IT Standards and Standardization:
A Graduate Course at the University of Pittsburgh (1989-2009)

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I. Introduction

This article reflects on the experiences at the University of Pittsburgh in developing and offering a course on information technology standards and standardization. The reflection is directed toward answering the question of what should be done in the future to educate professionals about standards so as to better prepare them for the workforce.

The course in question was developed at the request of the Dean of the School of Information Sciences who was responding to a request from the National Information Standards Organization (NISO) to develop a course.[1] I was more interested in X3 and IEEE standards, particularly document related standards such as the Standard Generalized Markup Language (SGML) and the Office Document Architecture (ODA). Given the political impetus for the course, it initially included both computer system standards and library and publishing standards. At the intersection of these two areas were document standards – SGML, ODA, MIME, Postscript, Interpress, X.400 – with which I had significant interest based on my own research in collaborative authoring systems and distributed document processing.

About the same time we began to develop the course, Martin Weiss joined our faculty in the Telecommunications program. He came to the School from Carnegie Mellon University where his dissertation had been on technological choice in the standardization process. A nice synergy developed between the University of Pittsburgh and Carnegie Mellon in the area of standards research.

In reviewing some of the publications written over the years, it was interesting to note a 1990 article in the February/March issue of the **Bulletin of the American Society for Information Science and Technology**. That publication is a shortened version of a draft article/proposal prepared with Martin Weiss in 1989 entitled *Education in Information Systems Standards*. Both articles detail the first course on standards that was being offered. Of more interest, both documents mention plans for a second course that

[1] NISO is an ANSI Standards Committee (Z39) which sets standards for the Library and Publishing Industries. The Dean was on the NISO board.

would be based on a simulation of the standardization process. Our draft contains more detail than the published article and given recent interest in simulating the standardization process, it is of interest to note what we were thinking in 1989. The course was to be entitled "Simulation of the Standards Development Process." In part the description said:

> *In this course, students will be given the opportunity to develop a standard over the course of the semester in a simulated standards setting committee.*
>
> *The purpose of this simulation is two-fold: to provide students with experience in the standardization process, and to provide a capability for in-depth observation of and experimentation in the standards development process. The first objective is intended to address the industry's need for trained and experienced personnel in standards development.*
> *The second objective is intended as a research vehicle. Raiffa(1982) has had considerable success in using such a simulation to develop an understanding of negotiation. This course follows Raiffa's model, but extends it to a problem area where the solution domain is discrete.*[2] *…*
>
> *In order to have a realistic and effective simulation, essential aspects of this [competitive product development process between firms] environment must be reproduced. In a competitive marketplace, one can assume that each firm has a different portfolio of technical strengths, product history, corporate culture, and corporate strategy. Each of these factors can affect the posture and behavior of a firm's representatives in a standards committee. Firms adopt positions through their representatives that they believe will give them the greatest advantage in the marketplace after the standard is complete. The objective of this game is market dominance…*
>
> *Participants in the committee are individuals, motivated by the desire to meet personal objectives and achievements. The employer of the participants, i.e., the firm they represent, influence those personal objectives to the extent that the representative becomes a spokesperson for the firm in the standards committee. In general, a victory for the firm also comprises a victory for the committee participant…*
>
> *To simulate this divergence of technical background, students from different groups can be tutored on (different) specific technologies relating to the standard to be developed. Various recitation sections would gain expertise in a specific area and not in another. This technical training should not only cover the theoretical aspects of the applicable technologies, it should also focus on applications using these technologies. The student should develop sufficient expertise in their technology that they will be unwilling to accept the other(s) without*

[2] *In standards, the participants must often choose between two alternatives; intermediate or compromise choices are not always available. Raiffa's domain of negotiation consisted of dollars, a continuous entity.*

considerable debate. When the simulated standards committee begins its deliberations, this divergent training should have an effect similar to the one that can be observed in actual standards committees.

The paper goes on to provide rather detailed discussion of several aspects of the project including simulating the standards setting process, the committee structure, and economic motivations.

II. The Bottom Line

In some ways, all the details that will follow are less important than an assessment of the bottom line. What did the students, faculty, university and standards community gain from a course on IT Standards and Standardization? That may best be answered in terms of the metrics by which we tend to measure academic programs.

