Development of Digital Audiovisual Lectures for an Engineering Course: A YouTube Experience

Autar Kaw[1], Sri Garapati[2]

Abstract – Cyberlearning is transforming education by offering course content through multiple context and platforms. As part of this transformation, this paper describes the experience of developing, recording, encoding, uploading, and organizing audiovisual lectures for an engineering course in Numerical Methods. More than 200 short modular videos are currently available that cover the syllabus of a typical Numerical Methods course. An initial assessment of these resources is made via the video analytics tool made available by YouTube. This assessment shows increasing popularity of the videos, but also gives insight into the audience attention, and demographics by gender, age, and geography.

Keywords: Numerical Methods, YouTube, Cyberlearning, Engineering Education, Online Videos.

INTRODUCTION

In 2008, NSF published a task-force report [1] on cyberlearning (defined as "learning that is mediated by networked computing and communications technology"). The writers of this report emphasized that cyberlearning can transform education as it offers a new approach to learning by offering the content through multiple context and platforms. In the same year, the National Academy of Engineers [2] came up with a list of 14 challenges for the 21st century, and one of those challenges is *Advanced Personalized Learning*. This is an acknowledgment that each of us learns differently and that we need to make instruction individualized for reliable learning.

Recently, more and more research has been focused on exploring ways to improve the quality of online materials and the variables that relate to enriching student-learning experiences [3]. The research base of exploring how the online materials have different benefits based on characteristics of the individual student [4] is a way to improve the quality of education. Based on Bandura's Social Cognitive Theory [5] it can be argued that learning as a behavior of knowledge is influenced by three variables: student characteristics (e.g., intelligence or motivation), learning behavior (e.g., study habits or learning styles) and learning environment (e.g., online or face-to-face learning). These three characteristics can be affected and altered by each other through reciprocal determinism [4,5].

As part of such goals, since 2002, NSF has funded the author and his colleagues with four multi-university consecutive grants to develop, refine, assess, and disseminate multiple online resources (http://numericalmethods.eng.usf.edu) for a course in Numerical Methods. The resources for a typical Numerical Methods course are now complete [6]. The topics include

(1) Fundamentals of Scientific Computing,
(2) Differentiation,
(3) Nonlinear Equations,
(4) Simultaneous Linear Equations,
(5) Interpolation,

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[1] Professor, Department of Mechanical Engineering, University of South Florida, 4202 E Fowler Ave ENB118, Tampa FL 33620-5350, kaw@eng.usf.edu.

[2] Graduate Student, Department of Mechanical Engineering, University of South Florida, 4202 E Fowler Ave ENB118, Tampa FL 33620-5350, sgarapat@mail.usf.edu.

(6) Regression,
(7) Integration, and
(8) Ordinary Differential Equations.

The multiple-context resources (Figure 1) developed include a textbook [7], 200 modular digital-audiovisual-lectures on YouTube [6,8], multiple choice tests, PowerPoint presentations, worksheets in various computational packages such as MATLAB®, MATHEMATICA®, Maple® and MathCAD®, experiments for project work to apply numerical methods [9], and a blog [10] to carry a discussion of the course content. All the resources are available openly without any restriction of access and follow the Creative Commons License [11] use of noncommercial reuse and remix.

