LETTER / LETTRE

EDITORIAL - "THE EVOLUTION OF TEACHING AND THE ROLE OF TEACHING-ONLY FACULTY IN PHYSICS DEPARTMENTS" JANUARY-MARCH 2009 (65(1)) ISSUE

Dear Prof. Joos:

I would like to comment on your timely Editorial in the latest PiC issue.

1) I agree that as soon as teaching-only positions are converted into tenure-track appointments, the role of teaching faculty within the Department will change. I see at least three reasons why it should happen. First, tenure-track teaching positions will attract not only higher-caliber, but also different candidates. Nowadays a number of students in North America pursue graduate degrees in physics education. The Physics Education Research (PER) groups at major research American universities have graduated by now dozens of PER researchers. Secondly, PER faculty, at least in the US (Canada still has very limited PER funding), often bring significant research funding to their Departments. As a result, they have a potential to make a broad impact on the quality of physics teaching. Unlike "teaching-only faculty", they establish research groups to investigate the effectiveness of different teaching methods on student learning. This is a paradigm shift from teaching-only faculty to researchers in the physics education. Thirdly, 52 years after Sputnik and almost 20 years after the end of the cold war, we are witnessing a renewal of interest in the level of science, engineering and mathematics education. As the universities compete for better students, the quality of undergraduate student experiences plays a more prominent role. The contribution of PER faculty here can be invaluable.

2) I would also like to respond to the concern regarding the age-evolution of the teaching-only faculty. If the universities hire PER faculty instead of the teaching-only faculty, the concern regarding their lack of ability to inspire and stimulate students as they age will significantly diminish. One thing that certainly does not apply to PER community is the lack of an exuberant and enriching research environment. Just for the information of PiC readers, the American Association of Physics Teachers has more than 10,000 active members (www.aapt.org). It holds two annual meetings, attended by about 1000 national and international members. Canada has four active AAPT sections (BC, Alberta, ON and Quebec). In addition, PER community in North America has an annual Physics Education Research Conference (this year organized by Canadians); it is represented in the APS conferences and at a number of other events. The community supports a number of peer-refereed journals: the American Journal of Physics, Physics Review Special Topics (Physics Education), The Physics Teachers, Physics Education, etc. In Canada, the events sponsored by the CAP Division of Physics Education at the 2008 Congress had very high attendance, and both PiC and CJP recently opened PER sections. Additionally, the most scientifically prolific years for many (albeit not all) science faculty happen during their 30s and 40s; this often does not apply to PER faculty who often continue their research over the entire span of their careers.

Sincerely,

Marina Milner-Bolotin
Department of Physics,
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EDUCATION CORNER - SEE / VOIR p. 62, 74, and 86

ESPACE ÉDUCATIF

BY ROBERT I. THOMPSON, UNIVERSITY OF CALGARY

Welcome to the first Physics in Canada "Education Corner". This section is designed to provide physics educators with useful tools to assist them in the classroom, be it a high school classroom, and undergraduate lecture hall or lab, or a graduate seminar room.

In this edition of the education corner we are pleased to offer you two articles. The first will introduce you to a series of videos being produced by TRIUMF as educational tools for high school physics classes, and thus of interest to high school physics teachers and university outreach coordinators (see p. 62).

The second article looks at the use of technology to provide students with more practical examples of physical phenomena through quantitative analysis of video data using commonly available computer software. Both of there articles are in fact previews of "Workshop Presentations" that will be given at the upcoming CAP Congress in Moncton, where attendees will be given a practical, hands-on introduction to these tools (see p. 74).

We have also included a book review of a highly promoted inttroductory physics textbook designed for bioscience students (see p. 86).

This is the first of an ongoing series of Education Corners that will appear in future issues of Physics in Canada.

If you have any ideas for articles or submissions for future Education Corners, please contact Dr. Robert I. Thompson (thompson@phas.ucalgary.ca), who is the Editorial Board Member responsible for education articles in *Physics in Canada*.

THE TRIUMF *PHYSICS IN ACTION* VIDEO SERIES FOR HIGH SCHOOLS

BY MARCELLO M. PAVAN, PH.D.
TRIUMF OUTREACH COORDINATOR

TRIUMF is well-known as a “meson factory” for nuclear and particle physics and materials science research, and as an “exotic radioisotope” factory, for leading-edge research in nuclear structure and astrophysics and fundamental symmetries. But less well known is the fact that TRIUMF is also a “factory” of exciting, real-world applications of high school physics. Indeed, most of the lab's operations can be understood in basic terms using the physics principles taught in high-school physics classrooms, offering teachers a valuable pedagogic repository to help students see that the very formulas they manipulate in class are actually used everyday at a world-class research lab. This article describes the content and philosophy of TRIUMF's project to bring its physics into the classroom through a series of computer-animated educational videos, with some words on what it takes to produce such videos.