A. Student Learning and Satisfaction

While student self report data is only one measure of the success of a course, I think it is an important measure. My courses tend to be rated highly because student discussion about the nature of the courses I teach tends to be positive. At the same time, I take the ratings shown from this 1998 course evaluation as indicative of the fact that learning about standards and standardization opened up new worlds and new ideas for our students.

For items 4-7, the following response scale was used:
1. Much less than in most courses I've taken.
2. Somewhat less than in most courses I've taken.
3. About the same as in most courses I've taken.
4. Somewhat more than in most courses I've taken.
5. Much more than in most courses I've taken.

	1	*2*	*3*	*4*	*5*
Before this term began, my desire to take this course was:	*0*	*0*	*6*	*8*	*7*
In this course I have learned:	*0*	*0*	*2*	*3*	*16*
Compared to other courses, the amount of studying required was:	*0*	*0*	*1*	*9*	*11*
The amount of effort that I put forth was:	*0*	*1*	*2*	*2*	*16*

In terms of the impact on students over the long run, I only have anecdotal evidence. I am personally convinced that the number of communications from students three to five years after graduation is significant and positive. Those communications have always related to understanding some business problem better than a colleague because of their appreciation for standards. In most of these cases, it was the knowledge about particular standards more than the standardization process that provided an edge.

B. Impact on Scholarship and Research

Over the first decade in which the course was offered, we authored 15 articles: nine in journals and six in conference proceedings. We also wrote six book chapters. Many of these were with students and were based on the outcome of class projects. Selected citations from the work at Pitt, with which I was involved, are provided in section 5.

Research funding was much harder to obtain, and while several SDO's and individuals made themselves available to us as resources[3], funding for pure research on standards and standardization fell through the cracks. Generally, it was too practical for the National Science Foundation and too theoretical for the National Institute for Standards and Technology (NIST). Foundations, Corporations, and SDOs were not interested. The single notable exception to this was a decision by Shukri Wakid of the Information Technology Laboratory at NIST to fund the development of a collaborative authoring system to support standards development. Research conducted by doctoral students based on the collaborative authoring system platform confirms some of our preliminary hypotheses about the process.

Over the years, several journals came and went and we served on the editorial board of most of them – Computer Standards and Interfaces, Standard View, and The International Journal of IT Standards & Standardization Research.

C. The Standards Process and Public Service

Over the decade in which we actively pursued a standards research agenda, we were warmly welcomed into the leadership of the standards community. I served on the Strategic Planning Committee of X3, was appointed to the National Research Council Oversight Committee for the Information Technology Laboratory of NIST, served on several panels brought together by the Office of Technology Assessment, and participated in a RAND panel to advise the White House on the need for standards related to the web and e-commerce. Overall, I think we were able to exert a positive influence on the standards community, but it was far from what might have been possible with a more extensive funded research program.

III. Evolution of the Course

The course on standards was offered 12 times between 1989 and 2009. Over that period of time, between 15 and 40 students took the course each time it was offered. The dates were as follows, with the numbers and names of the course:

- May 1989 IS259/LS259 Information Processing Standards
- Jan 1990 IS259/LS259 Information Processing Standards
- Jan 1991 IS2059 Information Technology Standards
- Sept 1992 IS2059 Information Technology Standards
- Jan 1994 IS2059 Information Technology Standards

[3] At the risk of leaving out the names of some of the many individuals who helped us, let me mention a few who were always available to help when we needed them. Carl Cargill, from Digital, and then Netscape, and then SUN was always an immense supporter as was Steve Oksala from Unisys and later with the Society of Cable Telecommunications Engineers. Don Loughry from HP and IEEE opened many doors for us as did Jean-Paul Emmard from CBEMA and now with Alliance for Telecommunications Industry Solutions. D. Linda Garcia with the Office of Technology Assessment provided many opportunities and continues her good work at the Communication, Culture and Technology Program at Georgetown University. As I mention elsewhere, colleagues at the Information Technology Laboratory at NIST were among the few who believed in what we were trying to accomplish. In particular Shukri Wakid and Sharon Laskowski provided significant assistance.

