Session 2520

INTEGRATING MULTIMEDIA INTO THE LABORATORY EXPERIENCE

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The Associate Mechanical Engineering Technology program at Penn State University at Wilkes-Barre offers a three course sequence in applied mechanics: statics, strength and properties of material, and strength and properties of materials laboratory. To aid in the understanding of the relationship between theory and application students chose to analyze suspension bridges and their construction. Bridges are ideal candidates for a discussion on types of supports, flexible cables, bolted and riveted connections, and tension and compression members.

This paper focuses on the integration of multimedia into measurement of mechanical properties, destructive testing, data acquisition and analysis, and reporting of results. Laboratory exercises include tensile testing of round stock, flat stock joined by rivets , and flat stock joined by a bolted connection. The results of the various tensile tests are compiled and presented as written and multimedia presentations.

1. Introduction

In the Associate Mechanical Engineering Technology program students are quite receptive to performing laboratory exercises which highlight and/or relate to life experiences. While students drive over and under bridges daily, appreciating the bridges' utilitarian function is not consonant with the ability to reach a given destination. To highlight the importance of the bridge to our daily lives students were given the task to photograph and/or video any number of bridges. This provided an opportunity to identify the many types of bridges in existence as well as provide a vehicle to identify expansion joints, fixed supports, and roller supports.

Traditionally the course focused solely on destructive testing using a Tinius Olsen tester having a 20,000 pound capacity. Currently a digital version of the traditional Tinius Olson tension/compression tester is used. The tester is connected to an XY flat bed recorder through a strain conditioner, as well as having extensometer capability. In addition, a computer can be used to communicate with the tester via an RS 232 connection.

A crucial function of this mandatory laboratory course is to familiarize students with testing equipment, data acquisition, testing procedures, and reporting of results. In addition, an equally important aspect of this course is for students to apply knowledge previously acquired in the strength of materials course to the analysis of various types of load carrying connections. In this instance, riveted as well as bolted connections are tested and results matched to theoretical calculations.

Today the course emphasizes the traditional approach to destructive testing along with the power of integrating multimedia into the presentation of data by incorporating video, text, and audio. Traditional flatbed XY recorder output is scanned, video is edited using Adobe Premier[1], Qpro[2] is utilized to generate data tables as well as perform necessary calculations. Additionally, the student enhances photos using Photoshop[3] and communicates with other lab partners through First Class[4]. Experiential results are presented using Power Point.

2. Laboratory Exercises

Until the acquisition of the Tinius Olsen series 5000 testing machine, students were limited to the traditional tension or compression test. Currently, in addition to the standard tensile test of round and flat stock, students perform tensile tests of flat stock having a hole drilled in the test section and of lap jointed overlapped flat stock joined by either rivets or bolts. An abrupt change in geometry, such as a hole, results in non-uniform stress distributions and this abrupt increase in stress at these localized regions is called stress concentrations[5]. The focus of the two latter tests is to confirm the predicted mode of failure of the lap joints, whether by shear or bearing. In addition, these exercises provide students with reinforcement and understanding of the interplay between theory and practice.

A. TENSILE TEST: ROUND/FLAT STOCK

To reinforce the concepts of elastic behavior properties of materials a tensile test is conducted using a standardized round stock aluminum specimen[6] . Also, this exercise is used to familiarize the student with the equipment, associated hardware, and attachments. Here the Tinius Olsen[7] with the 5000 pound load cell is used along with an XY recorder[8]. The result of the tensile test is directly outputted to the XY recorder in the form of a force-extension diagram. Various points[9]of this plot are identified and discussed in order to prepare the student for a tensile test that incorporates an extensometer[10] into the testing process. The electronic extensometer is designed for measuring tension strain. As the specimen is elongated during loading "the moving knife edge and lever of the instrument move the armature core within the differential transformer. This motion produces a voltage which when amplified drives the strain axis of the recorder."[11] Hence the second lab exercise is to perform a tensile test using an electronic extensometer[12]. Students convert the force axis (Y) to a stress axis by normalizing the force using the cross-sectional area of the test section.

B. STRESS CONCENTRATION

Students were given the task to drill a hole and then perform the tensile test. However, the tensile test must be run after the students predict the safe load which could be applied without exceeding the yield point. For this test, a 1/16 in hole was drilled in the center of the test section with a net width at the section of 0.428, and r/b of 0.073 resulting in a K of 2.6[13]. With this information in hand students predict the safe load which can be applied without reaching the yield point.

