Teaching Strength of Materials Using Web-Based, Streaming Video, and Interactive Video Technologies

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Abstract

This presentation examines the results obtained during the second year of a three-year project funded by a General Electric Fund grant, on the effectiveness of new instructional technologies in the teaching of basic engineering courses. During the first year of the project only the statics courses were taught as part of the project, while in the second year, both statics and strength of materials courses were included in the project. Only the experiences from the Basic Strength of Materials courses are reported here.

The project explores ways to use instructional technologies (web-assisted, streaming video, and interactive video) to optimize the learning process for students with different learning styles and personality types. These technologies were evaluated versus the standard lecture-based format in our basic engineering statics and strength of materials courses. Student learning styles were determined using the Learning Style Inventory and personality type determination utilized the Myers-Briggs Type Indicator.

For the strength of materials course, a significant degree of coordination was required among the different instructors for the four sections in order to obtain the desired uniformity among classes. The lecture material presented at each class session was consistent with the information contained in PowerPoint slides that were developed collectively by all four instructors, with the assistance of their graduate assistants. Organizing around a fixed set of PowerPoint lectures not only enhanced the visuals for clearer understanding by the students, but provided the necessary control to synchronize the delivery of material in all four sections of the course. Because all sections were taught at the same time, the same test could be administered simultaneously to students in all four sections. These tests were generated with equal input from all four instructors and a different graduate assistant graded a particular exam question for all four sections of the course. Visual examples of how each technology was used are provided. All these technologies were found to enhance the student learning process. Currently, all the technologies are used as auxiliary instructional support systems. The instructor is still the primary source for learning.

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The performance (course grade) and attitudinal (satisfaction and preference) results obtained were very positive.

I. Introduction

From web-based courses to interactive teleconferencing and streaming video over the Internet, new instructional technologies can be very impressive and awe-inspiring. But one of the basic questions has yet to be answered. How should the new instructional technologies be utilized to optimize the learning process for students with different learning styles and personality types? A three-year grant from the General Electric Foundation is sponsoring a study to determine the most effective way to use these new technologies.

During the fall and winter quarters of the 1999-2000 academic year, specific instructional technology material was developed for our Mechanics I (statics) course by mechanical and aerospace engineering faculty members. At the beginning of the spring quarter students took two basic tests, the Learning Style Inventory[1] and the Myers-Briggs Type Indicator[2] tests. The learning styles of our students, as measured by the LSI evaluation, are consistent with national norms. The MBTI showed similar results[3].

During the spring quarter of 2000, Mechanics I courses with four different formats were offered: an interactive video class (between Wright State University and the University of Cincinnati), a web-assisted class, a streaming video class, and a standard lecture class which was used as the control class. Following the conclusion of the quarter, statistical analysis were used to assess student learning and student learning styles in the control class and each of the three technology classes. Issues examined included: how do various personality types and learning styles perform within a specific class; how do various personality types and learning styles perform across all four instructional formats; and how does student interest in the class or instructional technology affect his/her grade? The results of the assessment and surveys during this first year were reported at last year's ASEE Annual Conference[3].

During the second year of this project, academic year 2000-2001, both Mechanics I and Basic Strength of Materials were taught during the spring quarter in the four different formats previously described. Of course, the experiences of the previous year with the development and teaching of the statics courses were invaluable in planning for the implementation of the new strength of materials course technology needs and formats. This article addresses the development of the material for the technologies used in the different sections of strength of materials and preliminary information on student performance and satisfaction.

II. Strength of Materials Course Material Development

Upon reflection about which of the different technologies had the most stringent demands for the quality of video required, streaming video[4] was the obvious controlling media. Quality recording of the visual material used during each lecturer was essential. Consideration of the

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video quality requirements for the various technologies determined that simply the video recording of information transcribed on a white board done for the streaming video statics lectures was not satisfactory for the strength of material streaming video lectures. The amount of graphic detail required during the derivation of force/stress and force/deformation relationships, for example, is too extensive and time consuming to transcribe during a "chalk and talk" lecturer. It was determined that the use of PowerPoint slides would significantly improve the clarity of the video material and significantly broaden the range of support material, such as photographs, sketches, freebody diagrams, etc., that could be incorporated seamlessly into each streaming video presentation. The PowerPoint slides would be used exclusively during the video taping of the lectures for streaming video for each class session. In addition, they provide a definitive documentation of the exact technical subject matter that is to be presented in the four classes of Strength of Materials, each using a different technology. While the standard "chalk and talk" class instructor did not use any of the PowerPoint slides directly in the classroom, the PowerPoint slides did establish the subject content for each lecture.

