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Standards Resources for Engineering and Technology

Margaret Phillips
Purdue University, phill201@purdue.edu

Sarah Huber
Purdue University, huber47@purdue.edu

Science and Technology Resources on the Internet

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Margaret Phillips
Assistant Professor of Library Science
Engineering Information Specialist
phill201@purdue.edu

Sarah Huber
Assistant Professor of Library Science
Engineering Technology Information Specialist
huber47@purdue.edu

Purdue University
West Lafayette, Indiana

Introduction

In the broadest sense, standards, often referred to as "technical standards," "industry standards," or "engineering standards," are documents that communicate agreement. The agreement conveyed may relate to a variety of topics, such as consistent methods, designs, processes, procedures, or use of language. The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) (2004) provide this formal definition of a standard:

> [a] document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.

Standards are developed by standards bodies, also commonly known as "standards developing organizations" (SDOs). A standards body is defined by ISO/IEC (2004) as a "...body recognized at national, regional, or international level, that has as a principal function, by virtue of its statutes, the preparation, approval, or adoption of standards that are made available to the public." The development process involves standards bodies forming committees of experts (e.g., industry professionals, academics, government officials) in a given area to create and revise standards.

Standards bodies create different types of standards, such as design standards and performance standards (Thompson 2011). Design standards detail how something must be

created. For example, a design standard may specify which materials must be used, the particular dimensions of a product, or how an item must be constructed. Performance standards state the required end results but don't dictate the specific technical details of a design. In this way, they are less confining than design standards. These categories are not mutually exclusive and many standards contain elements of both design and performance.

Standards are important on a national and international level because they have extensive economic and safety implications. They facilitate global trade, enable manufacturers to minimize costs and maximize productivity, and provide consumers with the assurance products they buy are safe, of high quality, and interoperable with other devices (Thompson 2011; USSSC 2015; ISO date unknown b).

In the United States there are hundreds of standards bodies. The bodies can be largely classified in four ways: as professional societies that develop standards as a portion of their work; trade organizations; companies that specialize in standards development; or industry consortia (Thompson 2011). Many of the standards these organizations create are subsequently approved as national standards by the American National Standards Institute (ANSI). In addition, standards are developed by government bodies in the U.S., but less frequently on a federal level as a result of the National Technology Transfer and Advancement Act (1996). This act calls for federal departments and agencies, such as the Food and Drug Administration (FDA) and Consumer Product Safety Commission (CPSC), to use "voluntary consensus" standards produced by non-government standards bodies whenever possible. These standards are often incorporated by reference or written into federal regulations, making them mandatory for compliance.

On an international level, major standards bodies include ISO, IEC, and the International Telecommunication Union (ITU) (Hunter 2009). Other countries have national standards bodies, such as the Standards Council of Canada (SCC) and the British Standards Institution (BSI), that coordinate standardization and provide representation on an international level (ISO date unknown a).

The global emphasis on standards demonstrates how essential standards education is for engineering and technology students. This is reflected in the ABET engineering accreditation statement "students must be prepared for engineering practice through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards..." (ABET 2016a), and in ABET's student outcome "c" for engineering technology programs, "an ability to conduct standard tests and measurements..." (ABET 2016b). It can also be seen in the engineering information literacy literature. For example, Osif (2014) includes standards in a discussion of resource types that are important for legal and safety aspects of the engineering design process. Additionally, employers also consider standards education to be important for students. Harding and McPherson's (2010) survey of employers found that 58% of respondents agree that "there is a need for engineers who possess the fundamentals of standards development and the knowledge to find and apply standards prior to employment."

The goal of this webliography is to provide an introduction to standards resources for librarians that support post-secondary engineering and technology programs, as well as engineering and technology faculty members and students. It serves as a reference on standards collection development and integrating standards information literacy into engineering and technology curricula. This is the first webliography on the topic of technical standards.

