LETTER TO THE EDITOR

Polar Research

Making science animations: new possibilities for making science accessible to the public

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Lubchenco (1998: 495) challenges scientists to: "(1) address the most urgent needs of society, in proportion to their importance; (2) communicate their knowledge and understanding widely in order to inform decisions of individuals and institutions; and (3) exercise good judgment, wisdom, and humility". As participants in the International Polar Year (IPY) of 2007–08, we hope we contributed to the first challenge. Here we address the second challenge, effective science communications.

The IPY occurred as visualization technologies such as "flying" explorations of geographic and geo-referenced data, zooms and rotations of three-dimensional data, animated and sequential displays of X-Y, position and time series data, and video vignettes became increasingly familiar to the public from popular and commercial sources, while they remained rarely used by the scientific community. The IPY therefore emphasized the urgent need for informative communication products in attractive formats to establish and reinforce links between science and the public in order to raise the general consciousness about the challenges we face in the polar regions as well as globally. Two recent guides to effective science communication (Schultz 2009; Baeseman et al. 2010) recommend the use of animations and video in presentations; a thoughtful comment by Baeseman points out that multi-sensory content (e.g., video and sound) can enhance learning experiences for people with dyslexia or other learning challenges. However, practical information on how to build such products is scarce.

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Table 1 The basic steps involved in building animations using readily available tools on personal computers.

Step	Action
1	Create an initial draft of the intended content and its visualization.
2	Build and assemble graphics components, from drawing tools, images, clip art or spreadsheets.
3	Import and assemble pre-existing graphics components within the presentation software, or use the drawing tools of the presentation software to create graphics objects.
4	Use animation functions of the presentation software to display and move the graphics objects in sequence, as if for a presentation.
5	Optimize colours, labels, timing, and other graphic formats for video use.
6	Using functions inherent to the presentation software or external conversion software, export the presentation to a movie file.
7	If necessary, convert the exported movie file format to.mov.

At the Association of Polar Early Career Scientists workshop in Victoria, Canada, in December 2009, IM, MA, MG, and MH—young polar researchers from four different countries—and DC agreed to confront the null hypothesis that an average scientist, using normal and available tools, *can not* produce effective science animations to communicate research results and conclusions.

Among the five of us, we used four personal computers equipped with the Windows Office 2007 package and one MacBook running both Office 2007 and iWork 2008. As a consequence, our presentation software options included PowerPoint 2007 and Keynote 2008.

By June 2010, six months after our initial meeting, all of the authors had developed the skills and mechanisms to make, with relative ease, an effective science animation, without narration, of about 3–4 min length. The exact sequences of components and steps involved in building these animations varied depending on content (data vs. graphic objects) and presentation software (Keynote vs. PowerPoint) but for most of us involved the basic steps shown in Table 1.

All of us created at least one animation related to our specific research interests, and we developed reliable ways to share our products. Those of us making our first animations invested an average time of three days to create what we deemed a satisfactory product. Table 2 summarizes our steps and choices, decisions that proved most important to our production, our collaboration, and the quality of our final products.

The full set of animations was presented by IM at the IPY conference in Oslo in the summer of 2010. Consistent with the IPY's policy of making the data and results of the IPY freely available via open access channels, we offer our

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Table 2 A summary of the main issues and options that proved most important to the production, sharing and presentation of our animations. Options in boldface were those that we selected.

Issues	Options		
Animation tools	**Export from PowerPoint[a] or Keynote**	Flash	Higher-level tools (Java)
Movie formats	.wmv	**.mov**	.m4v
Share and exchange files	E-mail	Proprietary compression formats	**Dropbox**
Optimize for projection	**Calibrate computer displays**	**Use bold colours, high contrast**	Test and adjust projectors

[a]We used PPT to Video, free software from Acoolsoft, to export animations from PowerPoint.

animations, as well as a step-by-step "how to" movie for creating such products, as supplementary material on the *Polar Research* website and at http://www.educapoles.org/projects/project_detail/apecs_scientific_animations/.