In this particular case, the results varied from the anticipated (calculated)values. The students concluded that several factors contributed to this inaccuracy, the shape of the specimen and some slippage of the specimen within the grips of the cross-heads.

C. LAP JOINT

C1. RIVETED/BOLTED

For this lab exercise students assembled two specimens for testing. One specimen lap jointed with aluminum rivets, and the other bolted. The students looked at shear and bearing calculations to serve as predictors for mode of failure. And in each case predicted correctly the mode of failure. However, although the mode of failure was predicted, the forces required for the riveted as well as the bolted lap joints to fail varied considerably.

Although the primary objective of this exercise was achieved, the students felt disappointed at not having predicted accurately the load at failure. In this case, the students identified several contributing factors; incorrect shear area of the rivet, and uncertainty of the allowable stress for the rivets and bolts. Consequently, the students realized that off the shelf fastening devices must first be properly identified and their mechanical properties verified.

D. PRESENTATION

Having completed the lab exercises, the task for the students was to integrate the results into a multimedia presentation that would summarize their semester's work. Students used First Class to communicate[14] amongst each other, Adobe premier to edit the video, photoshop to process photos, Qpro for spreadsheet and finally Power Point[15] to present the work. The students were given instructional support from an instructional design services person to facilitate the learning of these various software packages.

3. Conclusion

The Strength of Materials Laboratory course at Penn State University at Wilkes-Barre with the enthusiasm of the students has moved into a new era where a lab exercise is much more than the mere pushing of buttons and seeing recorders record. This lab course has provided a platform for the associate degree student to integrate oral, written, and social skills thereby fostering their collaborative and asynchronous learning skills.

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[1]Adobe Premiere™ is a video editing software package designed to perform desktop video editing (both on-line and off-line) or creating QuickTime movies for presentations or CD-ROM production. Students were required to procure video relevant to their presentation by utilizing existing VHS video clips available from the campus' library or to use a video camera to shoot their desired footage. Students were required to convert their desired VHS video clips into digitized format for incorporation into their production. In this case the students digitized the clips into Quick Time movies having a .mov format. This required the additional step of acquiring a Quiktime Movieplayer for Windows from the World Wide Web. (See Appendix E)

[2]Qpro™ is a spreadsheet software package used to generate data tables as well as perform all desired calculations.

[3]Adobe PhotoShop 3.0 is a photo design and production program that allows the user to create original artwork and for touching up and/or enhancing graphics, and scanned in photographs. Students used this program to convert photographs, existing computer graphics, and video into a digitized format compatible for insertion into their Microsoft Office's PowerPoint presentation. (See Appendix F)

[4]FirstClass is a software program with an interface designed to permit electronic communication among students, technical assistants, and professors. The general features of First Class used by the students working on this project were the e-mail, free open transport and chatting. (See Appendix G)

[5]Cheng, F-H., Statics and Strength of Materials, Glencoe, 1985

[6]Penn State University utilizes a round stock test section nominal diameter of .235 inches and a flat stock specimen having a test cross-section of 0.485 in. X 0.05 in. Both specimens are A1 6061-T6.

[7]Tinius Olsen Series 5000 Bench Universal Testing Machine (see Appendix A)

[8]Tinius Olsen series 1000/5000 Flatbed XY recorder (see Appendix B)

[9]Proportional limit, yield point, ultimate strength (see Appendix C)

[10]Tinius Olsen S-400-2A which is an English units extensometer with a highest strain magnification of 400 (in./in.). This averaging (A) type measuring system (i.e. Knife edges are opposite sides of the specimen) also has a gauge length of 2 inched. In addition , a strain conditioner (Model HSC) is used in conjuction with the extensometer. The strain conditioner is capable of four settings **1:1, 2:1, 4:1, 10:1** for the S-400-2A extensometer. (See appendix D)

[11]Tinius Olsen Instruction Pamphlet No. 3a, S-type and SM-type Electronic Extensometers.

[12]The extensometer must be removed prior to fracture, otherwise risk damage to the unit.

[13]Cheng, F-H., Statics and Strength of Materials, Glencoe, 1985 p255

[14]As many students Penn State/Wilkes-Barre reside one to two hours from the campus, establishing and maintaining group communication is critical for the success of any project. FirstClass Client Communication Software v3.5 provided this conferencing capability.