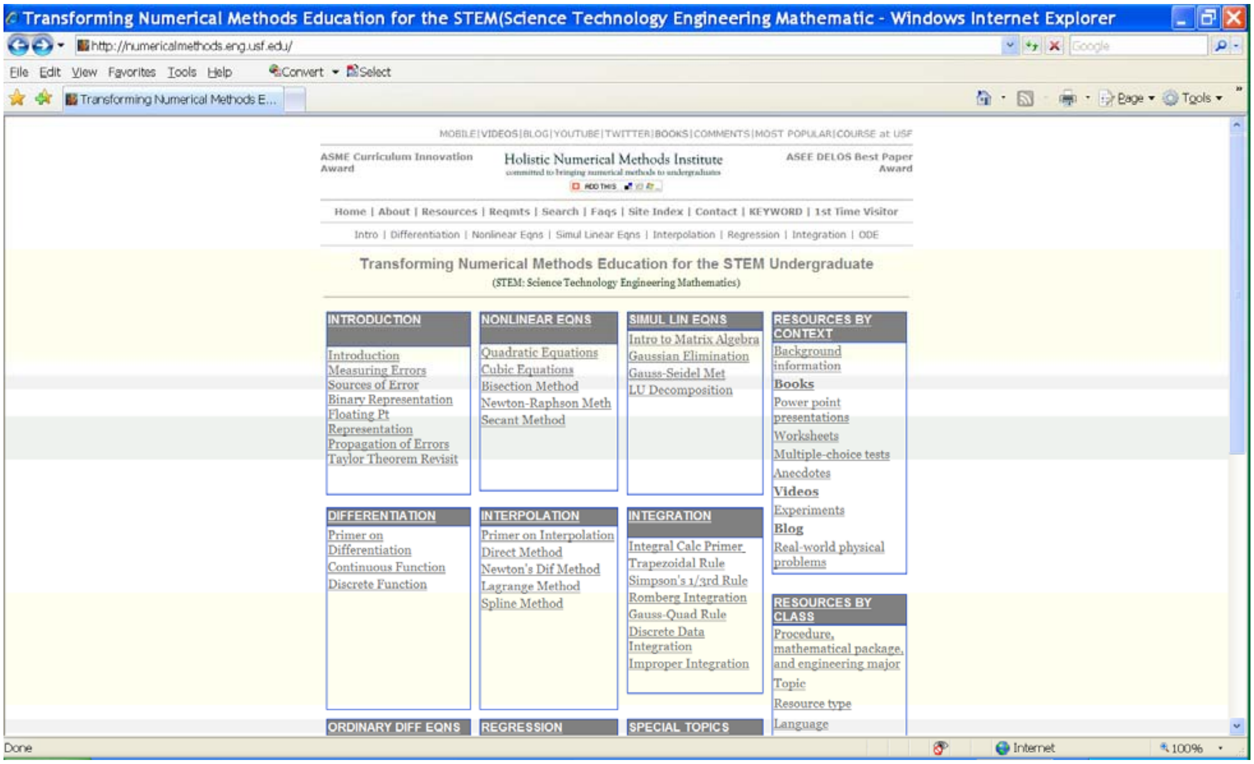

Figure 1. The home page of the course website at http://numericalmethods.eng.usf.edu

THE DEVELOPMENT OF AUDIOVISUAL DIGITAL CONTENT

As part of this multiple-context and multiple-platform development, in Spring 2009, lecture videos for a whole course in Numerical Methods were placed on YouTube (http://www.youtube.com/numericalmethodsguy). In this section, we discuss the complete experience of the development of these videos.

At University of South Florida, we have several studios for distance learning. These are used to teach off-campus students synchronously and asynchronously. Rather than simply recording such lectures in a classroom setting and uploading to an OCW website as has been done by many of the open courseware initiatives [12-14], we took a different approach. The lecture videos were recorded in a university studio without any students. The topics were recorded in short segments for two main reasons.

1) The resulting videos would be modular. For example, the topic of Newton Raphson-Method of solving nonlinear equations was divided into short separate modules of a) derivation, b) example, c) pitfalls, d) application to finding square-root of a number, etc. This allows the student to choose the modules they need to study or review.

2) YouTube limits the length of videos to 10 minutes. A quarter of the subtopics could not be explained in 10 minutes. In such cases, a subtopic was broken into several modules. To keep the modules organized and sequential, playlists were developed on YouTube as well as the course website [6].