Scope and Methods

This webliography is a selective compilation of the following: major standards bodies that create or approve standards frequently used by engineers and technologists, standards database aggregators, web sites that provide free or low cost, full-text access to standards, and standards education resources. Only major standards bodies that operate in the U.S. or on an international level are incorporated, excluding non-U.S. national and regional bodies that create or coordinate standards activities in other countries. The standards education resources listed are appropriate for university-level students. All of the resources included are English language web sites. Additionally, all of the resources included are free to search; however, most standards bodies and standards aggregators charge fees for full-text access to standards documents. The "Free (or Low Cost) Full-Text Access to Standards" section highlights resources that provide full access to standards documents for free, or at significantly reduced costs for educators.

The resources in this webliography were identified by general web browsing and through the course of the authors' work as engineering and technology librarians with seven years of combined experience in standards information literacy and outreach, standards education research, and standards collection development. The standards bodies section is not intended to be a comprehensive listing of all of the bodies related to engineering and technology, given there are hundreds in the U.S. alone. The bodies included were selected due to the perceived frequency of the authors' needs to provide access to and teach about standards from these organizations in engineering and technology courses.

Organization

[Major Standards Bodies](#)
[Standards Aggregator Databases](#)
[Free (or Low Cost) Full-Text Access to Standards](#)
[Standards Education Resources](#)

Major Standards Bodies

This section includes select, major standards bodies related to engineering and technology. It contains a large number of professional societies that have multiple functions and develop standards as part of their organization's mission. The focus here is only on their standards work. Individual, full-text standards in print and/or digital formats are available for purchase from every standards body listed.

American Association of State Highway and Transportation Officials (AASHTO)
http://www.transportation.org/
> AASHTO sets standards that are used in highway development. Topics covered include the design and construction of highways and bridges, the materials used, etc. AASHTO works as a liaison between state departments of transportation and the federal government.

American National Standards Institute (ANSI)
https://www.ansi.org/
> As the only accreditor of U.S. voluntary consensus standards bodies, ANSI facilitates the approval of American National Standards (ANS). It is the "sole U.S. representative and dues-paying member of the two major non-treaty international standards organizations, the International Organization for Standardization (ISO), and, via the U.S. National Committee (USNC), the International Electrotechnical Commission (IEC)" (ANSI 2017). Through ANSI or the USNC, U.S. standards are often submitted to ISO and IEC to be used in whole or in part as international

standards. ANSI offers institutional access to their approved standards, as well as U.S. and international standards from many other standards bodies, through the online platform ANSI Standards Connect ET.

American Nuclear Society (ANS)

http://www.ans.org/

ANS develops standards for a variety of nuclear related topics, such as reactor safety, waste management, materials handling and transport, accident response, and software for the nuclear industry. Currently there are over 70 active ANS standards. All ANS standards are approved by ANSI as American National Standards.

American Society of Civil Engineers (ASCE)

http://www.asce.org/

ASCE is the oldest engineering society in the United States. They develop and publish standards for the built environment. ASCE standards are applied in the areas of infrastructure, such as water irrigation and drainage, design loads, electricity and power transmission, retaining structures, tunnels, and underground construction. ASCE offers institutional access to their standards and other ASCE publications through the online platform ASCE Research Library.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

https://www.ashrae.org/

ASHRAE develops standards for refrigeration and heating, ventilation, and air conditioning (HVAC) systems. The three types of standards it publishes are methods of measurement (or test), standard design, and standard practice.

American Society of Mechanical Engineers (ASME)

https://www.asme.org/

ASME is an international developer of standards for mechanical engineering. ASME develops standards for a wide variety of areas, including nuclear plants, pressure technology, performance testing, elevators, escalators, pipelines and piping, pumps, valves, fittings, gaskets, and hand tools. ASME is well known for its Boiler & Pressure Vessel Code (BPVC) body of standards. ASME offers institutional access to their standards collections through the online platform ASME Standards Collection.

