Standards Education at the University of Pittsburgh
by Michael B. Spring

Introduction

There are a variety of approaches to teaching standards. Historically, there have been a number of efforts to include standards as economic tools and much of the very early research on standards was from this perspective. Standards may also be viewed as social efforts to provide for the common good. They may also be viewed as a component of business activity—an approach that has been championed by much of the more recent work in Europe and Asia. Finally, they may be viewed from a “standards” perspective in which various disciplines are combined to study the social dynamics of the process, the technical evolution of the standards and the economic and business impacts of the standards. This article examines an effort at the University of Pittsburgh that was funded by a contract from the National Institute of Standards and Technology (Project 70NANB13H206). We begin with a history of standards education efforts at the University of Pittsburgh and conclude with a description of the effort under the grant.

History of Standards Coursework at the University of Pittsburgh

The first course on standards was developed at the University of Pittsburgh in 1987. The Executive Director of NISO, Pat Harris, had suggested to one of her Board members and the new Dean of the Graduate School of Library and Information Sciences, Toni Carbo, that such a course might be an important addition to the curriculum. The task of designing such a course, which had to be equally of interest to information scientists, telecommunications engineers, and librarians, fell to me. The first syllabus stated that the “course endeavors to trace the processes by which standards are developed in various fields, by various standards organizations, and across international boundaries.” It laid out a framework based on standards for interconnection, communication control, information presentation, and process control. It examined standards from the perspective of economics, social psychology, business, publishing, telecommunications, and computer science.

By 1990, the course had taken a stable form and had two tracks, one for librarians and one for information science students. It examined the national and international organizations, the standards process, the academic literature on standards, and standards in several categories—networking, interface, data interchange, and operating systems. Students were reading A Guide to Information Technology Standardization by Carl F. Cargill, Technical Standards: An Introduction for Librarians by Walt Crawford and OSI Explained by Hensall and Shaw. The goals of the course were stated as follows:

• To define the basic characteristics of standards.
• To review the impact of standards on the development of information systems.
• To explore the processes by which standards are developed.
• To experience the process of designing/programming information systems in accord with some standard.
• To examine the implications of standards for the interpretation and analysis of document creation, conversion, and design.

By 1995, the course had evolved to take on both a more technical focus as well as a policy focus. The required textbooks for the course were now Information Technology Standards: The Quest for the Common Byte by Martin Libicki, Information Technology Standardization by Carl F. Cargill, and Global Standards: Building Blocks for the Future by Linda Garcia. Further, the course encouraged students to get involved in the research we were doing on standards with the cooperation of the major Standards Developing Organizations (SDOs) and the National Institute of Standards and Technology (NIST). Out of this work, students and faculty became involved in a number of research projects that led to several publications and funded research projects. More than a dozen papers were coauthored by faculty and students (see references at the end of this article). Some of the more prominent included papers on:

• Computer Based Collaborative Authoring for Standards Development
• Standards as Change Agents in the Information Technology Market
• Usability of a Collaborative Authoring System for Standards Development: Preferences, Problems, and Prognosis
• System Design for and Integrated Document System and its impact on Standards Development Efficiency
• Improving the Standardization Process: From Courtship Dance to Lawyering: Working with Bulldogs and Turtles

By the end of the 1990s, as funding for supporting research on standardization failed to emerge, the stand-alone course on standardization began to change and focus more on the use of standards and less on standards research. During this same period the faculty in the department was increasingly involved in standardization and the treatment of standards found its way into a number of courses. The most heavily invested course was the course on web technology but several courses on networking, security, and database began to incorporate more of a standards focus. The last year that the course was offered as a pure information technology standards course was 1999.

In 2005, in part as a response to a resurgence of interest in standards, the course on “web technologies” was retitled “web technologies and standards”. While the course only addressed those standards related to the web, the range of standards addressed included standards from a variety of organizations and lectures included treatments of the standards process, the standards organizations, and economic and business perspectives as well as technical perspectives on standards.

The NIST Project

Increased interest in standards education in Asia, Europe, and the US caused us to begin thinking again about how we might approach teaching people about standards.
Given that much of the research on standards seemed to be starting over from scratch, I was moved to put together a retrospective on what we know and don’t know about standards and standardization which served an update to a very early review of standards research published in 1991.

