive underground mining operations.

LAMODEL ONLINE TRAINING COURSE

To complement the user’s manual, an extensive online training course has also been developed. This training course is intended to instruct novice through experienced users in the technical background and practical application of the LaModel program, and it has been designed in accordance with traditional educational pedagogies. The topics discussed within the LaModel training course have been grouped into three primary learning tracks (“Novice,” “Intermediate,” and “Advanced”) with respect to the user’s current level of program knowledge and experience (see Table 2).

In order to progress through a given learning track, the user must complete a logical sequence of training modules composed of narrated and captioned slide presentations and/or hands-on software demonstrations. Typically, various example models will be developed, run, and analyzed as a result of the training sequences. After the user has completed studying certain groups of the training material, they will need to complete formative assessments to prove their mastery in understanding the presented materials. Users will only gain access to the succeeding training material by achieving a minimum assessment score of 80%. By completing all learning tracks, a LaModel user will have mastered all of the provided educational material on the background and application of the LaModel program for the evaluation and design of underground mine stability. In the future, it is planned to provide some type of professional development hours as a result of completing the various tracks in the training course.

Novice Learning Track

The Novice Learning Track has been designed to provide the initial knowledge and skills necessary to prepare, run, and analyze basic single- and multiple-seam mining scenarios. In this track, the user is introduced to the LaModel program (LamPre, LaModel, LamPlt, and the Stability Mapping application) through entry level slide presentations and software demonstrations. The learning material in the novice track provides an overview of the background information and practical application of LaModel for the calculation of underground convergence and stress distributions in underground mining scenarios, primarily through two example mine models, Tutorial 1 and Huff Creek. In completing this learning track, the novice user will have obtained a basic understanding of LaModel’s modeling procedures and available analysis options.

Table 2. Preliminary Summary of Online Training Course Materials.

<table>
<thead>
<tr>
<th>Section Title</th>
<th>Captioned Dialog</th>
<th>Power Point Presentation</th>
<th>Captivate Video</th>
<th>Recorded Audio</th>
<th>Papers</th>
<th>Theses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>words</td>
<td>slides</td>
<td>frames</td>
<td>hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novice Learning Track</td>
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<td>57</td>
<td>569</td>
<td>~ 2.17</td>
<td>3</td>
<td>0</td>
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<tr>
<td>Intermediate Learning Track</td>
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<td>77</td>
<td>335</td>
<td>~ 1.46</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Advanced Learning Track</td>
<td>~ 111,700</td>
<td>44</td>
<td>1093</td>
<td>~ 4.02</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Preliminary Course Results</td>
<td>~ 151524</td>
<td>178</td>
<td>1997</td>
<td>~ 7.65</td>
<td>13</td>
<td>4</td>
</tr>
</tbody>
</table>
Intermediate Learning Track

The Intermediate Learning Track has been designed to provide a more advanced understanding of the behaviors and characteristics of the laminated overburden model, and builds upon the knowledge and skills gained in the novice training modules. The intermediate track is composed of four independent training modules. Users are first educated on the Deep Cover Calibration techniques for the lamination thickness, coal strength and final gob modulus parameters as implemented in the LaModel material wizards. To further the user’s in-depth understanding of the behavior of the laminated overburden model as implemented in LaModel, the Gory Details module is presented. Then the Solution Options training module explains the various extended solution options available in the LaModel program. And finally, in the Stability Mapping training module, users are shown how to take the LaModel displacement and stress outputs back into the AutoCAD program for developing advanced illustrations.

Advanced Learning Track

The Advanced Learning Track has been designed to provide the experienced users with an understanding of LaModel’s most intricate details of its more complex program features, as well as provide a hands-on demonstration of programming the basic LaModel solution algorithm (see Figure 4). (Most of this material was taken from the graduate level course on LaModel at WVU.) The advanced track expands upon the intermediate track by further analyzing the behavior of the laminated model and by examining the most advanced forms of analysis available in LaModel: multiple-seam subsidence, energy calculations, beam bending stresses, etc. To really test and expand the user’s true comprehension of the laminated overburden model, the final training module steps the user through programming a simplified LaModel application (LAMLITE) in Microsoft Excel using the Visual Basic for Applications (VBA) programming language (see Figure 4).