The number of PowerPoint slides that are needed for an entire 10-week Basic Strength of Materials course is extensive and requires a considerable amount of time to produce. After establishing the detailed syllabus for the course, each of the four instructors was assigned the responsibility of developing the appropriate PowerPoint slides for a fourth of the course. Regular meetings of the faculty and graduate students involved were held throughout the fall quarter of 2000 to keep the development of the slide material on schedule. Examples of individual slides from four different lectures are presented in Figure 1. Beginning in January of 2001, the PowerPoint slides were used in the strength of materials class that was videotaped for use in developing the streaming video version of the class lectures for the spring quarter pilot class. The equipment used to record the lecture is shown in Figure 2. It should be noted that while a large console and two operators are located outside the classroom, the two small remotely operated cameras located in the classroom are not obtrusive.

Originally it was not anticipated that the students would be provided a hardcopy of each of the PowerPoint lectures. We did not want the students to have the temptation that they could refrain from participating in the appropriate class preparatory activities because they had a detailed copy of the lecture notes. However, students were very quick to point out that the nature and quantity of information contained on a large number of the slides precluded their transcription by students viewing the lecture, whether directly in a classroom or over the web. Therefore, a hardcopy of the PowerPoint slide lecture material was made available to the students for use while viewing the lectures. For the future classes, selected portions of the material presented in the slides are to be deleted from the printed copies provided to the students. This requires that the students follow the video lecture closely and "fill-in" critical information left off their hardcopy.

III. Course Delivery

During the spring quarter of 2001, four different sections of strength of materials were offered at the same time. The sections were scheduled to meet for one hour and fifteen minutes twice a

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week for the ten-week quarter. Students registered for the various sections with no indication of the technology to be used in each section. The distribution of students learning styles and personality types was intentionally not controlled in any way. At the first class meeting, the students were informed of the scope of the educational research project and the technology that was to be employed in that section of the strength of materials course. Very few students availed themselves of the opportunity to switch to another section that was using a different technology. In addition at the first class meeting, students took two tests, the Learning Style Inventory and the Myers-Briggs Type Indicator tests. Later students were given the opportunity to have the result of their individual tests explained to them. A brief description of the format for each of the three technology classes is provided below. The fourth section, the control section, used the standard "chalk and talk" format.

In streaming video section, students were expected to view a 45-minute lecture on the web before each class. A sample of the format of the computer video display is provided in Figure 3. The window on the left side of the screen displays a real-time video, with sound, of the lecture, while the larger window on the right displays the PowerPoint slide being discussed in the real-time video. Located below the left window are the video player controls, along with a dropdown menu, that allows complete flexibility in moving to desired parts of the lecture. An obvious advantage of this technology is that a student can move rapidly to any point in the lecture or repeat any part desired as often as necessary. During the class, the appropriate PowerPoint slides were available to the instructor for use in responding to student questions and in emphasizing important principles. A significant portion of each class was used to help students develop problem solving strategies and applying these strategies to solving problems presented by the faculty member.

In the web assisted section, students were expected to examine a website containing material designed to prepare them for the following class. For the original course, offered during the spring quarter of 2001, the material on the website utilized the PowerPoint slides and written text. There was no sound included with this material. The experience is intended to review any background relevant to the subject to be covered and to introduce the important aspects of the following classroom presentation. Also, automatically grade quizzes can be incorporated to allow the student to determine their level of preparedness for the next class. The classroom presentation could also utilize the PowerPoint slides designed for that particular subject. Of course, the cost of the equipment required to implement this technology is minimal, especially compared to the cost of streaming video.

A significant upgrade in the web-assisted material was developed for the next offering of the course in the spring of 2002. With Macromedia Flash software, it is economically feasible and tractable to develop animated web presentations with sound. The web-assisted material for each class was redone. Figure 4 shows the computer screen appearance during the development of a Flash presentation for the web-assisted course. It is anticipated that this upgrade will significantly enhance this learning experience.