The recordings were done two days a week in 75-minute sessions. Most of the recorded lectures used the whiteboard, while a quarter of the lectures were recorded via a Smartboard [15]. The recordings involved two remotely operated cameras manned by two technicians in a control room. The files of the recordings were encoded by a third technician and were given to me as wmv files at the next recoding session. Any files longer than 10 minutes were watched by me to find a suitable mark where they could be broken into less than 10-minute parts. This information was given back to the third technician who would then break them into separate wmv files, and add the beginning and the end slates. As soon as this was done, the videos were uploaded to the YouTube site (http://youtube.com/numericalmethodsguy) with information on the topic, tag words, and description. This process continued for 14 weeks until all the videos for a typical numerical methods course were recorded and uploaded. More than 200 videos are now available on the YouTube site (Figure 2). These videos are also available at the numerical methods website (http://numericalmethods.eng.usf.edu/videos/numerical_methods_course.html) as well as at a site for mobile users (http://numericalmethods.eng.usf.edu/mobile/).

The services of developing these videos came at an expense. With three technicians, a supervisor and use of the studio time, the total expense is estimated at $7,000 for the whole course. This is in line with the estimate of $10,000-$15,000 that MIT OCW [12] gives for putting a course online.

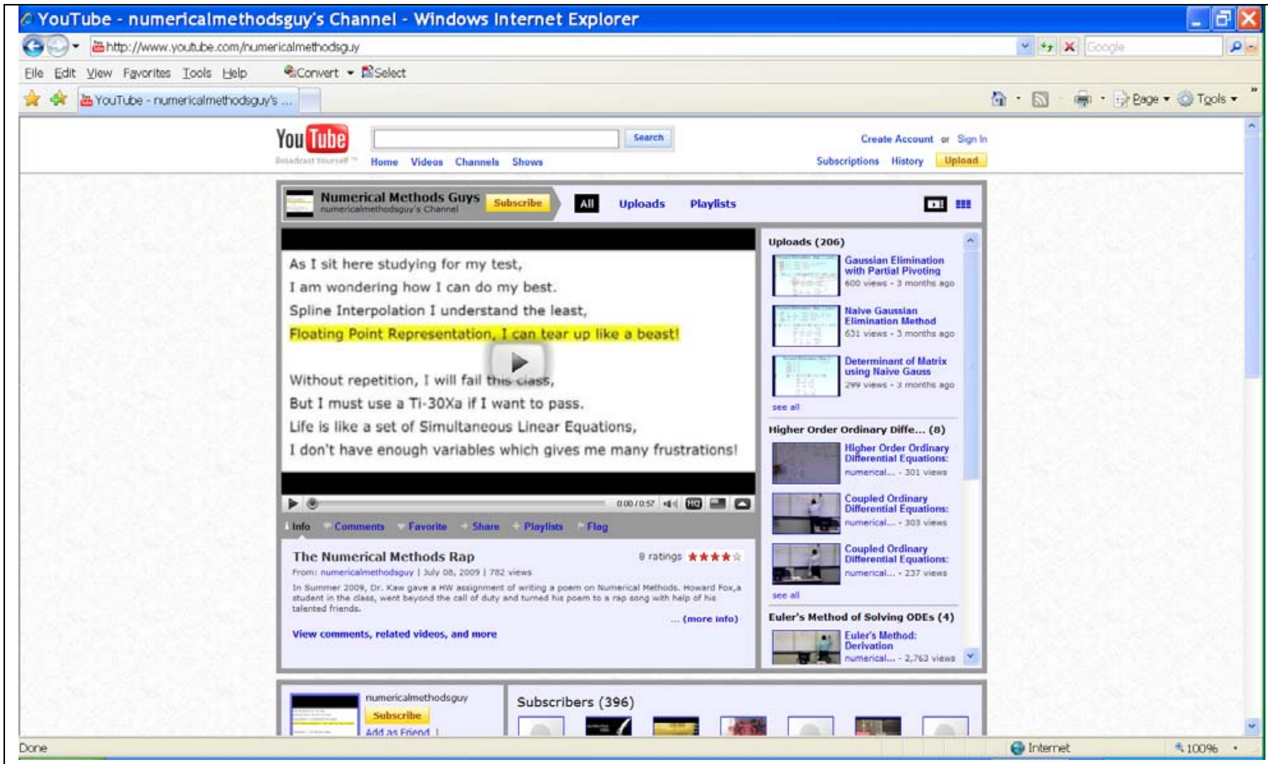

Figure 2. Home page of the numerical methods YouTube site.