While there has been growing attention to standards as business instruments and as instruments of international cooperation and competition, we felt that there was a lack of attention to the technical perspective on standards. To that end we responded to a call for proposals from the National Institute of Standards and Technology. It was our belief that we had learned a lot about standards, the standards organizations, the standards process, and the importance of standards that we could share with our colleagues. To that end, we proposed the development of a set of modules that could be used in a variety of different courses to introduce standards in a way that would interest and intrigue students.

Our experiences led us to several conclusions. First, while standards can be fascinating, they are often dealt with in a way that makes them boring and cumbersome. Second, standards have to be taken in small doses. Coming to grips with them in full blown form can be intimidating but dealing with their origins and goals is much more understandable. Third, the history of standards and the twists and turns make for fascinating stories that make it easier for students to understand them. Fourth, the structure of the standards organizations and their evolution is often not put forward with the novice in mind and the terminology and relationships often appear mysterious and undecipherable. Fifth, truly understanding an information technology standard only occurs when one implements it. To these ends, we focused in telling the story of how standards organizations emerged. We focused on showing how standards evolved and what the goals were of the efforts. Finally, we focused on providing an opportunity for students to get involved in ways that would peak their interest.

We developed the materials to be delivered via a website that was standards compliant, that presented material in small ten to twenty minute video clips, that introduced complex standards both conceptually and technically, and that provided students with exercises that were as game-like as possible—while still providing technically correct learning opportunities. Our design was to provide three “generic” standards modules and nine specific technically focused modules as follows:

- Generic:
  - Introduction to Standards
  - Standards Organizations
  - The Standards Process

- Specific Technical Standards
  - Security Standards 1: Cryptography, Certificates and Signatures
  - Security Standards 2: RBAC
  - Web Standards 1: http, html, and url
  - Web Standards 2: WAI, XML, and Semantic Web
  - Document Interchange Standards
  - Big Data and Data Mining
  - Emerging Standards for Cognitive Radio (IEEE P.1900)
  - Cellular Telephony and Wireless Networks
  - Networking Standards OSIRM and the Internet Stack

One of the most fascinating parts of the development process involved going back to check developments and verify our facts. For example, we have always worked hard to help students understand the process rules
and where they came from. In researching rules about involving "all materially impacted parties," we came across the details of the story of Charles Dudley in the history of ASTM. As many readers will know, but as some may not, Charles Dudley received his PhD in Chemistry from Yale and went to work for the Pennsylvania Railroad. In 1878, he published a paper on The Chemical Composition and Physical Properties of Steel Rails. The paper suggested that a particular composition of steel would better serve the Railroad’s needs. The rather vehement negative reaction of the steel producers led him to suggest that producers (who believed they knew the best way to produce steel economically) and consumers (who believed they knew how steel performed) meet together. Dudley’s efforts led to a standard for steel rails and to the creation of the ASTM. In the first three modules, a total of nine videos developed. They included:

- **The Invisible Infrastructure: The Rise of Modern Standards.** Introduces the importance of standards in the modern world. It traces the growth of commerce and the railroads along with the creation of standard time zones and standards for steel rails. It looks at the proliferations of boiler explosions and the impact of the American Association of Mechanical Engineers in the development of boiler pressure standards.

- **The Invisible Infrastructure: Standards All Around Us.** While standards are invisible to most people, they make possible everything from smart phones to interstate highways. The video looks at the standards in common use in smart phones and the standards for the interstate highway system—from numbering to grade and bridge heights. The “Dwight D. Eisenhower National System of Interstate and Defense Highways” standards are focused in part by understanding that one goal was a system for military transport. The video also addresses building and ADA (Americans with Disabilities Act) standards.

- **The Invisible Infrastructure: Standards Fill Many Roles.** While standards were first used and are still used to promote commerce by creating standards for trade, they fill many roles. They can control and build markets and spur innovation.

- **Complicated Relationships: The Rise of Modern Standards Organizations.** With the growth of science and technology and the industrial revolution, professional societies emerged to help set standards. The railroads, the telegraph, radio, and power systems all spurred new standards organizations.