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For the interactive video class, the live lecture delivered in the originating class is sent real time to another classroom, referred to as the receiving class. The originating class needs to take place in a highly specialized classroom specifically designed and equipped for live transmission of lectures. Of course, the receiving classroom must be equipped with monitors or projectors, and two-way sound transmission equipment, to provide for communication between two classrooms. Careful planning of the sequencing of the presentation material is required because only a single screen image can be transmitted at any one time to the receiving room. The students in this class were not asked to review any material on the web prior to their classes.

IV. Student Evaluations

At the completion of the spring quarter of 2001, students in all five classes were asked to complete specially designed evaluations. The responses to selected questions of all students in a class involving the web delivered coursework are provided below. The original responses are based on a modified Liekert scale, with students selecting among five possible answers, from strongly agree, agree, neutral, disagree, and strongly disagree. For clarity here, the data here is presented in the table below grouping strongly agree and agree as AGREE, Neutral stays NEUTRAL, and strongly disagree and disagree become DISAGRESS. The values in the table are the percentage of students responding to each question in each rating category.

Question	Class Format	AGREE (%)	NEUTRAL (%)	DISAGREE (%)
It was easy to follow the presentations on the computer.	Stream Web	92 41	8 36	8 23
While on-line, it was easy to maintain interest while viewing the entire lecture segment.	Stream Web	17 18	33 41	50 41
The pictures and graphics in the computer lectures helped me to understand the technical concepts presented.	Stream Web	58 64	38 18	4 18
The ability to view the on-line lectures at my convenience was an advantage versus traditional lecture courses.	Stream Web	58 64	21 27	21 9
The ability to review a portion of the computer material instantly aided in my understanding of the technical concepts.	Stream Web	58 46	38 36	4 18
The ability to review previous lectures at anytime was an advantage versus traditional lecture courses.	Stream Web	75 73	21 18	4 9
Compared to a traditional classroom, the computer format was a more effective way to present this material.	Stream Web	38 18	29 41	33 41
The face-to-face classroom sessions in addition to the on-line material increased my understanding of the concepts.	Stream Web	71 54	21 32	8 14
After viewing the on-line lectures, I did not think that I needed to attend the face-to-face classroom sessions.	Stream Web	8 5	33 23	59 73
Overall, I think the computer augmented Basic Strength of Materials course was a success.	Stream Web	29 36	42 32	29 32
Given a choice, I would enroll in a computer augmented course rather than a traditional lecture only course.	Stream Web	33 45	29 41	38 14

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The responses to selected question in the questionnaire given to students in the interactive video classes, both in the originating class and in the receiving classroom, are provided in the following table.

Question	Class Format	AGREE (%)	NEUTRAL (%)	DISAGREE (%)
The lecture in person, or transmitted over interactive video, was easy to follow.	Originating Receiving	83 40	17 60	0 0
Compared to a traditional classroom, the interactive video format was a more effective way to present the material.	Originating Receiving	33 0	50 20	17 80
The classroom interactions with the professor, either physically present or at the remote site, increased my understanding of the concepts.	Originating Receiving	66 20	33 20	0 60
Overall, I found this interactive video instructional format both interesting and engaging.	Originating Receiving	33 7	50 27	17 66
Overall, I learned the Strength of Materials concepts effectively using interactive video classroom sessions.	Originating Receiving	17 20	83 27	0 53
Overall, I think the interactive video course was a success.	Originating Receiving	17 7	50 47	33 46
Given a choice, I would enroll in an interactive video course rather than a traditional lecture only course.	Originating Receiving	0 13	33 7	67 80

V. Concluding Remarks

From the student evaluations it appears that a significant number of students (approximately 7 out of 10) would consider voluntarily taking another class utilizing either a streaming video or web-assisted format. This is an indication their perception of the benefits derived from the use of computer enhancements in a course. It should be pointed out that students in both computer enhanced classes were sensitive to the need to devote time to a structured experience outside the scheduled class meeting times.

