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SCIENCE COMMUNICATION: WHAT EVERY SCIENTIST CAN DO AND A PHYSICIST'S EXPERIENCE

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ABSTRACT

Since 1994, I have made an effort to merge my research as a working physicist with science communication (SC) activities. SC has helped my research and changed it in very exciting ways, leading to the creation of histophysics and my enlightenment in the history of science. My experience is described, and six recommendations are offered for others: (1) integrate popular science (PS) books into science teaching, (2) inject PS talks in departmental seminars or set up a separate series, (3) set up a university-wide PS lecture series, (4) give PS talks, (5) contribute to the scholarship of SC, and (6) merge science with the humanities. The first four can be practiced easily by every science professor, the fourth by all scientists, and the last two by some of them.

INDEX TERMS

Popular science book, two cultures, active walk, histophysics, bilinear effect

INTRODUCTION

Science communication (SC) (Gregory and Miller, 2000) involves four components: (1) funding and organized effort from the government and learning societies, (2) engagement of scientists as individuals, (3) participation of the public, and (4) the development of SC as a research discipline, by scholars and students. Engaging scientists and the science community to participate actively and regularly is a daunting task. What the government can do is to provide funding and encouragement to scientists who are willing and qualified. The other part of the game concerns the scientists themselves, at the individual level. Leon Lederman, a Nobel physicist, proposed that working scientists should devote 10% of their time to communicating science. This may not be very practical for those professors who do not yet have tenure, because the competition in research is very keen and research requires undivided attention, not to mention that SC is not always appreciated and rewarded by the administrators. But let us say, a scientist—tenured or not—want to contribute to SC, what can she or he do? This article addresses this problem, from the perspective of a working physicist.

My background as a scientist is not atypical. I have been working in physics research in the last 40 years. I obtained my B.S. from University of Hong Kong, M.S. from University of British Columbia, Canada, and Ph.D. from Columbia University, USA. (My Ph.D. thesis was done at Bell Labs.) My research was first in condensed matter physics, and later in nonlinear physics and complex systems. **Complex system** is the study of real world problems arising from social and natural sciences. I have published over 150 research papers and 11 books. I

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am now a physics professor at San Jose State University, California, USA, and a guest professor at both the Chinese Academy of Sciences (CAS) and the China Association for Science and Technology (CAST). My involvement in SC began in 1994. I was invited by Rosalio Rodriquez to visit the Universidad Nacional Autonoma de Mexico in Mexico City, Mexico. I gave a talk "Nonlinear Physics Is for Everybody," geared to the public. Since then, I have been doing physics research and SC simultaneously, trying to combine and synthesize the creative activities in these two endeavors. What follows is the adventure I went through in the land of SC, and my recommendations for others.

THE SCIENCE COMMUNICATION PROCESS

1. <u>What every science professor/teacher can do</u>: ***Integrate popular science books into science teaching***. The quick pace of interdisciplinary development in science and the ever-changing job market demand a broad knowledge base from our students. In the last five years, I integrated popular science books into my physics classes by giving extra credits to the students who would buy a popular science (PS) book, read it and write up a report (Lam, 2000a; Lam, 2001). The instructor does not actually teach the books, and hence will not find the teaching load increased—an important factor in any successful educational reform. It is like a supplementary reading, a practice common in the English classes but rarely adopted by science instructors. The aim of this practice is (1) to broaden the knowledge base of the students, (2) show them the availability and varieties of PS books in their local book stores, (3) encourage them to go on to buy and read at least one PS book per year for the rest of their life, and (4) become a science informed citizen—a voter and perhaps a legislator who is science friendly.

Professors in other universities have copied this approach, with equal success. It is equally applicable to high schools. Adopting this practice in the whole country or worldwide in large scale will fundamentally improve the science education of our students, the future average citizens. An immediate side effect is that in a few short months, all the PS books on the bookshelves of every bookstore will be wiped out. The PS book market will be drastically improved, attracting more skillful writers into the PS books profession, benefiting everybody.

2. <u>What every science professor can do (I)</u>: ***Inject popular science talks in the departmental seminars, or set up a separate popular science seminar series in the department***. Since 1994, I have given general talks on science, history and religion. I usually tried them out first in my physics department. The titles include "Wu Chien-Shiung: The First Woman President of American Physical Society", "Does God Exist?", "The Real World", "The Birth of a Physics Project: What Happened to My New Book?", "Why the World Is So Complex", and "How to Model History and Predict the Future". In almost all universities around the world, there is a weekly departmental seminar. Recent research results are presented by either outside speakers or the faculty members. These talks are usually dry and quite often poorly attended. The exceptions are PS talks, because they are easy to understand, even for undergraduates.

What every science professor can do is to insert PS talks into their departmental seminar series, which can be given by themselves or outsiders. If the department does not allow it, a separate PS seminar series can be set up separately, with the help of the student science clubs if they exist. And, of course, any seminar is open to the whole university and the outside community.

