

Applications of the Internet Archive to Dynamic Geometry

Jen-chung Chuan

Department of Mathematics,
Tsing Hua University, Hsinchu

jcchuan@gmail.com

Introduction

Long before computer/Internet became well-known, the query “how can the technology help me doing the mathematics?” was raised subconsciously in every mathematical mind. Unlike mathematical truth, the answer to this question appears to be time-dependent due to the forever-changing nature of technology.

Need for Technology in Mathematics

Why is the computer technology important to mathematics? Ever since the first processor was built, we have seen the change in weight on the importance of these three factors:

- **Numerical Computation:** “By way of Fortran” appeared as the sole approach before the appearance of the personal computer. A large amount of fascinating historical documentations chronicling the activities are hidden at Internet Archive.
- **Algebra:** When the first computer algebra system Macsyma was published in 1968, the attention was shifted from Numerical Analysis to Algebra.
- **Geometry:** Around 1993, the first Dynamic Geometry software entered the scene, making the good old Synthetic Geometry playable again.

Even if such wonderful developments had never existed, technology has nonetheless been silently helping the research and teaching of mathematics in the most essential manner by way of manuscript production and distribution. In every mathematics department, the amount of money spent for journal subscription still occupies a substantial portion the total annual budget.

At this stage of technology/economics development, messages like “California looks to replace textbooks with ebooks” (<http://www.pcauthority.com.au/Tools/Print.aspx?CIID=147297>) appear in the news headline more and more frequently. A new factor for the need for technology in Mathematics now takes place:

- **Ebooks:** Books have always been the essential part of intellectual development. A key component in making ebook a technology need is the Internet Archive (www.archive.org)

A Brief Survey of the Internet Archive

At this moment (10/07/2009), the Internet Archive contains over 1.62 million texts ready for downloading. The files belong to the Open-Access Text Archive (<http://www.archive.org/details/texts>), so all the legal matters are taken cared of. The archive provides supreme quality in:

- **Academic Contents:** most books in the archive are library copies borrowed from Harvard, Oxford, U. of Michigan, Berkeley etc.;

- **Searching Efficiency:** the magic phrase (<http://www.google.com/support/websearch/bin/answer.py?hl=en&answer=136861>) is “site:archive.org/stream keyword”, Google technology will take care of the rest;
- **Scanning:** logos such as “Google” and “Microsoft” appearing on the first page of each text file indicate what technology is behind the clear images;
- **Downloading Speed:** the whole system is backed by the supercomputing architecture Sun Fire X4500 Server combining four-way x64 server with 48TB of storage (<http://www.archive.org/iathreads/post-view.php?id=238517>).

Why Book Enthusiasts Love the Internet Archive?

- **Linking ancient wisdom with contemporary technology:** Artificial Intelligent has failed to link contemporary wisdom with contemporary technology. Our experience shows, paradoxically, linking ancient wisdom with contemporary technology appears more promising. Browsing through the texts in Internet Archive we see many works are accompanied by labor-intensive illustrations. Investigating the meaning of these illustrations is very much like working through pages of “Proofs Without Words” that no full understanding of the language is needed to catch the crucial mathematical ideas. Under this method of Mathematical Archeology we may rightly say that Internet Archive directly links ancient wisdom with contemporary technology.
- **Tackling the knowledge management task:** Book lovers very often acquire book- collecting as the second nature. The nightmare of managing the collection and making the best uses of them, however, soon become the new headache. We now see how Internet Archive can be admirably tamed when the Google technology is appropriately applied. This technology not only benefits giant libraries, each reader can also make use of the same technology to sort out the personal collection on a microscopic level. Book lovers everywhere are thus self-promoted from slaves to masters.
- **Expansion of horizon:** The world longed for “globalization” long before the word entered media’s glossary. Go to a bookstore or a library in a developing region you won’t fail to notice people actively searching for the true meaning and the true means of globalization there. Internet Archive has been silently making a quantum leap in this direction by adding 2000+ titles a day to the archive while scanning at major libraries throughout the world never stops.
- **Localization:** Before any of the wonderful ideas in the books are internalized into the brain, the basic task of downloading the work into the personal storage system is essential. As Moore’s Law coming to its last moment, wearing a 64G USB jump drive containing the contents of a dozen encyclopedias should become fashionable. Copying 64G of data into such a device is so monotonous a task that not many of us are fond of doing. So, before USB 3.0 becomes widely available, the best localization strategy now is to move the archive into a 500G hard disk, the current price of which equals one half that of the newest edition of Thomas’ Calculus. In the past we see portable electric generators popping up at the major disaster-stricken areas. In the future we expect to see personal data centers popping up along side with the generators to relief disasters.
- **Immunization from technology trap:** Some contemporary author has been reported to have published 200,000 books (<http://www.nytimes.com/2008/04/14/business/media/14link.html>), mostly generated by the computer. The author happens to have gained undergraduate degrees in mathematics, biology and economics, and now holds Chair Professorship of Management Science. It is highly likely the e-book collectors may already have fallen into this virus-like