One may wonder why use YouTube and take the effort of breaking lectures into 10-minute segments when one could have put these videos on the course website, which would equally be available worldwide. The following were the main reasons to do so.

(1) We use YouTube's bandwidth as opposed to the bandwidth of the university.
(2) We used YouTube's compression technology for making the size of the video files smaller without sacrificing quality, and hence reaching users who have slower internet connections.
(3) The videos get Google-searched immediately.
(4) It gives wider publicity to the resources.
(5) It forced the author to think about giving information in small chunks to modularize the course content.

(6) Users can comment and give feedback on the quality of instruction.
(7) Mistakes can be annotated by a simple interface.
(8) Resources of other developers are automatically shown next to the video and hence improving the diversity of instruction.
(9) The free "Insight" program of YouTube keeps track of demographics of users.

INITIAL ASSESSMENT

In an earlier study [4], the author and his colleagues assessed the effectiveness of four instructional delivery modalities – 1) Traditional lecture, 2) Web-enhanced lecture, 3) Web-based self-study, and 4) Combined web-based self-study & classroom discussion for a single instructional unit (Nonlinear Equations, the course at USF has eight instructional units) over separate administrations of an undergraduate course in Numerical Methods [6]. Two assessment instruments – 1) student performance on a multiple-choice examination, and 2) a student satisfaction survey were used to gather relevant data to compare the delivery modalities.

Student Performance

Four multiple-choice questions were used to assess student performance in the Nonlinear Equations topic of the course delivered under the four different modalities. Two questions were asked at lower levels (Knowledge, Comprehension, and Application) of Bloom's taxonomy and two questions were asked at upper levels (Analysis, Synthesis, and Evaluation) of Bloom's taxonomy. Each correct answer was given a score of one while an incorrect answer was scored as a zero, for two possible points for each of the lower and upper level sets of questions. For each of the four classes, Table 1 contains the sample size and the mean scores on the Bloom's Taxonomy questions.

Table 1 – Sample Size and Final Examination Score

Class	N	Examination Score Mean (max=4)	SD
Traditional lecture	42	2.14	0.814
Web-enhanced lecture	27	2.51	1.122
Web-based self-study	49	2.27	0.953
Combined web-based self-study & classroom discussion	56	2.68	1.01

Student Satisfaction

A seven-point Likert scale was used for the eight selected response items, ranging from 1 (Truly Inadequate) to 7 (Truly Outstanding). In addition, an analysis of variance was conducted on each of the items. The results of these analyses are provided in Table 2. The results of all eight items are statistically significant at the set Type I error rate of 0.10. In all cases, students in the *web-enhanced lecture class* had notably higher scores than in the other three classes of delivery modality. Contrast statements support the contention that this group of students rated these items higher than their peers in the other classes at an alpha level of 0.05. The *traditional lecture class* tended to have the next highest mean scores, followed by students in *combined web-based self-study & classroom discussion class* and then the *self-study class*.

For complete details of the analysis of the two assessment instruments, please refer to Reference [6].

Now with the resources being developed for the whole course, in Summer 2010 at USF, we plan to use the videos, coupled with other developed resources, to develop an online course which will be compared with the in-class course taught at the same time. We plan to use the results from the assessments to develop a personalized cyberlearning experience.

However, we have the initial assessment of these videos through the YouTube users. YouTube provides a video analytics tool called *Insight* [16]. Several metrics are measured by this tool including number of views, age and geographic demographics, relative popularity, how viewers discover the videos, etc.