- Sept 1996 IS2059 Information Technology Standards
- Jan 1997 IS2870 Information Technology Standards
- Jan 1998 IS2870 Information Technology Standards
- Jan 2006 IS2870 Web Technologies and Standards
- Jan 2007 IS2560 Web Technologies and Standards
- Jan 2008 IS2560 Web Technologies and Standards
- Jan 2009 IS2560 Web Technologies and Standards

Like any good graduate course in a technical field, the standards course grew and developed over the years. The first offering of the course attempted to bridge the Departments of Information Science and Library Science. In the beginning, the instructor was little more experienced than the students. Over the years, the teaching was enriched by an active research program and the course became very popular. From 1999-2005 the course disappeared. This was a result of two things. First, I was more involved in other research and had less interest in doing standards research. Second, the portfolio of courses that I taught had expanded to the point where two of my course had to go, and the course on standards was one of them. The third phase of course evolution came in the last half of the current decade as I expanded my course on document processing into three courses which supplemented other courses we offered to form a web and database systems track.

A. 1989-1992: The Beginning

The goals of the course during the first three offerings were 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.

B. 1993-1999: Pure Standards and Standardization

With time, less focus was devoted to publishing and more time to information technology standards. By 1994, the goals and objectives of the course had become:

- To define the basic characteristics of standards.
- To explore the processes by which standards are developed.
- To review the impact of standards on information systems.
- To experience the process of designing/programming information systems in accord with some standard.
- To understand the scope of information technology standards in the data, communications, operating system, and human-computer interface areas.
- To analyze the functional needs for standards for enterprise wide computing systems.

Of greater interest, in retrospect, was the reading list. It is a little hard to believe that students read as much as they did during this period. The course was very demanding, but I think also very exciting. The readings included:

Required

- **Information Technology Standardization**, Carl F. Cargill
- **Global Standards: Building Blocks for the Future**, Linda Garcia, Office of Technology Assessment
- **The Open Book: A Practical Perspective on OSI**, Marshall T. Rose.
- **The Common Byte or Why Excellent Information Technology Standards are Absolutely Essential and Utterly Impossible**, by Martin Libicki.

Recommended

- "Information Technology Standards." In M.E. Williams (ed.) **Annual Review of Information Science and Technology.** Volume 26.
- **Journal of the American Society for Information Science**, Volume 43, No. 8, September, 1992, which is devoted to Information Technology Standards.

Supplemental

- **The SGML Handbook**, by Charles Goldfarb.
- **OSI Explained**, by Henshall and Shaw.
- **The Little Black Book**, by Marshall Rose.
- **TCP/IP**, by Ulysses Black
- **POSIX 1003.1** by IEEE
- **A Sourcebook of Standards Information**, by Stephen Spivak and Keith Winsell.
- **Postscript Language Tutorial and Cookbook**, Adobe Systems.
- **Postscript Language Reference Manual**, Adobe Systems.
- **Designing the User Interface**, by Ben Schneiderman.

Looking back at the 1994 readings suggests three things to me.

1. While we continued to use Cargill as the basis for thinking about standards, we were making use of an expanded theoretical and political literature that was growing. **Global Standards** was only one of three reports written for Congress by D. Linda Garcia of the Office of Technology Assessment. Martin Libicki's **Common Byte** took a larger socio-political-technological focus. It was a prelude to his later work for Rand, and the White House, on **Scaffolding the Future**. Martin Libicki, D. Linda Garcia, and Carl Cargill were all willing to join in class lectures via phone as their schedules permitted. It was incredible to see students talking with the authors of the books they had just read. It was also a great instructional motivator – "read the book and prepare questions for the author who will be joining the class next week!"
2. The recommended readings were an article I had written for the **Annual Review of Information Science and Technology**, an important compendium in our field and a special issue of the **Journal of the American Society of Information Science** which I had pulled together. In retrospect, this reminds me that this was a period of significant productivity in doing research on

standards and standardization. In some ways, it was absolutely the perfect form of a graduate course – one that links teaching and cutting edge research.

3. The supplemental readings reflect the highly technical nature of the course. About a third of the course focused on the standards process, the history of standardization, and the research that was growing. More than half the course was devoted to an in-depth treatment of important technologies and the related standards in information technology.