3. <u>What every science professor can do (II)</u>: ***Set up a popular science lecture series in the university for general audience***. In Dec.1999, I established a public lecture series "God,

Science, Scientists" at San Jose State University. The first three speakers (Fig. 1) are: (1) Michael Shermer, who gave a talk in May 2000 on "How People Believe: The Search for God in the Age of Science." Shermer, a monthly columnist for *Scientific American*, is the founding publisher and editor of *Skeptic* magazine. He is the author of many PS books such as *Why People Believe Weird Things*, *How People Believe*, *Denying History*, *The Borderlands of Science,* and *Science Friction.* He is also a professor of history and science associated with Caltech and the Occidental College at Los Angeles. (2) Eugenie Scott, the executive director of the National Center for Science Education in El Cerrito, California. Scott is a nationally known authority on creationism and evolution controversy. (3) Charles Townes, the Nobel laureate in physics and co-inventor of laser. These talks were attended by a wide audience and were well received. I still get letters from the fans who were there five years ago.

Every science professor can set up a PS lecture series in their university, which will be highly appreciated by the administrators. It is not that difficult to do if you limit yourself to one speaker per semester. And don't forget to invite your Dean or President to introduce the distinguish speakers.

Figure 1. *The first three speakers of the "God, Science, Scientists" lecture series at San Jose State University. From left to right: Michael Shermer, Eugenie Scott, and Charles Townes.*

4. <u>What every scientist can do</u>: ***Give popular science talks in high schools, the community, and other places***. For the past 11 years, I gave invited talks in various high schools (such as the Provincial Senior High School, Hsinchu, Taiwan, whose graduates include Li Yuan-Jie, the Nobel laureate in chemistry) and universities in Mexico, the United States, Taiwan, and Hong Kong. In Nov. 2000, Shermer was one of four PS experts I invited, in my capacity as a member of the International Advisory Committee, as a speaker at the *International Forum on Public Understanding of Science*, Beijing, organized by CAST. We became close friends. He invited me to write an article on active walks (Lam, 2000b) for his magazine *Skeptic* (Lam, 2000c). This article led to an unexpected invitation from the Foundation For the Future, as a keynote speaker in their annual seminar, *Humanity 3000*, held in Seattle, 2001. The 23 invited "participants" included the famous Edward Wilson (from Harvard) and Richard Dawkins (from Oxford); I was the only physicist there. I gave a talk on "How to Model History and Predict the Future" (Lam, 2003a), and became a futures-study expert, *ipso facto*.

After that, I was invited by Doug Vakoch of the SETI Institute (Search for Extraterrestrial Intelligence, based in Mountain View, CA), who attended this Seattle seminar, to go to Paris in March 2002 and talk about what science-and-art message to send to the ET, in case they exist. I proposed to send them electronically the Sierpinski gasket, a fractal. Vakoch liked the idea and included it in his workshop report (Lam, 2004a). And I suddenly found myself an ET expert. One thing led to another, like in a chain reaction. I met some artists during this Paris workshop, and we are now collaborating on a physics-art-music (PAM) project called "Candle in the Wind". Another participant in that Seattle seminar was Clement Chang, founder of Tamkang University in Taiwan. In Dec. 9-11, 2003, I was invited to give the Tamkang Chair Lectures (Fig. 2). My host was Kuo-Hua Chen, Chair of the Graduate Institute of Futures Studies and Director of the Center for Futures Studies. The result is my first PS book, *This Pale Blue Dot: Science, History, God* (Lam 2004b).

Not every science professor is good at giving PS talks, but every one can try and be successful. You just keep practicing, giving the same talk many times and modifying it with the help of PowerPoint. And as shown by my story above, the reward is huge. It gains you many new friends, from all walks of life. It might even take you to Paris.

Figure 2. *The poster and book covers of my Tamkang Chair Lectures*.

5. <u>What some scientists can do but all can try</u>: ***Contribute to science communication as an emerging discipline***. Science communication is an emerging discipline of study, and a profession without a formal name—unlike physics. A new and short word is needed. My suggestion is to call it scicomm, or popsci (after pop art). It is rare to find a SC course in American universities. China has a lead here; there are already degree programs in SC in at least four universities, and a research institute on PS (under CAST). Obviously, the contribution of working scientists in making popsci a mature discipline is much needed; e.g., they can provide different perspectives and help to clarify science issues. In June 2004, I collaborated with Daquang Li of CAST (now at CAS) and Xujie Yang of the *ScienceTimes* (a Beijing daily), CAS, and presented a paper in Barcelona, Spain, on the absence of professional popular science book authors in China (Lam *et al*., 2004), which was selected into *The Pantaneto Forum*, Issue 18. This was followed by a paper on new concepts for science and technology museums, presented at the *International Forum on Scientific Literacy*, Beijing, July 29-30, 2004 (Lam, 2004c). The idea is that unified themes governing natural and social sciences should and can be injected into the display of science museums, to avoid the possible misconceptions conveyed to the visitors that the two are completely separated from each other. And, reporting for *ScinceTimes*, Yang and I co-wrote an article on the *10th Int. Conf. on the History of Science in China*, Harbin, Aug. 2004 (Yang and Lam, 2004).