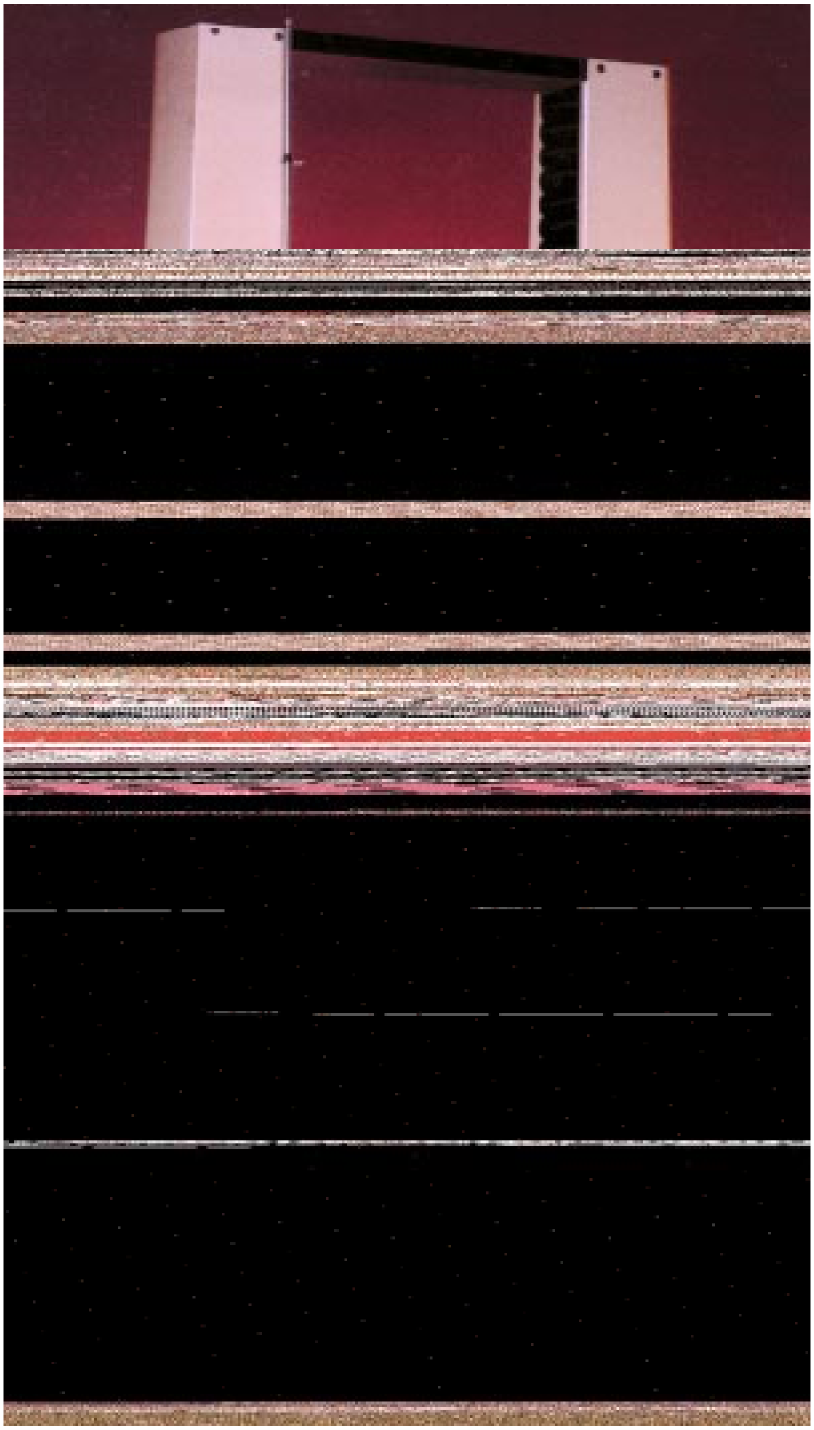
The e-mail was carried out in two ways:

1): posting to a group bulletin board contained within the conference, or
2): individual mailing to private accounts.