It may be that the period from 1992-1998 was the golden age for this course. I have included a detailed list of lecture topics as Appendix 1. There are more than 3 dozen power point slide sets which are related to these lecture outlines, as well as a dozen drafts of book chapters that I am still in the process of trying to pull together. While these outlines would surely change if I were to outline a pure standards course today, I think they provide a starting point for a serious technical course on IT standards. Many of those who graduated during this period reported back over the years that significant job and advancement opportunities had opened up because they were the only member of a team who knew what POSIX, SGML, X.400 or some other standard were all about.

C. 2006-2010: Web Technologies and Standards

In 2006, in part responding to the growing body of work in Europe, the US and Asia, I redesigned my courses on web technologies and included a course on Web Technologies and Standards. The last four years have seen a different kind of standards course, which deals with web technologies with an intense focus with web related standards. The course has been well attended and received by students. While pure theory on standards and standardization play a secondary role to web technology, the study of the impact of standards and the standardization process may be more intense. Four aspects of the current offering, related to the teaching of standards and standardization as manifest in the current course, are worth mention:

1. An important aspect of understanding all of the browser technologies involves understanding how the implementation of the Document Object Model (DOM) affects what can and can't be done cross browsers. The non-conformance or partial conformance of browsers with the W3C DOM in terms of namespaces, schema, etc. could be the subject of a whole term of study. The discussion of this weaves it way coherently through several of the lectures.
2. The course allows students to understand the evolution of important standards. As a case in point, the evolution of XML and the family or related standards serves as a great example of how standards evolve and change shape. Students are exposed to SGML, HTML, xhtml, XML, XML Schema, XSLT, XLink, XQuery, CSS and shown how the standards have evolved and matured. All of the derivative standards are also reviewed – SVG, RSS, RDF, OWL, Atom, GRDDL and SPARQL just to name a few.
3. The course presents a unique opportunity to examine the relationship between SDO developed standards and consortium standards with a focus on the W3C. The accessibility of working group information on the web makes this a

particularly fertile arena for discussion and research. Each term I have offered the course, I have learned new things from students who are asked as one of their assignments to take an area of work and trace its evolution – i.e. who is involved, what are they trying to do, how are they progressing, what are they missing, etc.

4. The course offers an opportunity to look at arrays of standards as they impact some operation. To fully understand web technologies, students must not only understand all of the directly related technologies such as those mentioned above, but they need to understand Internet and Ethernet protocols – DNS, IP, TCP, Ethernet, ARP, RIP, etc. They also need to understand application level protocols such as the web services suite, SSL, SMTP, MIME, etc.

I am not sure that I could have managed the integration of the standards and standardization topics in this current course without having had the experience of the previous two versions. I am biased toward this way of teaching standards and standardization having experienced the course taught three different ways. This seems to me to be the best way to make both the theory of standards and the process of standardization real to students in the scope of a single course.

IV. Conclusion

Over the last two decades, more than 250 Masters and PhD students graduating from the School of Information Sciences at the University of Pittsburgh have been exposed to a course on standards and standardization. While we have done no rigorous formal evaluation, student evaluations of the course, resulting research and scholarship, graduate feedback related to its impact in employment, as well as this academic assessment of the integrity of the experience are all positive.

Personally, I found the process of developing the course of great value. I remember asking colleagues when I joined the department about various document standards. They didn't know anything about them. IT standards and standardization is a broad field that requires serious study to come to grips with an enormous body of knowledge. While my research on the pure theory of standards and standardization has lapsed, I continue to benefit both from the broad understanding of my field that it has provided. I might go so far as to suggest that it provides the instructor with as many benefits as it does the student.