- **Complicated Relationships: Standards Organizations for Information Technology.** As it became clear that the computer would play a significant role in commerce, new organizations were created to supplement the work of existing standards organizations in setting standards. These organizations rapidly evolved with the technology.

- **Complicated Relationships: The Rise of Consortia.** As information technology continued to evolve with great rapidity, traditional standards organizations—which worked slowly and deliberately—were challenged and replaced in many cases by more agile consortia.

- **Open, Fair, Consensus: The Standards Development Process.** Early in the twentieth century, as part of the effort to improve the quality of products, a process emerged that showed promise as a way to develop standards by involving all the impacted parties. That process has evolved as the basis of all standards development.

- **Open, Fair, Consensus: Two Variations on Standards Development for IT.** Two organizations emerged in the 1980s and 1990s to develop standards for the Internet and the World Wide Web. This video explores how the Internet Engineering Task Force (IETF) and Worldwide Web Consortium (W3C) develop standards.

- **Open, Fair, Consensus: Working with Bulldogs and Turtles.** Academic Research on the standards process explores how we might improve it. This video explores some of the things learned in a research study on IT standards development.

Each of these modules also has more formal PowerPoint presentations as well as pointers to readings on the history of standards, standards organizations, and the process of standardization. Finally, each module has one or more exercises meant to engage students.

The modules on particular standards or areas of standardization varied in their approach. In some cases, there are additional stories about the evolution of the standard. In other cases, the video materials seek to provide an overview of the technical standard that can serve as a roadmap to the details. In yet other cases, the video portion makes an effort to explain the importance of the standard by reference to the context in which it came about.

As an example, in the two modules on the web standards, there are six videos. While these videos might have taken any number of different forms, the first provides an overview of the computer and internet standards and developments that made the web possible, from personal computers to DARPA.net to TCP/IP. A second video looks at the evolution of the core web standards—the Uniform Resource Locator (URL), the HyperText Transfer Protocol (HTTP) and the HyperText Markup Language (HTML) tracing them from Tim Berners-Lee’s first brief papers to the IETF RFCs. A third video demonstrates applications like Google Maps and responsive designs that are made possible by JavaScript, the Document Object Model, and Media Queries. Each of the modules, again with similar components—videos, PowerPoint, directed readings, background material, and exercises—exposes a particular technical standard or area of standards development.

As we developed the modules, we gathered important documents, articles, and reference materials. We decided to provide these additional materials along with the modules via a website that was itself standards compliant. In developing an HTML5 compliant website that included a responsive design—including how the website works on desktops, tablets, smartphones, and other devices—we used the opportunity to help students understand what it meant to be standards compliant. Indeed, we included references to webpages that traced the history of browser compliance and that measure the compliance of the particular browser an individual was using.

While we don’t anticipate that every student will be bitten by the standards bug, we provided a significant amount of research material. More than 200 articles and books were included in an annotated bibliographic
Further, there is significant room to expand the information technology standards that are covered.

Beyond the base materials that might be developed, we have been exploring two other projects. The first would make use of the experiences we have had in researching the standards processes and standards organizations. There are a variety of ways in which students can be given first-hand experience with standards. For example, several committee chairs allowed us to listen in on standards meetings with our side muted. This allowed me to comment on what was going on in the process without disturbing a meeting. We also interacted with several committees via survey instruments and phone interviews. This allowed for data gathering and analysis. Finally, while it has now been done by some of our colleagues, we have long envisioned a computer based simulation of the standards development process that would allow students to experience a meaningful form of the experience while other students engaged in research on it. We have outlined these possible extensions of our work with NIST but have not yet formalized a proposal to develop the materials.

The full set of materials produced under this project is available at http://its.sis.pitt.edu/NIST. Interested faculty may download all the materials on the site, or may request a DVD containing the complete website along with all of the materials in a form that can be quickly mounted at any institution and modified or enhanced. We are already working with students to expand and enhance the website at Pitt. For further information or a copy of the materials, send an email to Michael Spring (spring@pitt.edu) or to the NIST Standards Services Group (erik.puskar@nist.gov).

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4 www.astm.org/HISTORY/hist_chapter1.html

5 http://html5readiness.com/

6 http://html5test.com/