The students in both classes with interactive video, originating and receiving, were reluctant to voluntarily take another class with an interactive video format (approximately 3 out of 10). This reaction to the interactive video experience could be significantly improved with enhanced audio and video equipment in the classroom.

While student evaluation results for the traditionally taught class were not provided in this article, the responses were very positive. Throughout the quarter students were also sensitive to the fact that they were part of an educational "experiment", with them as the "test specimens". Every effort was made to assure them that, no matter whatever else happened, their education in the subject matter would not be compromised and that they would be treated fairly, especially with respect to their final grade for the course.

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Even though student satisfaction survey results were quite varied, there was no statistically significant difference among the average of the final numerical grades for the students in each of the five classes. The average of the final numerical grades, based on a maximum value of 100, for the students in each of the five classes are as follows: Streaming Video, 78.4; Web-Assisted, 81.9; Interactive Video-Originating, 80.7; Interactive Video-Receiving, 78.6; and Traditional Lecture, 79.7. These class averages are about 5 points, or half a letter grade, higher than the course averages for strength of materials classes taught in previous years using the standard lecture format.

During the fall and winter quarters of the 2001-2001 academic year considerable time and effort was devoted to evaluating, planning, and implementing changes for the five class formats. All five classes were offered simultaneously again in the spring quarter of 2002.

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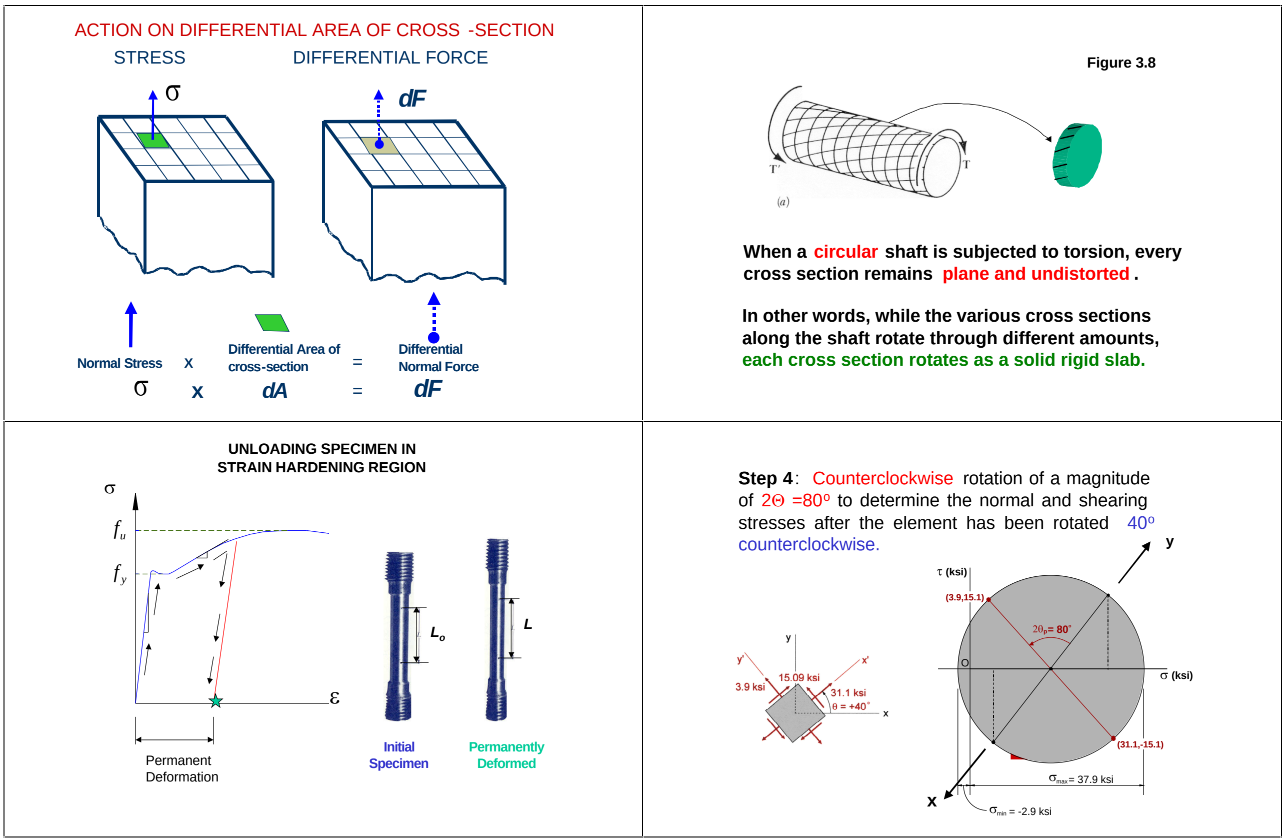