Have we learned anything that might help us as we look toward the future? I think we have. First, standards are complex entities and standardization is an enormously complex process. Any effort to simplify these entities or the process by looking at it from a simple disciplinary perspective, whether it be the economic aspects, the business imperatives, government policy, or scientific theory does a disservice to students. The treatment of standards and standardization in the classroom should take a multidisciplinary perspective. Second, the process of standardization and nature of the products has and will change over time. What we teach professionals today will surely have changed by the time they grow to the senior level positions which will be their gateway to participation in the process. Coursework for young professionals needs to

acknowledge this inevitability and focus on the concepts and processes that will be most likely to still be manifest in some form in the future. Third, the process of standardization has significant "flaws", with the most notable being the *de facto* standard. It would be nice if all standards were developed with the best forward looking and technically informed insights of scientists and engineers. Unfortunately, technical excellence sometimes fall to business practice, and future vision is sometimes flawed. It is generally accepted that the VHS/Betamax wars demonstrated a business decision on the part of vendors (and consumers) to opt for longer tape time over video and audio quality. Regards future vision, who would have guessed that users of the web would adopt a document form to use for blogging (RSS) that had originally been designed to hold metadata about a website. (RSS, which has come to stand for "Really Simple Syndication" was originally developed by Netscape to hold an "RDF Site Summary" – RDF stands for Resource Description Framework and is a part of the semantic web effort.) Students will need to have an appreciation for the fact that standards come about not only in planned ways but in very messy ways that can introduce new sets of problems. Fourth, we deal with standards in many different ways. It is fun to think about the process of developing a standard, but most professionals are more likely to have to deal with implementation of a standard. Thus, any course on standardization should provide students with a rigorous exposure to using standards that are well developed and poorly developed. This experience may have a far greater impact than the theory of "good" standards practice on informing the behavior of a future standards developer. Fifth, while there is little doubt that business goals and government policy influence the standardization process, it is equally clear that technological choice is of critical importance in the quality and longevity of a standard that is produced. Technological choice, at the level at which standards are developed, is not a matter for a novice. It is not clear how to overcome this expected lack of theoretical expertise in students. Yet without it, they will fail to understand why processes take so long or why certain decisions and compromises are made. In the current version of the course, students are given several projects that begin to tackle this issue. In one case they are asked to develop an xml schema for a common document type – e.g. a resume, or a course syllabus. An important criterion in evaluating the result is whether or not it would be used not by a single individual, but by all individuals that develop documents of this type. It is easy to make clear where the obstacles will arise and why. In another case, they are asked to develop a website compliant with the xhtml schema and conformant to the Web Accessibility Initiative (WAI) guidelines. In the process, they are asked to meet performance criteria, such as the use of AJAX, that create problems in related to conformance. They are also asked to address issues that should be, but are not addressed by the standards – e.g. the WAI guidelines tend to focus on physical and ignore cognitive disabilities.

V. Selected Publications

The following is a selected list of publications on standards and standardization authored or co-authored by Michael B. Spring. They span the period 1998-2005 and are listed in Chronological Order.

Spring, M.B., and Carbo-Bearman, T., *Information Standards: Models for Future Development.* **Book Research Quarterly**, Fall, 1988, **4**(3) pp 38-47.

Spring, M.B., *Information System Standards Education.* **Bulletin of the American Society for Information Science**, February/March, 1990**, 16**(3), pp. 28-29.

Ledrick, D.P., and Spring, M.B., *International Standardized Profiles.* **Computer Standards and Interfaces.** 1990, **11**(2), pp 95-103.

Spring, M.B., Jamison, W., Fithen, K.T., and Thomas, P., *Preliminary Notes: Human-Computer Interaction Reference Model(HIRM).* SLIS Research Report LIS032/IS90010; December, 1990.

Spring, M.B., *Information Technology Standards.* In Martha E. Williams(Ed.) **Annual Review of Information Science and Technology**, Volume 26, 1991, pp 79-111.

Spring, M.B. and Weiss, M.B., *Education in Information System Standards*, in **A Sourcebook on Standards Information: Education, Access and Development**, Steven Spivak and Keith Winsell (eds.) Boston: G. K. Hall, 1991, pp 53-72.

Bonino, M.J. and Spring, M.B., *Standards as Change Agents in the Information Technology Market.* **Computer Standards and Interfaces.** 1991, **12**(2), pp 97-107.

Spring, M.B., and Lunin, L.F., Guest editors, Perspectives on ... Information Technology Standards. **Journal of the American Society of Information Science**. September, 1992, **43**(8).