The TRIUMF Outreach Program was revived in the summer of 2002, with the goal to “*[introduce] teachers to real scientific research environments, and [to supply] resources to translate their experiences to their classrooms, [providing] teachers with the tools required to encourage their students to continue studying science*” . Several successful TRIUMF-teacher ventures emerged including the B.C. Association of Physics Teachers/B.C. Science Teachers Association biennial professional development day, where teachers from across B.C. visit TRIUMF for a full day of lectures and hands-on workshops. One such workshop demonstrating special relativity using pions, muons and electrons from a secondary beam channel was such a hit that TRIUMF scientist Stanley Yen, Richmond, B.C. high-school teacher Philip Freeman and I decided to turn it into a video so that more teachers can bring the experience into their classrooms. The “*Physics in Action*” video series was born here.

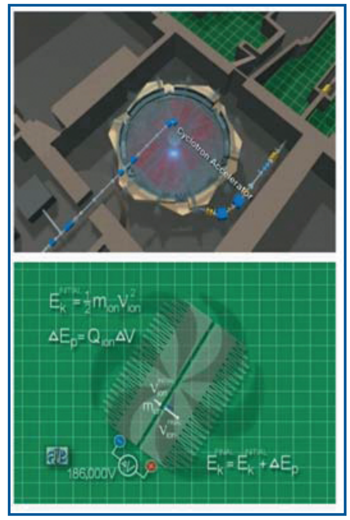
The first video entitled “Approaching the Speed of Light” was produced on a minimal budget with simple 3D animation tools. Nonetheless it exhibits the structure used in all subsequent videos:

- *Address the curriculum*. Teachers have a great need for supplementary materials, but have precious little time for content not directly related to the curriculum.
- *Use computer-generated graphics for visualization*. A subatomic-physics lab is rather complex and so it is very difficult for non-experts to visualize what is happening without simplified animations.
- *Provide data to manipulate*. Many teachers expressed dismay that students have little access to real data, so we provide it wherever possible.
- *Stick to high-school nomenclature, units, etc*. Minimize jargon (and use none undefined), stick to SI units, and use wording and analogies commonly used in classrooms.
- *Be pedagogically complete*. Explain all relevant parts of the equipment, apparatus, etc necessary to understand how the system works. The video should be “turn-key” easy to use for teachers.
- *Put details in a companion workbook*. Put the essential information and visualizations in the video, and put everything else in a workbook that teachers can edit to suit their teaching needs.
- *Make the video free for teachers*. School budgets are very tight, and even a modest cost is a significant barrier to entry for most teachers.

All told, “Approaching the Speed of Light” was successful. A few hundred copies have been sent across Canada, the US, and as far away as China. The feedback from teachers has been very positive. But naturally, the video was not perfect, and the feedback received led to a few changes in the second video.

- *Use high-quality computer animations*. A generation brought up on amazingly realistic computer games (like ‘Resident Evil”) are not easily impressed, and amateurish looking graphics can be a quick turn off.
- *Make it short*. Feedback indicated that videos work best if students watch only up to 5 or so minutes before being asked to “do something” (a calculation, short quiz, etc).
- *Keep it fast paced*. The video should move at a brisk pace, perhaps with a music, to keep the students’ interest.

The above principles would put into the production of the second video, “Electromagnetism and Circular Motion in a Cyclotron”, which shows how high-school physics is manifest at TRIUMF creating and accelerating beams, and creating and mass-filtering radioisotopes. A professional video-production team was hired to create higher quality video and computer graphics. The video itself is split into self-contained modules (including 6 classroom lessons), the longest about 7 minutes long, and the workbook contains additional advanced lessons. Feedback from the second video was even more positive than the first, and interest for it is strong across Canada. We are applying our ‘formula’ with some minor tweaks for the final two videos : one on the evolution of the universe, and another on demystifying radioactivity and its uses, both of which are in well into production.