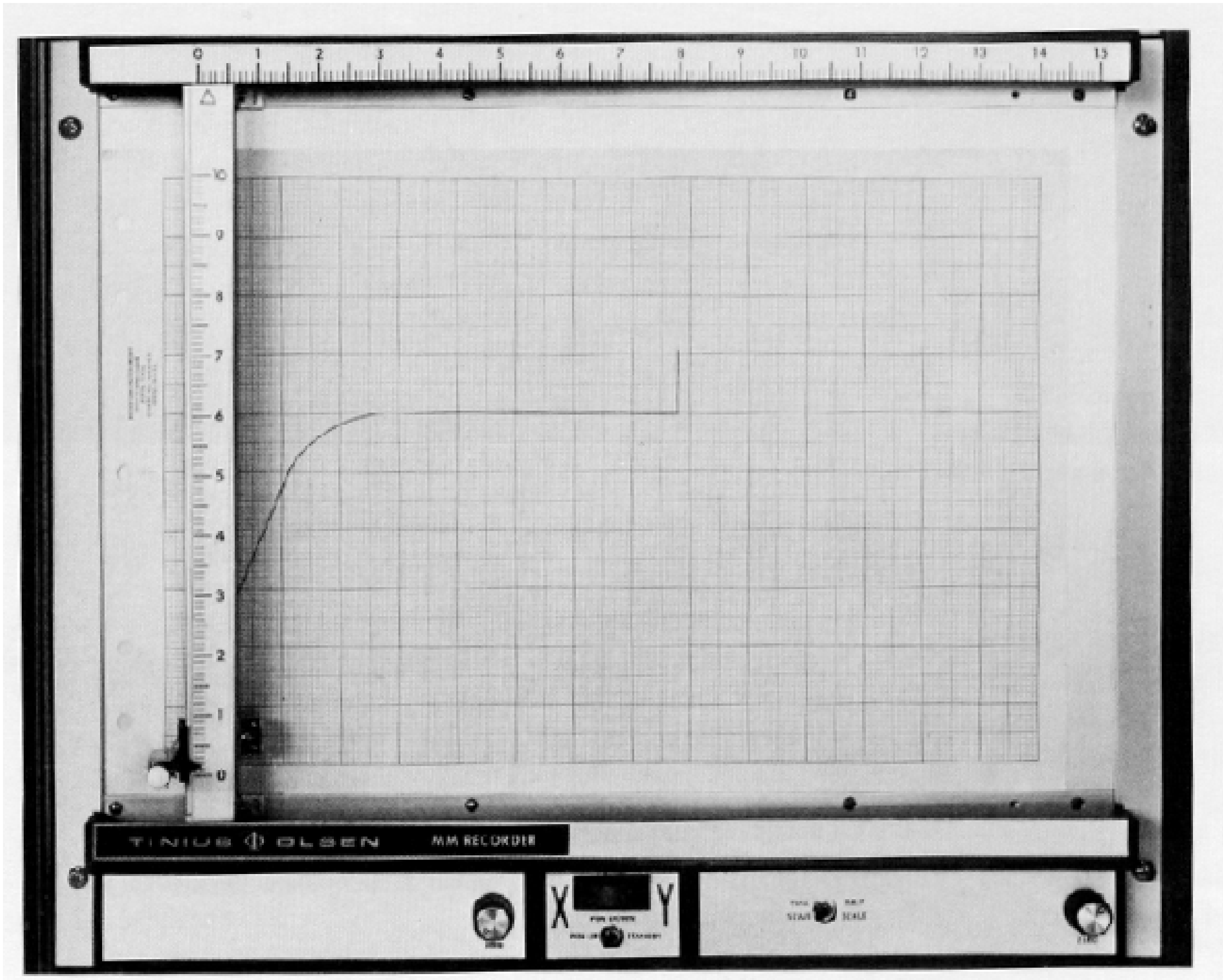
The individuals within the groups were able to monitor receipt of e-mail by using the History function of tracking e-mail provided by the software. This History function enabled students to monitor who had actually viewed and/or downloaded the messages posted from their server. In addition, students were able to use the conference site as an FTP site for the uploading and downloading of files. Due to the large size of the files each student group used the free open transport function to store their presentation and research files.

Furthermore, the students utilized the chat function provided within the software package to conduct group on-line, real time, chats from their homes providing for fruitful discussions with respect to progress, task assignments, and to air problems.