In order to provide free and open access and enrollment to the LaModel Online Training Course, it is being hosted by the “CourseSites” (www.coursesites.com) free online learning platform. CourseSites is powered by the “BlackBoard” technology and learning management system and provides course hosting, student management, and performance monitoring for web-based (e-learning) course materials within a user-friendly online learning environment (see Figure 4). Each learning track within the course is accessed through a “Table of Contents” style navigation pane on the left of the CourseSites window. Each learning track is further subdivided into a series of training modules as described above (see Figure 4). The formative assessments at the end of each learning track evaluate student comprehension and retention of the presented materials and require a minimum score of 80% to demonstrate mastery of the subject material to permit progression through the course. Through utilizing the CourseSites online learning platform, LaModel training materials are available to all users anytime, anywhere through a modern, user-friendly, and full-featured online learning environment available on Windows, iOS, Android and Blackberry phones, and PC devices.

At the time this paper was written, the online course was about 70% complete, with mostly the course audio needing to be finalized. The present version of the online course contains 178 PowerPoint presentation slides and 1,997 Captivate video demonstration frames with about 151,524 words of narrated dialog and an estimated 7.65 hours of audio recordings (see Table 2). The training modules provided within this course are further supplemented with 17 academic publications which further detail the mathematical derivation and provide examples of practical LaModel applications. When the online course is finalized, the modern mining engineer who completes the course will have developed the knowledge and skills necessary to analyze the most complex underground mining scenarios with LaModel and thereby design safe and efficient mines.

EVALUATING COGNITIVE ABILITIES WITH THE ONLINE LEARNING ENVIRONMENT

In developing the LaModel Online Training Course, it was important for the course administrator to evaluate course quality standards and to accurately track student performance from the online course. In particular, it was strongly desired to know if the online course would provide the same quality of education as either the classic lecture delivery or the workshop environment. Due to the obvious lack of face-to-face contact between an online student and the educator, online educational assessments would need to be the primary strategy for evaluating the online student’s grasp of the presented materials and the effectiveness of online instructional format. Therefore, 14 assessments were developed for the course, and they were designed in accordance with standard educational pedagogies that facilitate learning and material comprehension.

Specifically, the Mastery for Learning Model and Bloom’s Taxonomy for the Cognitive Domain were used to develop the assessments and thereby provide the online class administrator with direct evidence on both the user’s understanding and the quality of course material delivery.

The Mastery for Learning Model refers to an educational approach in which each student stays within a certain learning module in a cyclical process of assessing and correcting until
the learning objectives of that module are met (Bloom, 1976). Therefore, after a student has reviewed the training material, they are assessed on the learning objectives of that material. If they demonstrate a mastery of the material objectives (a minimum score), they move on to the next set of material. If they do not show a mastery of the material, they are provided with corrective material until they are able to successfully master the material as demonstrated by a satisfactory grade on the assessment (see Figure 4). This instructional model provides a process by which educators can be sure to achieve student mastery of the learning objectives through the implementations of frequent diagnostic testing to highlight and correct user mistakes along their learning path (Guskey, 2007).

Following the model structure (Figure 5), all students in the LaModel online course begin together within the same training module, Tutorial 1, but progress through the training modules at their own pace, moving from one topic to the next as they master each module in turn. To ensure that learning objectives are being met, user knowledge and comprehension of the LaModel concepts and application skills presented within each training module are assessed at the end of that module (as represented by the Knowledge Check in Figure 5). In passing the assessment with a score equal to or above 80%, users will have shown mastery of the subject. Upon obtaining mastery, users will be provided with direct access to the subsequent training module and enrichment material further increasing student proficiency, if so desired. If the LaModel course user does not achieve an assessment score of 80%, they have not demonstrated mastery of the presented LaModel materials and, therefore, will be sent back to review the material in the module. Users who are struggling within the training module are encouraged to review the previously presented material until mastery has been achieved, as demonstrated by successful completion of the original assessment (Knowledge Check 1).