Figure 1 – Examples of PowerPoint Slides

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Figure 2 – Video Equipment Recording Lecture for a Streaming Media Presentation

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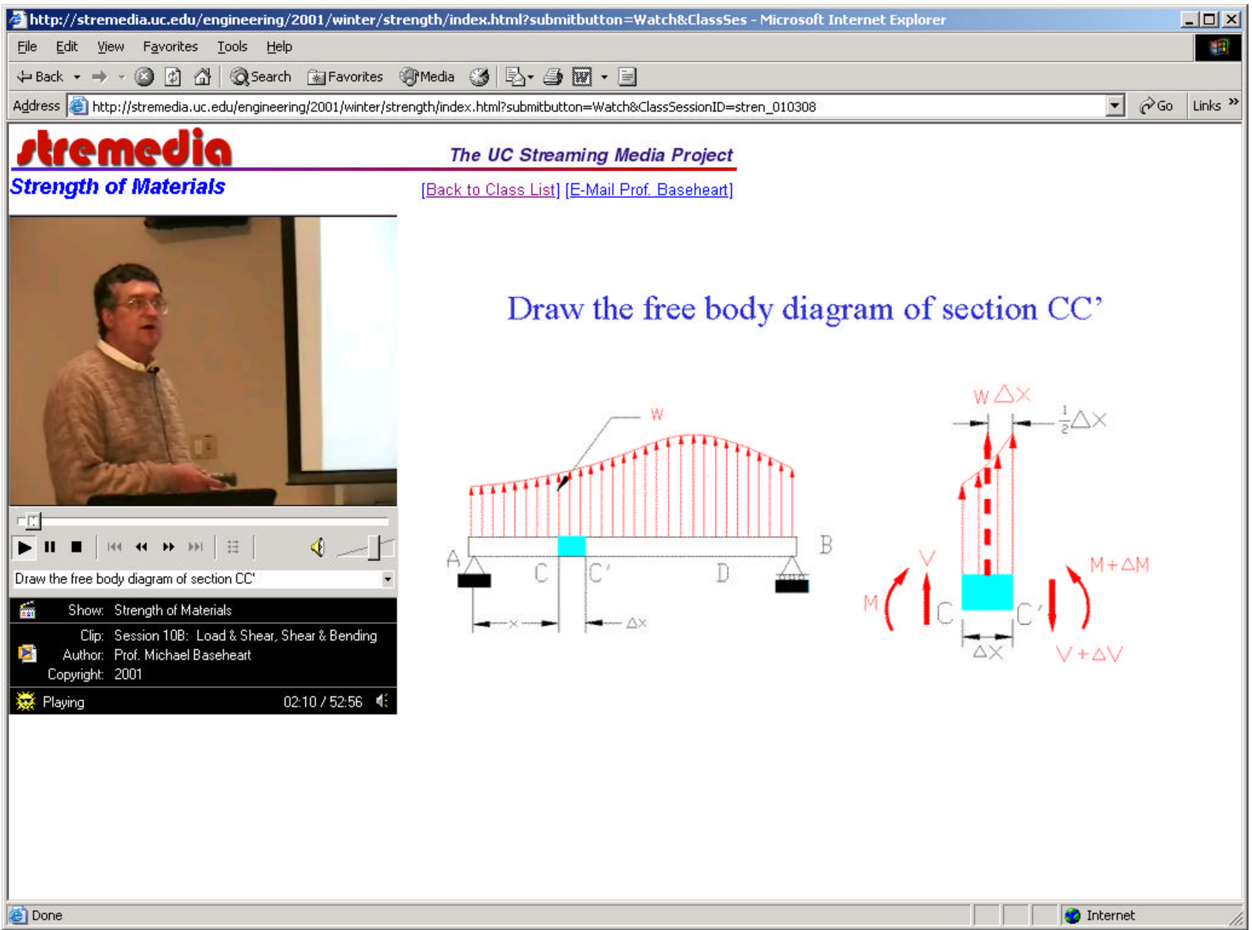