A note to prospective physicists *cum* video producers - creating these videos is much harder and takes much more time than you think. And making videos is expensive - a few thousand dollars per minute and more. It is essential to work with an experienced production team that preferably has educational-video experience, since usually their skills and protocols are highly optimized for ‘standard’ shoots (film, commercials) . Teachers should be consulted closely on the content and delivery, and advanced planning and preparation is crucial - production teams are accustomed to brief, intense work, and reshooting or reediting animation can be expensive. Nonetheless, it is an invigorating and rewarding experience, and it is very gratifying when a teacher tells you that they use your video in their classrooms. It is nice to know you are helping.

Copies of the Physics in Action video series can be ordered form the TRIUMF website, or by contacting outreach@triumf.ca. The second video will be widely available soon, while the next two should be released next fall.

MMP would like to acknowledge the invaluable contributions from Richmond high-school teacher Philip Freeman, and the expertise of his production team of producer/writer Ross Belyea and video/animation director/editor John Lambert.

A BRIEF INTRODUCTION TO VIDEO-ANALYSIS

BY TETYANA ANTIMIROVA AND MARINA MILNER-BOLOTIN
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Video Analysis (VA) represents a general class of techniques used to extract physical data from digitally recorded images that has recently become a valuable tool in teaching introductory physics.[1,2] Originally used for the study of kinematics, nowadays its application has been extended to the study of any phenomenon wherever visible changes in the setup or in the device reading takes place [3]. VA can be used effectively for both in-class and homework activities, becoming a feasible, cost effective alternative to live experiments when the equipment is unavailable, the motion is too fast to observe with the naked eye or the phenomena under study take place outside of the classroom. Based on our experience with VA, it has enormous potential to captivate and engage the students.

In VA of motion, the staged experiments or real-life events such as roller-coaster rides, car races, objects falling, etc., are video recorded, uploaded on a computer and analyzed using commonly available software packages such as Logger Pro [4], Tracker [5], or other similar open source or commercial software. A camcorder or a webcam connected directly to the computer captures the event in real time. In addition to photographs, most modern digital cameras allow the recording of short video clips that can be later inserted in the program. Cell phones with video recording capabilities can be used as well. The software allows you to obtain motion data (time and position) from each time frame (30 frames per second for a typical camera). This recording speed is usually sufficient to capture most of the popular classroom experiments. Webcams can exhibit some delays in displaying the movie being recorded, but even webcams works well enough for slower events. Faster events like explosions and collisions might require more expensive high-speed recording equipment. Once the video clip is inserted in the program, it can be advanced by one frame at time, and the positions of objects in each video frame can be measured by pointing a mouse and clicking. The dots representing a motion diagram appear in the movie window, and the numerical data table, along with the graphs of motion, is generated by the program. The data generated can be graphed, analyzed using spreadsheets, fitted and compared to theoretical models.

An example of VA of a free falling object is shown in Figure 1. In this example a ball is dropped and allowed to fall freely while a video of its descent is recorded and then entered into, in this case, the Logger Pro software package. The graphs on the right show vertical displacement and vertical velocity of the ball as functions of time. Logger Pro software used in this analysis allowed us to fit the data to obtain the values of instantaneous velocity values of the ball and its acceleration. This example can be used to link students' mathematics and physics knowledge: the raw data contains the position-time information, while the velocity and acceleration values can be obtained from it either using calculus or graphically. We use this activity to help the students to overcome persistent difficulties with interpreting graphs of motion [6] and linking different representations of motion such as motion diagrams, kinematics graphs and numerical values.

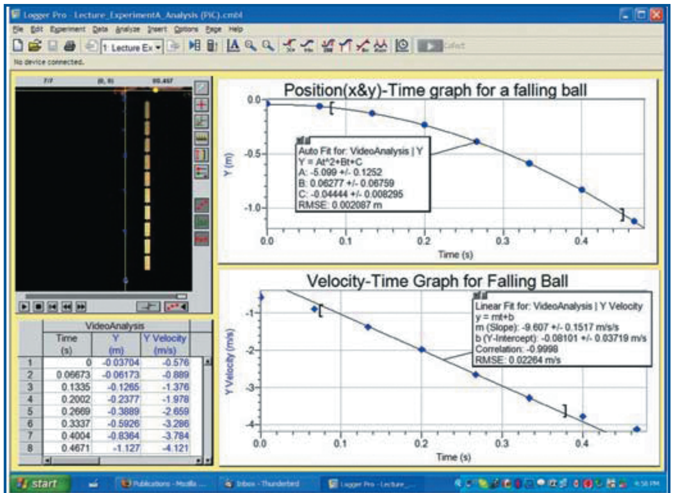

Fig.1: Video Analysis of a free falling object

There is a wealth of online resources on VA. LivePhoto Project at Rochester Institute of Technology has a large collection of very short video clips [7] and a collection of links to other relevant resources. Patrick Cooney's website [8] has a section that covers all aspects of making movies for VA. His hands-on advice ranges from the choice of recording equipment to the discussion of potential problems and pitfalls. Another great resources, mentioned earlier, is a free Java Video Analysis tool developed by the Open Source Physics Project called Tracker.5