6. <u>What some science professors can do</u>: ***Merging science with humanities***. Science and the humanities are considered by some as "two cultures" (Snow, 1998). But in fact, humanities are about humans, which is nothing but a (biological) material system of *Homo sapiens*. Thus, humanities could be a part of the natural sciences, which is about *all* material systems. The

two can be integrated, but how? In 1992, two years after I founded the International Liquid Crystal Society (Lam, 2005a; Lam, 2005b), I came up with a new paradigm for complex systems. I named it **active walks** (AW), reviewed in (Lam, 2000b; Lam, 2005a). An active walker is one that changes a landscape—real or mathematical—as it walks; its next step is in turn influenced by the deformed landscape. An ant is a living active walker; the landscape is the distribution of pheromone the ant releases. AW is now widely applied in natural and social sciences. By 2000, I was trying to create a new discipline by merging AW with a branch of the social sciences/humanities. Contact with Shermer through our shared PS interests made me look at history seriously. Two years later, I presented my first paper (Lam, 2002) on the physics of history, or **histophysics** (Lam, 2003b; Lam, 2005c), at the 80th birthday workshop of C.N. Yang, a physics Nobel laureate, at Tsinghua University, Beijing.

Whether there exists any law in history is under constant debate. The only way to settle it is to find at least one law and show it. I found two (Lam, 2005a). Both are *quantitative* laws concerning the duration of regimes and dynasties in the Chinese history, from Qin to Qing, ranging from 221 B.C. to 1912. The first law shows that the distribution of regime lifetimes obeys a power law (i.e., $y = Ax^{\alpha}$), similar to that found in earthquakes and many other complex systems. The second law is shown in Fig. 3, where the lifetimes of the 26 dynasties are arranged in a monotonic decreasing order. They fall on two straight lines, which I call the **bilinear effect**. What it means is that (1) the "curse of history", as Chinese dynasties are concerned, does exist. (2) A dynasty can survive every 3.5 years if it lasts less than 59 years; beyond that, every 25.6 years—dynasty lifetime is discrete, or "quantized". A quantitative prediction: Any dynasty after Qing, if exists, will either (1) last 290 years or less and fall on the two lines in Fig. 3, or (2) end definitely and exactly in its year 329. Presently, as far as I know, no other quantitative non-statistical historical laws and predictions are known.

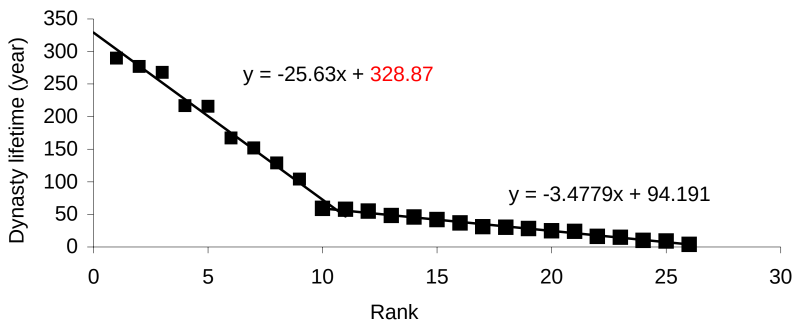

***Figure 3**. The bilinear effect: dynasty lifetimes fall on two linear lines in a Zipf plot.*

EVALUATION

My popsci presentations to the public and my work on histophysics were well received by the audiences, judging from the questions they raised in the Q and A periods, and the feedbacks conveyed to me by my hosts. Furthermore, professional scientists from many countries sent me requests for reprints on histophysics, with very positive comments.

DISCUSSION

My activities in scicomm actually include something more. To help China's fight against pseudoscience, and sometimes "evil religions", I became the Chinese-copyright agent of Michael Shermer and James Randy. I got Shermer's *Why People Believe Weird Things* (Hunan Educational Press, 2001) and Randy's five books on magic and pseudoscience fighting (Hainan Press, 2001) published in Chinese.

CONCLUSION

There are many things scientists can do in scicomm, as individuals, without funding. Six of these are recommended here, with the first four suitable even for untenured professors. Scicomm is fun, adventurous, and enables one to meet interesting new friends/colleagues beyond their own discipline, or even helps one's research career. As an important Chinese leader advocated: When facing a daunting task, learn from the ants. Mobilize the masses and trust them. It worked for China, and will work for scicomm.

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