Spring, M.B., Jamison, W., Fithen, K.T., Thomas, P. and Pavol, R., *Models for Human Computer Interaction*. In A. G. Holtzman, A. Kent, and J.G. Williams (Eds.), **Encyclopedia of Microcomputers.** Volume 11. New York: Marcel Dekker, 1993, pp 189-218.

Weiss, M.B. and *Spring, M.B., Alternatives to Financing the Standards Development Process.* **Twenty-Second Annual Telecommunications Policy Research Conference**, Solomons, MD, October 1-3, 1994.

Spring, M.B., Grisham, C., O'Donnell, J., Skogseid, I., Snow, A., Tarr, G. and Wang, P., *Improving the Standardization Process: Working with Bulldogs and Turtles*. In **Standards Policy for Information Infrastructure**, (B. Kahin and J. Abbatte, eds.), Cambridge MA: The MIT Press, pp 220-252, 1995.

Spring, M.B., and Weiss, M.B., *Financing the Standards Development Process.* **Standards Policy for Information Infrastructure**, (B. Kahin and J. Abbatte, eds.), Cambridge MA: The MIT Press, pp 289-320, 1995.

Morse, E.L., Willms, S., Pollak, W., Meyers, C., and Spring, M.B., *The Impact of Collaborative Authoring Software on the Standardization Process.* SLIS Research Report LIS061/IS96002; April, 1996.

Oksala, S., Rutkowski, A., Spring, M.B., and O'Donnell, J. *The Structure of IT Standardization*. **StandardView**, March 1996, 4(1), pp 9-22.

Sapsomboon, B. and Spring, M.B., *Computer Based Collaborative Authoring for Standards Development*. **Open Systems Standards Tracking Report,** November, 1996, 5(8), pp4-6.

Spring, M.B., *Reference Model for Data Interchange Standards*. **IEEE Computer**, August, 1996, 29(8), pp 87-88.

Willms, S., Morse, E.L., and Spring, M.B., *System Design for and Integrated Document System and its impact on Standards Development Efficiency*. **IEEE International Engineering Management Conference ' 96**, Vancouver, Canada, August 18-20, 1996.

Spring, M.B., Andriati, R. and Vathanophas, V., *Usability of a Collaborative Authoring System for Standards Development: Preferences, Problems, and Prognosis***, Proceedings of the First IEEE Conference on Standardization and Innovation in Information Technology**, Aachen, Germany, September 15-17, 1999

Spring, M.B., and Weiss, M.B., *Intellectual Property Issues in Standardization*. In K.Jakobs(Ed.) **Information Technology Standards and Standardization: A Global Perspective** 2000. (ISBN is 1-878289-70-5).

Spring, M.B. *The Courtship Dance of Bulldogs and Turtles*. **IEEE Computer**, February, 2001, pp 120-122, 34(2).

Gennari, J., Harrington, M., Hughes, S., Manojlovich, M., and Spring, M.B., Preparatory Observations Ubiquitous Knowledge Environments: The Cyberinfrastructure Information Ether. **NSF Post Digital Library Futures Workshop,** Chatham, MA. June 15-17, 2003.

Spring M. B. and Gennari J., Standards for the Next-Generation Web :Architectural Considerations from a Standardization Perspective, **10th ISPE International Conference On Concurrent Engineering: Research And Applications,** Madeira, Portugal, July 26-30, 2003.

Spring, M.B. Creating Better Standards More Efficiently, **Standardization: Unifier or Divider, Standards Edge**, Vancouver, Canada, November 20, 2005.

Appendix 1: Course Outline (from 1998)

This course is addresses a subject which has not traditionally been a part of the information science curriculum. The topics are interdisciplinary, broad, deep, and complex. From the academic perspective there is not any comprehensive perspective or model from which the subject may be suitably studied. For these reasons, students should anticipate that the sequence of topics may be adjusted, expanded, or contracted as the term proceeds.

In general, the course will be divided into four parts.