If you are planning to attend CAP 2009 Congress in Moncton, you will have a chance to participate in a hands-on introductory workshop that will help you get started using Video Analysis for classroom and homework assignments. The examples of recording and analyzing of short video clips will be demonstrated.

Acknowledgement: We would like to thank Sergey Zhdanovich for helping with the videotaping of a free fall motion.

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BOOK REVIEW - "PHYSICS FOR THE LIFE SCIENCES"

BY EDUARDO GALIANO-RIVEROS, PH.D., P.PHYS.
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I first crossed paths with Prof. Zinke-Allmang's new book "Physics for the life Sciences" in the early Fall of 2006. I was asked to review the first three chapters in which the concepts of kinematics and force are introduced from a deliberately physiological perspective. It quickly became obvious that I had before me a text unlike any other introductory physics text that I had ever come across. The physics was certainly mathematically "lighter" than the standard introductory texts such as Serway and Beichner's "Physics for Scientists and Engineers", in that Zinke-Allmang chose a non-calculus platform for his book. However the book addressed an area of physics which was in sore need of some attention at the introductory level: a text specifically targeting the clinical and biological aspects of physics. This is a substantial market that so far has been largely ignored by the major publishers. Almost invariably similar texts which at their core were aimed primarily at physical science and engineering students, with occasional clinical references or problems sprinkled at the end of the chapters. Zinke-Allmang on the other hand, started with a clean sheet design with the health sciences student in mind and in addressing his/her needs, I believe he succeeds admirably.

In the Fall of '08 I taught a one semester course PHYS 2616 "The Physics of Hearing & Vision". I settled on Zinke-Allmang's text as the best fit, covering chapters 16 through 20, and as a special topic chapter 21 which introduces the concept of aerospace medicine. Chapter 16 is an interesting introduction to the phenomena of elastic behavior followed by the establishment of the conditions necessary for simple harmonic motion, from a physiological perspective. Chapter 17 is an introduction to acoustics as applied to the human auditory organ. Chapter 18 is an introduction to geometric optics comparable in level to what would be found in other standard introductory physics texts. Chapter 19 is a short chapter on microscopy, in which the author deals effectively with the fundamentals of optical microscopy, but his treatment of electron microscopy is inadequate and could use some expansion. In chapter 20, the author introduces the concept of color vision, touching among other things on the "psychological vs. physical" debate on the nature of color. The last chapter this reviewer tested in class was chapter 21, which effectively addresses two key challenges to long duration manned spaceflight: the detrimental physiological effects of weightlessness on bone mass, and the anticipated in-transit absorption of high doses of ionizing radiation of cosmic and solar origin. The questions and problems at the ends of the chapters were generally found to adequately address the concepts contained in the chapters.

The publisher and author provide additional supporting materials one might expect in a product of this type, such as a printed student solutions manual, and in CD format an instructor's solutions manual, and Power Point slides to accompany the lectures. This reviewer found that the slides were frequently very useful for lecturing, however they do contain their share of typographical errors. The text does have some weaknesses as well; perhaps the most substantial one being that in his attempt to present a unified view of medical/biological physics, the author omits any serious introduction to the crucial subjects of radiotherapy, nuclear medicine, and/or diagnostic radiological physics. By adding a chapter (or chapters) addressing these subjects in a future edition, the market footprint of this text should be significantly enhanced.

My overall impression is that this text represents a breath of fresh air in the somewhat stuffy introductory physics market in that the author is targeting a subset of the student population that other authors have either treated as an afterthought, or not at all. This reviewer is unaware of any other text in the North American market which specifically addresses this special target audience.

A more complete review of this book can be found on the CAP website.

Eduardo Galiano-Riveros, Ph.D., P.Phys.

Prof. Galiano-Riveros is an Associate Professor in the Dept. of Physics at Laurentian University, in Sudbury, ON. He is a medical physicist and his research interests lie in radiotherapy and nuclear medicine imaging.

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