Figure 3 – Example of Streaming Video Presentation Format

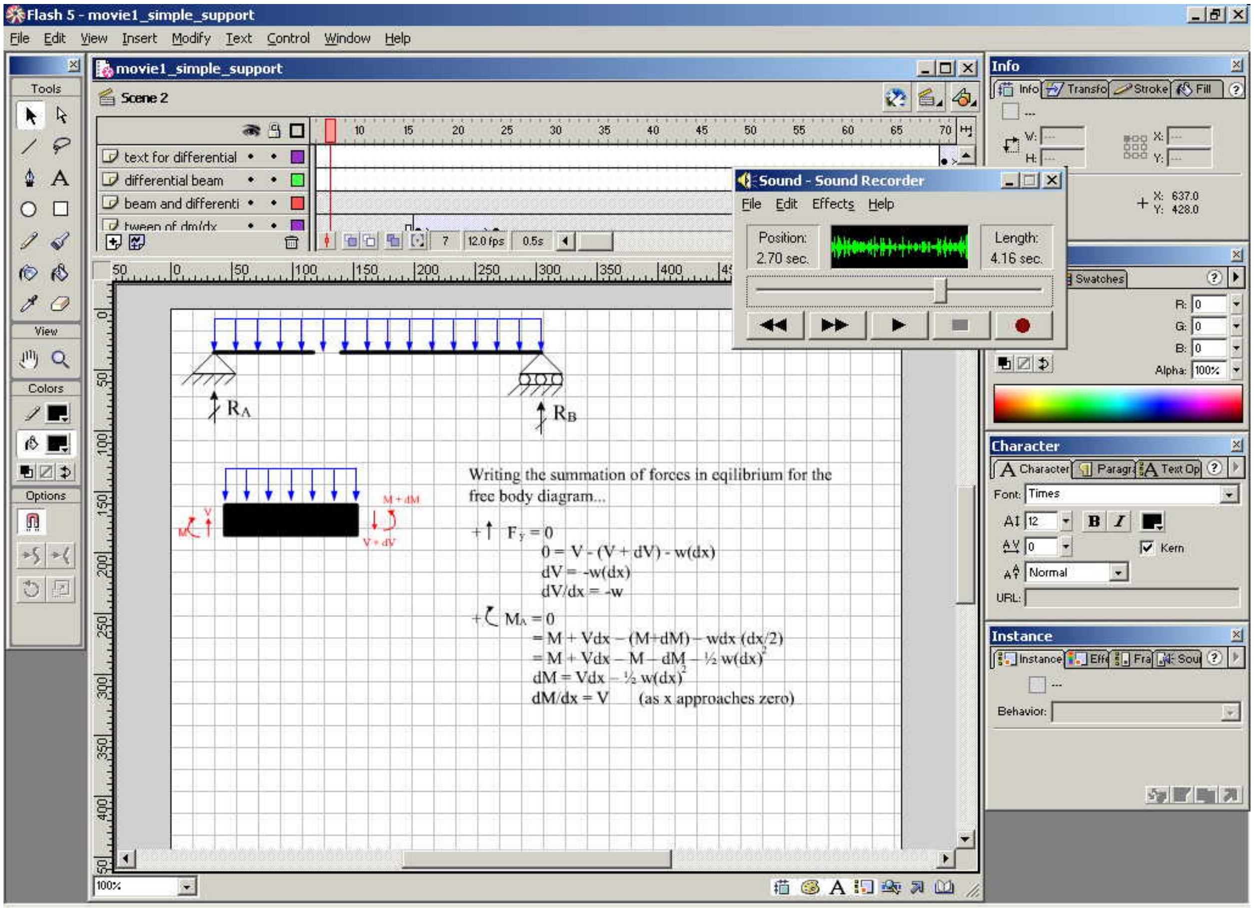

Figure 4 – Sample of the Web Assisted Flash 5 Format