- In part one, standards and the standardization process will be examined conceptually. Models will be examined and the research will be reviewed. The various organizations involved in standards development will be examined, and the process for consensus standards development will be explored.
- In part two, several families of standards will be explored in four broad categories:
    - Communication Standards
    - Data Interchange Standards
    - Operating System Standards
    - Human-computer Interaction Standards
- In part three, we will look at a couple OSI application standards. This will include a look at the facilitating components of the upper layers of the OSI standard as well as the important aspects of the applications. Specifically, we will look at X.400, X.500, and FTAM.
- In part four, we will return to the standardization process and look at it in the broader context of the electronic enterprise, software development broadly, and globalization.

Introduction and Overview

- Introduction to the course
    - Review of the course syllabus
    - Discussion of the assignments
- The use of CASCADE
- The purpose of standards
- The history of standards development
    - nationally (in the U.S. and in other countries)
    - internationally
- Approaches to the Study of Standards
    - Economic
    - Technical
    - Policy Studies
    - The Study of Standards

Types of standards

Readings

- Cargill, pp 1-36.

Lecture

- Broad Categories
  - Internal corporate standard
  - De-facto standard
  - De-jure and client determined standards
    - Safety standards
    - National security standards (highway standards)
      - Military standards
      - DIF, CALS
      - TCP/IP, Unix
    - Industrial Combine Standards
      - MAP and General Motors
      - Boeing and TOP
      - FIPS 195 and GOSIP
  - Formal consensus standards
- IT Industry Standards
  - Library Standards
  - Computer Standards
  - Communication Standards
  - Interchange Standards
- Standards in typical information transactions
  - Hardware Standards
    - Terminal design
    - The communications interface
    - LAN (local area network) cabling
  - Data Interchange Standards
    - Character sets
    - Escape sequences and control characters
    - LAN protocol standards
  - Software Standards
    - Operating System Standards
    - Programming language
  - Application Standards

Frameworks for Understanding Standards

Readings

- Cargill, pp 38-67.
- Libicki, pp1-32.
- Bonino and Spring, Anticipatory Standards.

Lecture

- Classificatory Models
- Taxonomies
- Economic Models
    - Impact on research and development
    - Impact on end user purchases
    - Cost of the standards themselves
    - Impact of technological developments
- Operational Models -- OSI
- Organizational Models

Consensus Standards: Organizations

Readings

- Cargill, pp 191-261.

Lecture

- International Organizations
    - International Standards Organization (ISO)
        - Total of 83 National Representatives
        - American National Standards Institute (ANSI)
        - British Standards Institute (BSI)
        - Deutsch Institute fur Normung (DIN)
        - Association Francais de Normalization (AFNOR)
    - Consultative Committee on International Telegraph and Telephone (CCITT)
- Regional Organizations
    - European Computer Manufacturers Association (ECMA)
    - CENELEC
- US National Organizations
    - American National Standards Institute (ANSI)
    - Institute of Electrical and Electronics Engineers (IEEE)
    - Engineering Industries Association (EIA)
    - National Information Standards Organization (NISO)
    - Others

Consensus standards: Process

Readings

- Cargill, pp 69-130.

Lecture

- Accreditation of a developer
- Planning and coordination of standards
- Designation, publication, maintenance, and interpretation of standards
- Procedures for development of a standard by a committee
    - Organization of the committee

    - Responsibilities, officers and membership
    - Subgroups of the committee
    - Meetings
    - Voting
    - Submission
    - Communications
    - Termination of the committee
    - Appeals
    - Maintenance
- Role of consortia

A Functional Framework for IT Standards

Readings

- Spring and Bearman, Information Standards: Models for Future Development
- Libicki, pp 39-45; pp 331-360.

Lecture

- MUSIC
- Communications and interoperability
- Data Interchange Standards
- Operating System Standards
- Interface Standards

Data Interchange Standards

Readings

- Libicki, pp 133-172; pp265-301.

Lecture

- Revisable Form Document Exchange Standards
    - Z39.2
    - SGML/Z39.59
    - ODA/ODIF
- Final Form Document Exchange Standards: Page Description Languages
    - Postscript
    - Interpress
    - SPDL
- Other Data Interchange Standards
    - PDES
    - EDI

Human Computer Interaction and Operating Systems Standards

Readings

- Spring et. al., Human Computer Interaction Reference Model
- Libicki pp 47-69; 179-200.