trap set up by the machine-generated publications. Judging by the care taken by the staff, such dark hole cannot exist in the Internet Archive.

Why the Schools Love the Internet Archive?

- **A Valuable Source of Intellectual Capital:** Every newly formed school faces prohibitively expensive bills to finance the necessary monographs and journals that ceased printing. For such schools a jump-start at the library race can be fueled simply by having Internet Archive's contents linked. For libraries that already hold some out-of-print works, the digital contents of the Internet Archive will increase the utilities of the academic work either by way of cross-referencing or by direct searching. In either case, the library fiscal burden can be drastically relieved.
- **A Means of Increasing the School Prestige:** Every webpage accompanying every Internet Archive file contains a "Description" section recording from which library the work is originated from. It comes as no surprise that the name Harvard appears everywhere. Of the large expenses the universities spent to increase the school prestige each year, contributing image copies of out-of-print work to Internet Archive achieve highest prestige /expense ratio.
- **A Measure of Technology Competence:** "Technology Competence" sounds like a local business. In the age of Internet Everywhere, the number of hyperlinks connecting school webpages with the outside world can be used to measure school's competence. To help schools to achieve this goal, Internet Archive contains millions of nodes ready to be linked.
- **An Opportunity for Propaganda:** Any course adopting materials from the Internet Archive can substantiate the claim that their students do "learn from the masters".
- **A Source of Tradition and Heritage:** After searching in Mathematics Genealogy Project (<http://genealogy.math.ndsu.nodak.edu/>), the instructor can boast that "such and such author is the boss of the boss of my boss's boss. Here is the link in the Internet Archive of what he wrote." The school at once becomes a node in the huge maze of academic heritage.

Specific Inspiration for Dynamic Geometry

We now list a number of topics in Dynamic Geometry whose original ideas can be traced back from the contents of the Internet Archive.

- **Synthetic Construction of Conic Sections:** For many students of Modern Mathematics, terms like ellipse, parabola and hyperbola are inseparable with algebraic expressions. Searching through the current publications, it is rare to find treatments of these important geometric objects geometrically. We have discovered that the glory of Visual Geometry is back, not through Dynamic Geometry but by way of the ancient works (<http://www.archive.org/search.php?query=subject:%22Conic%20sections%22>), all summarized in Luigi Cremona's Elements of Projective Geometry (<http://www.archive.org/details/elementsofprojec028846mbp>). For a contemporary student of Analytic Geometry, the task of drawing a conic curve passing through five arbitrarily given points is far beyond the power of the tools given by coordinate systems and algebra. Based on Pascal's Theorem and its projective dual Brianchon's Theorem, the solution to this of interpolation problem, together with the related degenerate cases, become amenable with dynamic geometry software such as Cabri Geometry or Geometer's Sketchpad.
- **Special Curves:** Before the existence of Dynamic Geometry, the book with the title "A Book of Curves" written by E. H. Lockwood was an exciting introduction in this field. The excitement will pass to the curve enthusiasts for generations to come, since it is now available

at the Internet Archive (<http://www.archive.org/details/bookofcurves006299mbp>). Want to read more? Start from <http://www.google.com/search?hl=en&q=site:archive.org/stream+Special+Curves&btnG=Search&aq=f&oq=&aqi=> .