[15]PowerPoint 7.0 is a presentational package which allows the user to create presentations that my incorporate animation, video, audio, and graphics. Each group was required to incorporate relevant text, animation, video, and graphics into their presentation. (See Appendix H)

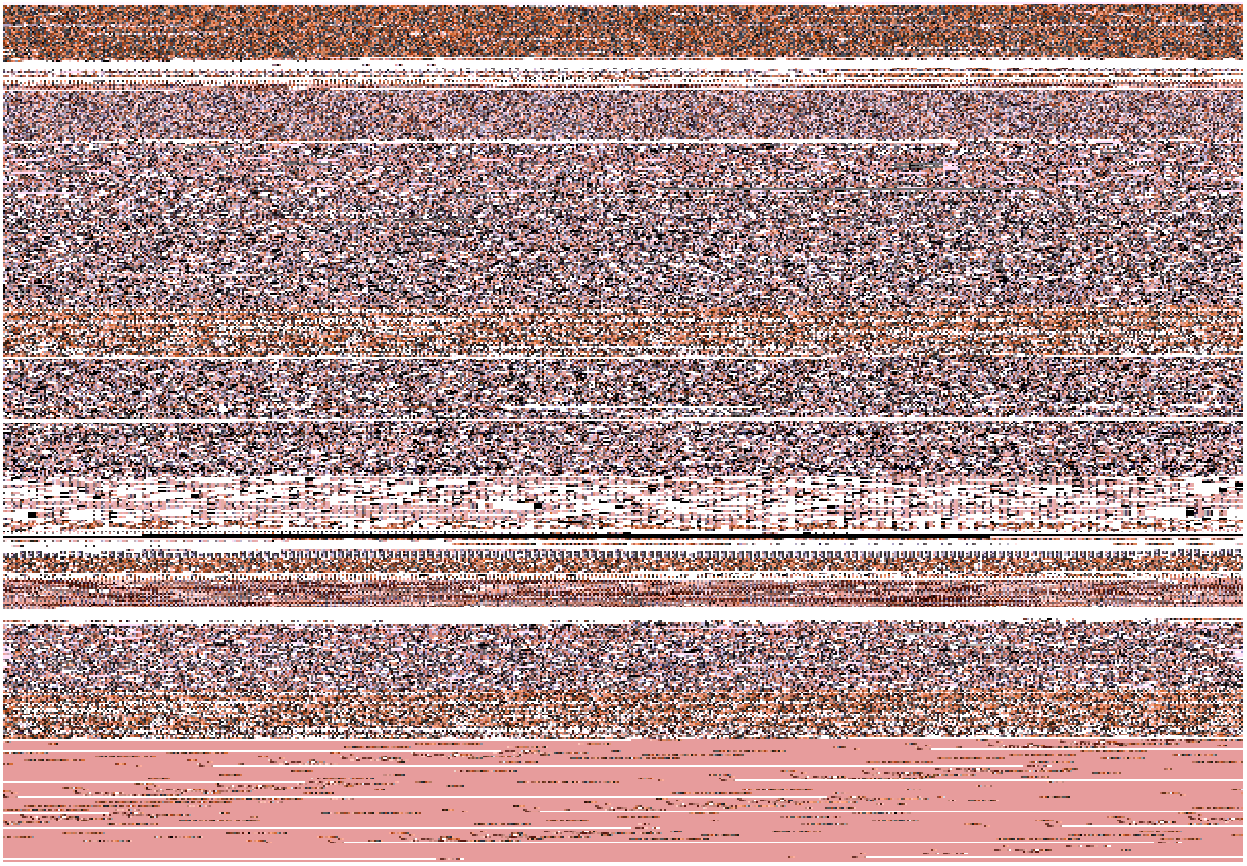


Tinius Olsen Series 5000 Bench Universal Testing Machine



Appendix B

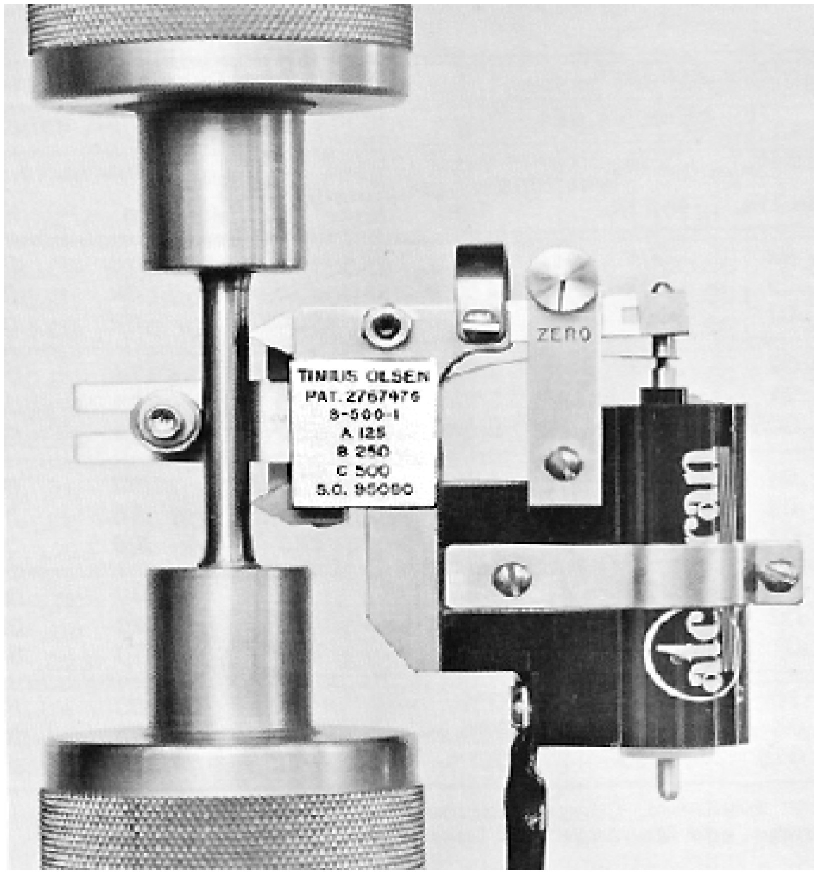
Tinius Olsen series 1000/5000 Flatbed XY recorder



Appendix C

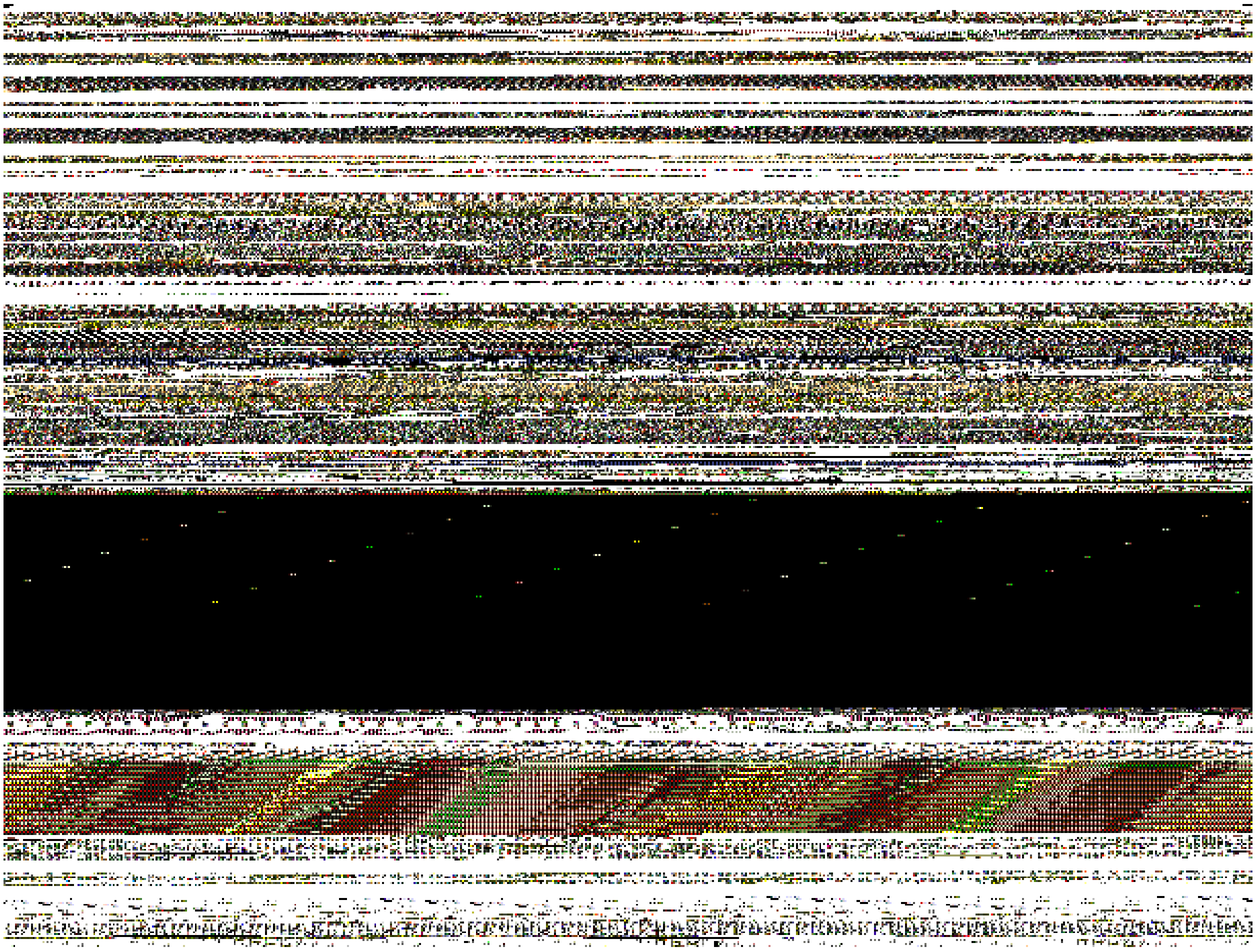
Proportional limit, yield point, ultimate strength