Examples presented by one of us (DC) allowed us to recognize that using Flash would enlarge our animation possibilities and enhance the quality of our products. However, many of us would require time and training to gain skill in using those more complex tools, and we did not find a way to share our single Flash user license among all of us. Because of time constraints, and in view of our objective to use easily available tools and methods, we rejected using Flash and instead chose to use the animation and export functions within our presentation software for this project.

We considered the common movie formats .avi, .m4v, .mp4, and .wmv but found that even among personal computer users not all of us could view all formats. Due to the widespread use of the .mov format and with easy accessibility on our computers of free .mov viewing software (e.g., QuickTime), we adopted the .mov format for all our products. For our simple animations, use of a lossy format such as .mov had no discernable impact on final quality.

As some of the .mov files exceeded 30 MB, we could not share these files as e-mail attachments. Instead, we set up and shared a Dropbox (http://www.dropbox.com) for movie files and documents. The use of this free file-sharing service enabled us each to deliver the latest versions of movies into a folder designated for access and viewing by all of the other team members. We did several iterations of comment and evaluation by e-mail, and one additional mutual projection test and evaluation at the conference in Oslo.

We looked carefully at issues of composition, colour, and contrast and learned to develop our initial pleasing-to-our-eye palettes into clear and bold imagery better suited to the vagaries of projectors and classrooms. We learned to adjust, whenever possible, the colour control parameters of classroom or auditorium projection systems, parameters that might otherwise detract from our careful preparations. We also identified the colour calibration of our own laptop screens or desktop monitors as a useful step to help maintain fidelity between our intended designs and eventual projected products.

Recognizing students as an open-minded and inquiring audience, one exposed to the vast and visually-rich world of "infotainment", we worked with teachers to better understand how to develop and modify our products for classroom use. We created and distributed a questionnaire (available at http://www.apecs.is/outreach/1636-animated-graphics-survey) to gain knowledge about hardware and software equipment at an average middle or high school as well as to understand teachers' capabilities and concerns for use and sharing of video products.

Responses to the questionnaire indicated that animations should not be longer than 2–5 min and that most of the schools are equipped with at least one computer and a projector that could show short movies like ours. Our questionnaire revealed a broad consensus that students need to understand the largest changes associated with global warming and that examples from the polar regions can act as a "hook" to grab students' interest in science. Many teachers also felt that a major goal should be to provide students with tools to evaluate climate change information they receive from mass media. As polar regions are not included in the curriculum of most school systems, help from outside, such as these animations, seemed to be very welcome.

We combined all the animations into one presentation to an assembled group of educators and scientists at the conference in Oslo. That audience, which included many high-school teachers who had attended the international polar teachers' workshop prior to the Oslo conference, responded very positively to our products and stimulated a fruitful discussion between scientists and educators. We heard enthusiasm as well as valuable suggestions for improvement and we got a clear impression that teachers were grateful that scientists had initiated such projects to provide them with accessible material. We also received positive responses from other researchers, senior as well as earlier-career scientists. Our science colleagues generally showed great enthusiasm about this project, both for the utility and impact of the products and for the

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information we had developed about how—and how easily—to make such products.

Our short collaborative project effectively refuted our initial hypothesis. We demonstrated that with a relatively small effort any scientist can produce an animated presentation of her or his research in a form and format understandable and accessible by anybody. We believe the process of making products such as animations, combined with interactions with teachers, and other users, will raise scientists' awareness for the necessity of interaction with the public. We react to a recent assessment—"... science education has become—with notable bright spots to be sure—a joyless, alienating and frustrating experience for millions and millions of kids" (Goodenough 2011)—with the hope that we have described useful and accessible steps that will encourage more scientists to produce and share interesting and effective animations.

Inspired and motivated by very positive feedback from teachers and scientists, we intend to push this outreach project further. We intend to: (1) explore the possibilities and technologies to add narrations to our existing animations; (2) identify platforms where everybody can access our animations; (3) demonstrate the utility of our animations on digital tablets such as an iPad; and (4) incorporate our products into the larger framework of the Polar Information Commons.

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