Lecture

- Human Computer Interaction
    - Human Factors
    - Window Systems
    - API's
    - Look and Feel
- Operating Systems
    - POSIX
    - NT

Communication Standards

Readings

- Libicki pp 75-118; 213-256;

Lecture

- TCP/IP
- ISDN
- Frame relay and SMDS
- OSI

The OSI as a Model Reference Standard

Readings

- Rose, The Open Book, pp 1-50, 150-219;

Lecture

- Layered Model
    - Transport versus application groupings
    - The Application Level
- Open Systems in Context: The Players
    - Standards Organizations
    - Functional Profiles
    - Standard Profiles
    - Internet Standards
    - Conventions in the OSI Model
- Connection Establishment, Data Transfer, and Connection Release
- Session Services
- Presentation Services
- Application Service Elements
    - Association Control
    - Naming and Addressing
    - Reliable Transfer
    - Remote Operations
- OSI Applications
    - The Directory
    - Message Handling Systems

        - File Transfer, Access and Management
    - Session Service Concepts
        - Session Addresses
        - Connection Identifier
        - Functional Units
        - Tokens
        - Serial Numbers
        - User-Data
        - Quality of Service
    - Session Protocol
        - Use of the Transport Service
        - Elements of Procedure
        - Encodings

Abstract Syntax Notation and Presentation Services and Application Service Elements

Readings

- Rose, The Open Book (pp 225-375, 379-440);); Black: OSI (pp 329-410); or other source

Lecture

        - Abstract Syntax Notation
            - Lexical Conventions
        - Transfer Syntax Notation
            - TLV approach
        - Presentation Service Concepts
            - Presentation Addresses
            - Context Management
            - Functional Units
            - Presentation Protocol
            - Use of the Session Service
            - Elements of Procedure
            - Encodings
        - Lightweight Presentation Protocol
    - Application Elements
        - Association Control
        - Naming and Addressing
        - Reliable Transfer
        - Remote Operations

X.400, X.500, and FTAM

Readings

- Rose: The Open Book (pp 445-493); Henshall: OSI Explained (pp 130-200); Black: OSI (pp 413-506); or other source

Lecture

- Directory Services
    - Models of the Directory
    - The Directory Service
    - Use of Directory Services
    - Directory Use of Application Services
    - Directory Standards
- Message Handling Systems
    - Model of Message Handling Systems
    - The Message Handling Service
    - Use of the Message Handling Systems
    - Message Handling Use of Application Services
    - Message Handling Standards
- File Transfer, Access and Management
    - The Virtual Filestore
    - The File Service
    - Use of the File Service
    - FTAM Use of Application Services
    - FTAM Standards

Business Practices and Standardization

Readings

- Cargill, 130-190;

Lecture

- Internal Standardization
    - Starting a program
    - Funding a program
- Methods for adopting standards
    - Internal standards
    - External standards
- Formal Standards Process
- Standards Life Cycle
- Standards and Market Creation

Open Systems

Readings

- Cargill, pp 69-96;

Notes

- Standards suites
  - MAP
  - TOP
  - GOSIP/CALS
  - Implementor's Workshops
- Conformance Testing and Certification
  - The Corporation for Open Systems
  - SPAG
  - POSI
- The Politics of Open Systems
  - Problems with the Standards Process
  - Conformance Testing
  - The Lessons of Interoperability Testing
  - The Internet Community -- Internet versus OSI
- Ledrick and Spring, International Standardized Profiles

The Importance of Standards in the Global Economy

Readings

- Global Standards: Building Blocks for the Future.

Lecture

Be prepared for a DISCUSSION during this class session of what you have read. If possible, we will discuss the reading with the primary author, D. Linda Garcia of the Office of Technology Assessment.

Standards Issues

- Professional Issues
  - The Communications Act of 1934 -- Standards and information access
  - Privacy, security, and freedoms
- Legal issues
  - Liability
    - Liability of the standards groups
    - Liability of the validating organization
    - Liability of the vendor
  - Intellectual Property
- Political issues in standards development
  - Capitalism versus the Social Good
  - Professional associations: Engineers versus Producers versus Users
  - Self Certification versus third party certification
  - National governments and international organizations