

The Web and Publishing in Science: The ArXiv and LaTeX

The past two decades have seen a quiet revolution in how scientists publish their work. Twenty years ago the World Wide Web was invented by physicists working at the CERN particle accelerator near Geneva, Switzerland. Notwithstanding the fortunes made by Amazon and Facebook, the Web was designed originally to facilitate the exchange of scientific results. The Internet itself is older, but in pre-Web days it was all straight text, without graphics, and far less accessible. A byproduct of the Web is an important site called the **arXiv**, (pronounced “archive”), a repository now holding more than half a million articles in physics, mathematics, statistics, astronomy, computer science and quantitative biology. (The spelling is a sort of pun, which will be explained presently.) The arXiv may one day take the place of many scientific journals.

When a scientist has completed some research, she or he wants to publish it quickly, not least to establish authorship of the work. Frequently two or more rivals are working in the same area, and may reach a conclusion nearly simultaneously. Priority is important. Usually the time lag between submission of an article and its appearance in a journal is at least six months, and may be more than a year, much too long to wait for new results (or for credit to be recognized.) To sidestep these delays, scientists used to send out *preprints* of their work, copies of what they sent to the journal. In effect, the preprint served as an informal statement of priority. It was expensive and labor intensive to duplicate and mail the preprints, and it was entirely hit or miss; maybe you had a rival you were not even aware of at a school you hadn’t thought to include, and in any case, only the leading schools got preprints from each other.

Things have changed dramatically. In 1991, around the time the Web was born, the theoretical physicist Paul Ginsparg had the idea to establish an on-line repository of physics preprints. Originally housed at Los Alamos National Laboratory, the arXiv has moved to Cornell University (where Prof. Ginsparg now teaches), and its holdings have expanded to other areas besides physics. Articles are accepted at the arXiv based on a recommendation from a trusted author (someone who earlier had an article at the arXiv, or whose reputation is already established.) Many very important articles have appeared first at the arXiv, and at least in one celebrated instance—the work of Russian mathematician Grigory Perelman on the Poincaré conjecture—have not been published in any other way. Now, instead of mailing out preprints, scientists upload their articles to the arXiv, where anyone can get a copy for free. This is an enormously better system: it is widely accessible, it’s cheap (it doesn’t require paper or postage), it’s very fast, and it’s easy. MIT runs a blog highlighting the most interesting new entries at the arXiv every week: <http://www.technologyreview.com/blog/arxiv/>.

A little before the birth of the Web, a Stanford computer scientist named Donald Knuth had grown increasingly dissatisfied with the appearance of the typesetting of his textbooks. He realized that layout and appearance of books and articles was something that computers were particularly well suited to do, and thought that he could write a program to do the job in six months or a year. In the end, it took him the better part of a decade. Knuth’s program is called **TeX**. In addition to his many other interests and talents, Knuth is a biblical scholar, and knows Greek; the name “TeX” is derived from the Greek *techné*, “craft”. The capital X is supposed to suggest the Greek letter *chi*. Knuth has made his program freely available; others have modified and extended it. The best known extension is Leslie Lamport’s **LaTeX**, a somewhat more user-friendly version of Knuth’s original program. Free versions of LaTeX can be downloaded to run on just about every computer known. The LaTeX output is typically a PDF file, easily viewed or printed from a computer. Though designed originally for mathematics, LaTeX can do all sorts of things with typefaces (including many Native American languages, hieroglyphics, and even musical notation.) Papers submitted to the arXiv can be in Microsoft Word, but the original intent was that they be in LaTeX, as most technical papers are today; hence the odd X in “arXiv”. Students intending to major in mathematics or physics should at their earliest convenience develop a working familiarity with LaTeX, which has become the typesetting *lingua franca* of technical writing. You can get your own copy, for free, here: <http://www.latex-project.org/ftp.html>. For samples of what LaTeX can do, go here: <http://www.tug.org/texshowcase/> or here: <http://nitens.org/taraborelli/latex>.

I became aware of the arXiv in a roundabout way. A famous theoretical physicist named Freeman Dyson had given a historically and scientifically important set of lectures at Cornell in 1951; notes from these lectures were one of the first textbooks in the new field of quantum electrodynamics (Richard Feynman, a close friend and colleague of Dyson’s, won a Nobel Prize for his work in this area.) Dyson’s lecture notes were available on line as photocopied images, but each was very large, and to download the complete set

of images was very time consuming. I was interested in learning LaTeX to make better handouts for my physics students, and thought it might be a useful exercise to retype Dyson's Cornell notes in LaTeX. A college friend, Bob Jantzen, a mathematician at Villanova, was my LaTeX tutor. He suggested the notes go on the arXiv, a site then unknown to me. With Dyson's approval I typed out his notes, about two hundred pages, and with Bob's help uploaded the notes to the arXiv. Much to my surprise a few weeks later a publisher emailed Dyson and me about publishing Dyson's notes as a book. I did not want to profit from Dyson's work, and he didn't want to profit from mine, so we donated the proceeds to the rebuilding of the New Orleans Public Library, devastated from the flood after Katrina. A few years after his Cornell lectures, Dyson gave a series of talks in France which served as a supplement. I am now at work typing up (and in one case, translating from the French) these notes as well, which will be added to a second edition of the book to appear this year.

I became a Golden Apple fellow in 2007. For a long time my wife had wanted me to take a sabbatical (I began teaching in 1979), so after the Golden Apple quarter off in the fall of 2007, I stayed on leave till the fall of 2008. Much of that time was spent working on a textbook for first year physics, *Blue Physics*, designed primarily for independent study by adults who'd missed out on physics at school or who wanted to refresh their memories. It's all in LaTeX. I hope to put it on line either at the arXiv (if they think it's worth having) or at my school's web site, for free. If eventually some textbook company wants to publish it, so much the better, but the book is not intended as a commercial enterprise. I am about a third of the way through. Here's a sample of what I've written so far.