- **Dissections:** Henry Dudeney was the most well-known mathmagician at the turn of the 19th Century. He once demonstrated how a regular triangle may be dissected into four pieces and then reassembled to form a square, in front of the eminent mathematicians at Edinburgh Society with a wooden model. The full text and the related geometric diagram showing the ruler-and-compass construction of the dissection are vividly displayed in “The Canterbury puzzles and other curious problems”, written by the master himself. This work can now be downloaded from <http://www.archive.org/details/canterburypuzzle00dudeuoft>. For the curious reader, you may discover more at <http://www.google.com/search?hl=en&q=site:archive.org/stream+geometric+dissection&aq=f&oq=&aqi=>.
- **Rhombic Polyhedron:** “Gallery of rhombic polyhedra” (<http://vismath7.tripod.com/hafner/>) is the first item returned in Google search when the term “rhombic polyhedron” is entered. It would appear that all such curious objects and related animals belong to the man-made universe. Looking up the term in the Internet Archive (<http://www.google.com/search?q=site:archive.org/stream+Rhombic+Polyhedron&hl=en&start=40&sa=N>), however, we see that over 100 years ago, the term occurred in the fields of Crystallography and Mineralogy more often than in Mathematics. It is thus comforting to see that, after all, Dynamic Geometry is intimately linked to the world of Natural Science. You may find the result of the author’s efforts in creating various forms of rhombic polyhedron (<http://sylvester.math.nthu.edu.tw/d2/Rhombic%20Polyhedra/>).
- **Linkage:** Just before the Visual Geometry disappeared from the mainstream Mathematics over 100 years ago, the competition to design the novel device “linkage” (also known as the link-work) was a popular sport among the high-powered mathematicians like J.J. Sylvester, Arthur Cayley, Lord Kelvin and Chebyshev. A. B. Kempe summarized these activities in a series of lectures given at the Royal Institution entitled “How to draw a straight line: A lecture on linkages in 1877” (<http://www.archive.org/details/howtodrawastrai01kempgoog>). You are invited to visit our website <http://sylvester.math.nthu.edu.tw/d2/linkage/> to see the various extensions of the plane linkage to the sphere and to the 3D space.
- **Poncelet Porism and Steiner Porism:** Looking up the dictionary, we fail to find the proper definition for the word “porism”. Pappus was quoted to say “in addition to the Elements, Euclid also published a treatise Porisms of Euclid”. Since no one knew how the exact contents of Porisms of Euclid looked like, M. Chasles published in 1860 “Les Trois livres de porismes d’Euclide” (<http://ia310109.us.archive.org/3/items/lestroislivres00euclrich/>) in Paris telling people how it ought to be. I have to confess that the I have never internalized the proof of neither the Poncelet Porism nor the Steiner Porism, yet I am still able to “discover” various forms of the porisms on the sphere and in 3D space, thanks to Cabri 3D. You are invited to take part in the workshop 3D Poncelet Proism and Steiner Porism (<http://sylvester.math.nthu.edu.tw/d2/atcm09/3D%20Poncelet%20Proism%20and%20Steiner%20Porism.htm>) (Receipt ID: 2812009_17317) in this conference to find out more about this discovery.

Summary

Internet Archive is now intellectually rich enough to serve as an important academic resource for universities and schools throughout the world. We have discussed the benefits of learning from the ancients through the archive. We have also showed how Dynamic Geometry can be concrete enriched by the archive.