In addition to the structured delivery of the material using the Mastery for Learning model, a pedagogical classification system, known as Bloom’s Taxonomy for the Cognitive Domain, has been implemented into the design of each individual assessment. Bloom’s Taxonomy for the cognitive (or knowledge) domain divides a student’s knowledge into six cognitive levels moving from the lowest order knowledge process to the highest order process: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. The taxonomy assumes that learning at the higher levels is dependent on having attained the prerequisite knowledge and skills at lower levels; therefore, learning begins at the foundation, or Knowledge, level (see Figure 6) and progresses to the next cognitive level until the user reaches the apex of high order thinking, Evaluation. Bloom’s Taxonomy for the Cognitive Domain provides a framework for assessing the “level” of a student’s knowledge, comprehension, and critical thinking within a specific learning area. Using this pedagogical practice, students are assessed across the six cognitive levels. Therefore, specific questions are designed to assess different levels of cognition in order to fully investigate student performance and the effectiveness of pedagogical practices.

The formative assessments for LaModel’s online training course have been developed with respect to Bloom’s Taxonomy for the Cognitive Domain so that course administrators are able to compile evidence on the level of the user’s grasp of the presented training material as well as on the effectiveness of the educational pedagogies implemented for material delivery within the online learning environment. In analyzing the data obtained from the course assessments, the classroom can be evaluated as a whole through grade distributions, and also each individual student’s comprehension level can be assessed. Using the assessment information, the course administrator can ultimately evaluate if the online course is providing the same quality of education as either the classic lecture delivery or the workshop environment.

**PRELIMINARY RESULTS**

During the early stages of the data collection to date, the three different educational environments used to deliver the LaModel learning material (traditional college classroom lectures, industry workshops, and online course) have each been assessed. Specifically, ten senior undergraduate student volunteers have completed the assessments after training in the traditional classroom setting. Five graduate students have attended an 8-hour LaModel workshop and completed the assessments, and six graduate students have enrolled in the LaModel online training
course and have completed both the Introductory and Tutorial 1 training modules and associated assessments.

The students from all three training environments completed both the LaModel Introduction module and the Tutorial 1 training module and were subsequently assessed. The grade distributions from each of the three environments and two training modules are plotted in Figure 7. This is very preliminary data with small samples of students, and, unfortunately, the cohorts of the various environments are somewhat confounded by the participation of only undergraduate or graduate students in certain environments. One might expect that the graduate students’ higher level of education and presumed harder work ethic might influence the result, and indeed, it is seen in Figure 7 that the undergraduate students that are in the traditional classroom setting obtained the lowest average assessment grade on both the Introductory and Tutorial 1 training modules, 55% and 59%, respectively. While the graduate students in the workshop obtained slightly better assessment scores, 83% and 64%, and the graduate students using the self-paced training module obtained the highest average assessment of 92% and 91%. If the group of undergraduate students is not considered an equivalent cohort to the groups of graduate students, then the preliminary assessment results only provide a potential comparison between the workshop and online environment used by the graduate students. A t-test was performed on these two sets of results, and it indicated that the grade distributions were statistically different, with the graduate students’ knowledge higher in the online environment than in the workshop environment. These results are very preliminary with insufficient sample numbers to make any strong inferences; however, at this point, the online learning course and environment seems to be at least (if not more) as effective at training LaModel users as either the workshop or traditional classroom environments.

![Normal Distribution of Tutorial 1 Assessment Results](image)

**Figure 7. Normal Distribution of Tutorial 1 Assessment Results.**

**SUMMARY AND CONCLUSION**

More difficult mining conditions coupled with a desire for higher design standards for safety and stability in the mining industry have greatly increased the use of the LaModel program in recent years. With this increased use of the program, there is also a larger demand for better support and training on the technical details and practical application of the program for the evaluation of mine stability. The work presented in this paper details the design and implementation of an online user’s manual and training course for the LaModel program, which are intended to meet the needs of the LaModel user. This online user’s manual and training course have been designed to be comprehensive, online and multi-media based, using written technical documentation, hands-on software demonstrations, narrated slide presentations, and academic publications to present the material.

Using the online manual, users are able to quickly access detailed, technical documentation on building, running, and analyzing case histories using the LaModel program. Further, self-paced instruction, hands-on demonstrations, and assessments on examples of using LaModel can be obtained by using the online training. At the present time, the user’s manual and training course have over: 100 pages of technical documentation, 200 narrated slides with over 1250 lines of narration, 2000 frames in over 7.5 hours of demonstration video, and 17 professional papers. It is the intention of this project to better educate and train academic, industry, and regulatory users on both the practical application and detailed technical background of LaModel through the developed user’s manual and training modules. It is hoped that these efforts will improve the design of underground mines and thereby improve overall mine safety and productivity.

**WORKS CITED**


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