Table 2 – Results of Presentation Items on Surveys on Nonlinear Equations (number of samples, means, F-values, and p-values)

Questions	Mean* (SD)				F	p
	Traditional lecture (N=38)	Web-enhanced lecture (N=27)	Web-based self-study (N=43)	Combined web-based self-study & classroom discussion (N=56)		
In terms of their value in helping me acquire foundational knowledge and skills, I'd say that the presentations were	4.63 (1.21)	5.86 (1.06)	4.53 (1.32)	4.60 (1.06)	9.68	<0.0001
In terms of their value in reinforcing information presented both in the reading assignments and in the problem sets, I'd say that the presentations were	4.71 (1.19)	5.86 (1.03)	4.49 (1.25)	4.94 (0.96)	8.70	<0.0001
In terms of their value in helping me learn to clearly formulate a specific problem and then work it through to completion, I'd say that the presentations were	4.37 (1.40)	5.86 (1.09)	4.30 (1.25)	4.72 (1.10)	10.66	<0.0001
In terms of their value in helping me develop generic higher-order thinking (e.g. analysis, synthesis and evaluation from Bloom's taxonomy brochure I gave you) and problem solving skills, I'd say that the presentations were….	4.34 (1.27)	5.61 (0.98)	4.14 (1.37)	4.30 (0.98)	11.31	<0.0001
In terms of their value in helping me develop a sense of competence and confidence, I'd say that the presentations were	4.58 (1.25)	5.68 (1.20)	3.95 (1.24)	4.39 (1.00)	13.54	<0.0001
Overall, I'd say that the clarity of the explanations contained in the presentations were	4.55 (1.32)	6.04 (0.94)	4.35 (1.33)	4.79 (1.08)	17.58	<0.0001
In terms of helping me see the relevance of the course material to my major, I'd say the presentations were	4.18 (1.27)	5.79 (1.08)	4.02 (1.37)	4.68 (1.16)	8.47	<0.0001
Overall, I'd say that the helpfulness of the illustrative examples and practical applications contained in the presentations were	4.47 (1.40)	5.71 (0.96)	4.28 (1.25)	4.89 (1.13)	9.25	<0.0001

* 1=Truly Inadequate, 2=Poor, 3=Adequate, 4=Good, 5=Very Good, 6=Excellent, 7=Truly Outstanding

For example, Figure 3 gives the summary of the Insight Statistics for the three-month period of Aug 3, 2009 – Nov 3, 2009. It shows that the video views have been increasing at a steady rate and about 800-1200 views are made per day. It also gives the list of the most popular videos and shows the audience attention that is a measure of the ability of a video to retain the audience. Demographics are given by gender and age, and the popularity is shown by geographic locations.