Appendix D



Tinius Olsen S-400-2A

Appendix E

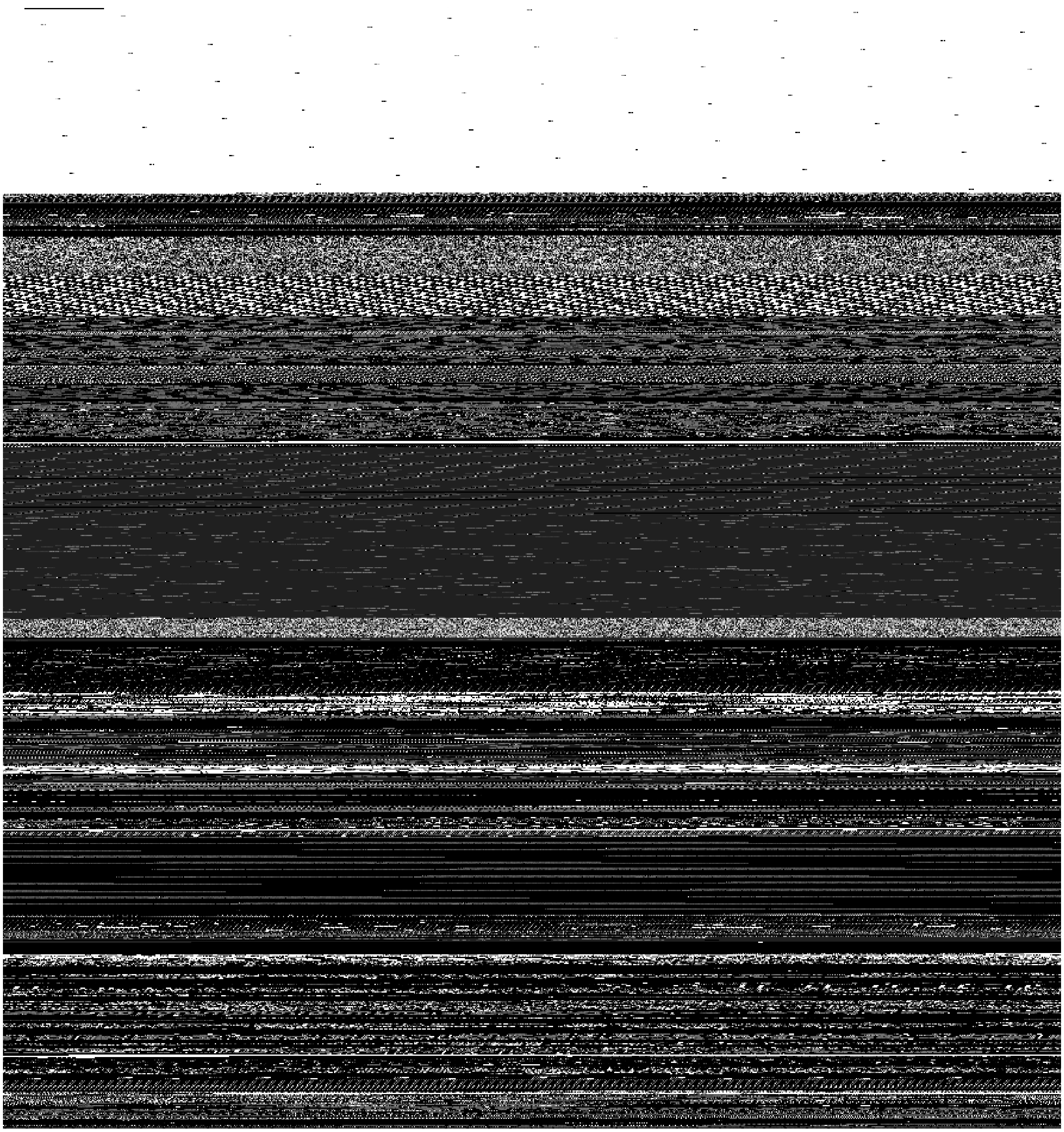


Adobe Premiere™ is a video editing software package

Appendix F

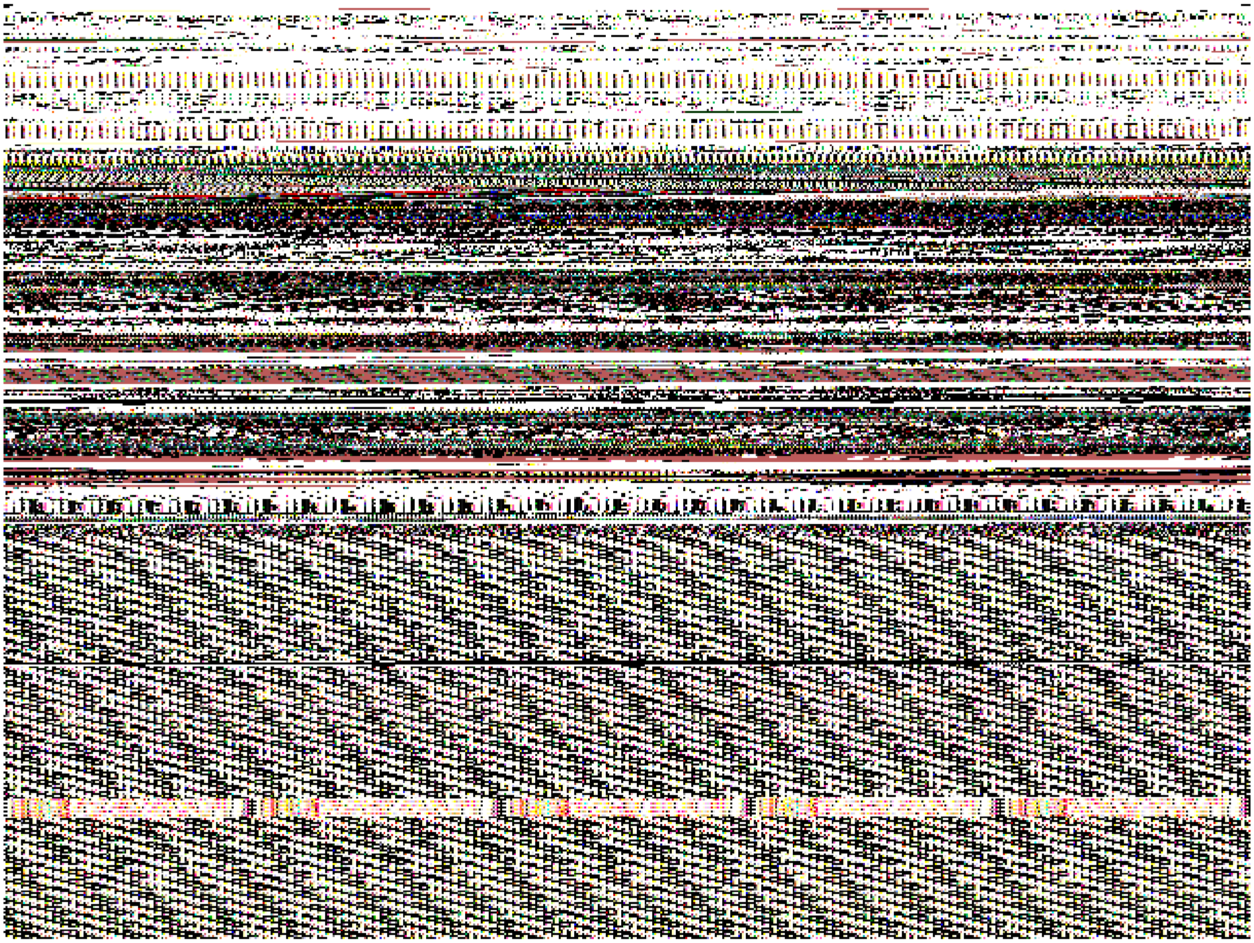
Adobe PhotoShop 3.0 is a photo design and production program

Appendix G



FirstClass Client is a conferencing software program

Appendix H



PowerPoint 7.0 is a presentational package