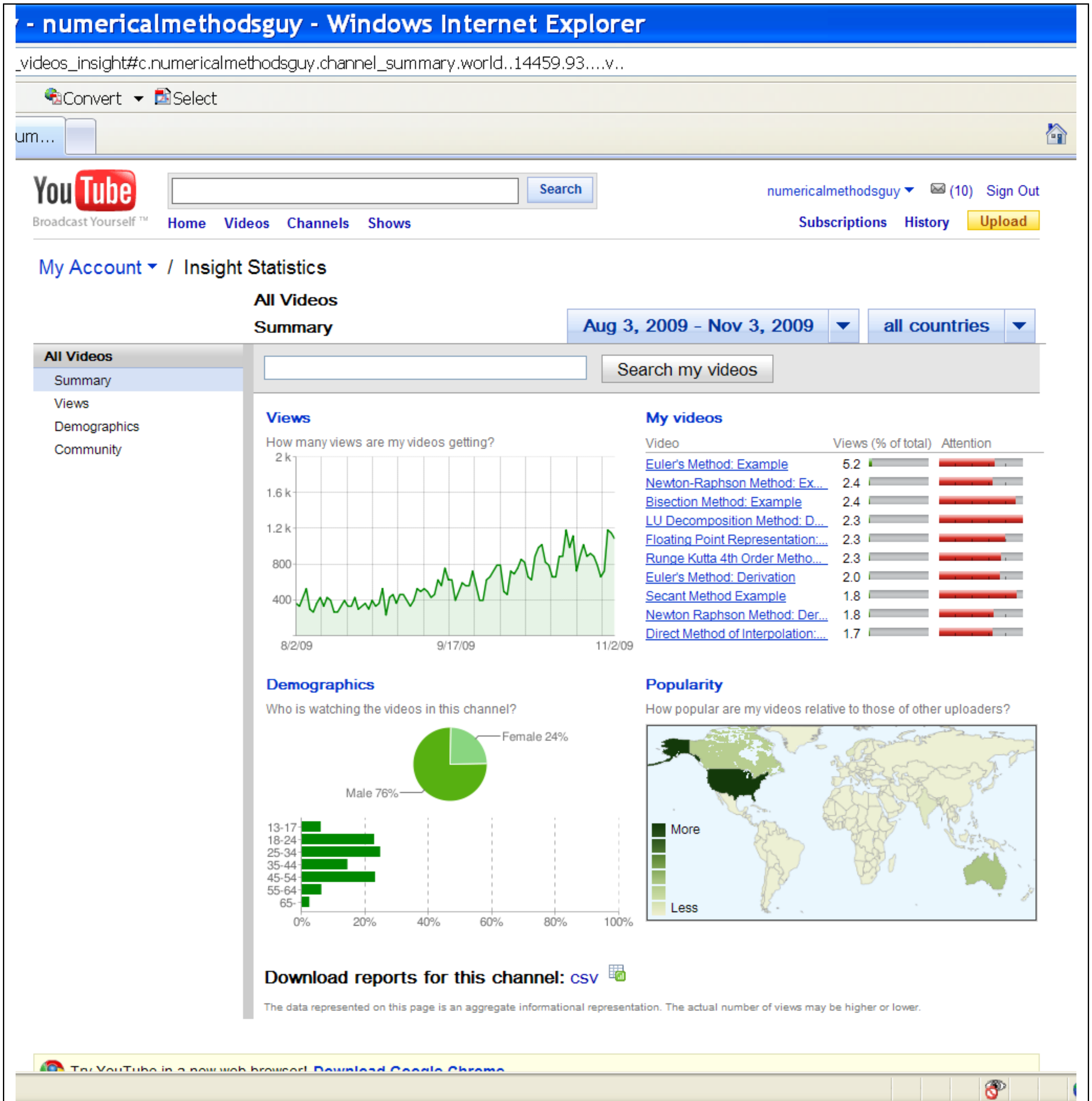

Figure 3. The Insight statistics for the YouTube site.

In addition to the above statistics, each video is rated and commented on by logged-in users. This gives a qualitative sense of how the videos are being accepted by the general audience.

Some of the general comments on the videos are given below. Almost all of the comments are positive, and the few negative comments are generally related to the instructor's accent or a few typographical mistakes in a small number of videos. The typographical mistakes are immediately annotated with the correct text, while a couple of videos were replaced with revised re-recorded versions.

- I've never had a lecturer that can explain concepts as clearly and quickly as you can. Thank you so much, you have really helped!!

- If all professors can lecture like you, no one would fail in this world
- first off...thanks a ton!! ....i am expecting an A in numerical methods course this semester....extremely grateful student :)
- Got an A in my modeling methods class thanks to you. THANK YOU!!
- Man its the most interesting and easiest course I have ever taken. At least it makes sense lol.
- Thank you very much... it's people like you who make the world a better place. God bless you!!!!
- you rock! i mean numerically.

CONCLUSIONS

Short modular videos of a complete typical numerical methods course have been uploaded to YouTube as part of the multiple resources available online. The experience of how these videos were recorded, encoded, uploaded, and organized is shared. An initial assessment of the quality of the resources made via a video analytics tool shows its gaining popularity amongst users worldwide.

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Autar Kaw

Autar K. Kaw is a Professor of Mechanical Engineering and Jerome Krivanek Distinguished Teacher at the University of South Florida, Tampa. Professor Kaw's scholarly interests are in engineering education research, biomechanics, bridge design, thermal stresses, computational mechanics, and fracture. His research has been funded mainly by National Science Foundation, Air Force Office of Scientific Research, and Florida Department of Transportation. He is a Fellow of the American Society of Mechanical Engineers. He has written more than forty journal papers and authored four textbooks on subjects of mechanics of composite materials, matrix algebra, and numerical methods. Professor Kaw received the CASE & CFAT Florida Professor of the Year Award in 2004, the ASME Curriculum Innovation Award in 2004, and the ASEE Archie Higdon Mechanics Educator Award in 2003.