ASTM International (formerly the American Society for Testing and Materials)

https://www.astm.org/

ASTM develops and publishes national and international standards for materials, products, systems, and services. ASTM standards are used in a variety of industries, including aircraft, chemical, construction, consumer product, energy, highway, metals, testing solutions, automotive, health care services, technology, and textiles. ASTM offers institutional access to their standards, other ASTM publications, and standards from other standards bodies (AASHTO, etc) through the online platform ASTM Compass.

Institute of Electrical and Electronics Engineers (IEEE)

https://www.ieee.org/

IEEE develops standards through the IEEE Standards Association (IEEE-SA). IEEE-SA develops industry standards in a range of technologies, including aerospace electronics, health care IT, wired and wireless communications, computer technology, nanotechnology, nuclear power, and transportation. IEEE offers

institutional access to their standards and other IEEE publications through the online platform IEEE Xplore.

International Electrotechnical Commission (IEC)
http://www.iec.ch/
> IEC prepares and publishes international standards for electrical, electronic, and related technologies. IEC works with ISO and the International Telecommunication Union (ITU) under the banner World Standards Organization (WSC) to ensure that standards work together globally.

International Organization for Standardization (ISO)
https://www.iso.org/
> ISO is an independent, non-governmental, international organization that develops and publishes consensus-based international standards. ISO publishes standards in almost every industry for materials, products, processes, and services.

International Telecommunication Union (ITU)
http://www.itu.int/
> An agency of the United Nations, ITU focuses on information and communication technologies (ICTs). ITU's Telecommunication Standardization Sector (ITU-T) develops international standards known as ITU-T Recommendations. ITU-T Recommendations ensure countries' ICT networks and devices communicate seamlessly.

National Fire Protection Association (NFPA)
http://www.nfpa.org/
> The NFPA develops codes and standards to establish criteria for fire prevention in building processes and maintenance. NFPA 70, National Electrical Code (NEC), is widely used in the built environment for electrical installations. Select read-only codes and standards are freely available through their web site.

Society of Automotive Engineers (SAE International)
http://www.sae.org/
> SAE develops standards for mobility engineering around the world. Standards are developed for aerospace, aerospace materials, ground vehicles, and the United States Council for Automotive Research (USCAR). SAE offers institutional access to their standards and other SAE publications through the online platform SAE Mobilus.

UL (formerly Underwriters Laboratories)
http://www.ul.com/
> UL standards are used to assess products, test components, materials, systems and performance. UL creates or revises standards through their Standards Technical Panels (STPs). The UL listing and classification marks from UL's testing and certification programs are widely recognized on consumer products.

Standards Aggregator Databases

This section provides links to databases that are tools for searching standards from a variety of organizations. Select information, such as a summary of a standard and document history, can be viewed freely. However, individuals typically must purchase full-text access to standards from these databases. The aggregators often sell access to a premium search interface with more capabilities than their freely accessible tools.

ANSI Webstore
https://webstore.ansi.org/
> The ANSI Webstore offers access to over 60,000 U.S. and international standards (both ANSI approved standards and others not designated as American National Standards). Standards can be searched by keywords or document number and browsed by publisher or standards package. As part of the search function, there is a "News" tab to explore standards related news. ANSI offers ANSI Standards Connect ET, a subscription platform for searching and accessing standards. ANSI previously provided the standards database NSSN (A National Resource for Global Standards); NSSN was retired and taken offline on December 31, 2016.

Document Center
https://www.document-center.com/
> Document Center carries global industry and government standards from hundreds of standards bodies. Standards can be searched by title, keywords, or document number. Standards can also be located by subject, industry sector, and ASTM Volume. This platform is widely used in the medical device industry. Document Center offers Standards Online Document Center, a subscription database for searching and accessing standards.

IHS Markit Standards Store
https://global.ihs.com/
> The IHS Markit Standards Store carries documents from over 460 standards bodies. Standards can be browsed by publisher, industry, or product. Under each publisher, there is a description of the organization, newly revised documents, top selling standards, and related publishers. IHS offers IHS Standards Expert (soon to be Engineering Workbench), a subscription platform for searching and accessing standards.

MADCAD
http://www.madcad.com/
> MADCAD carries standards from organizations such as ASCE, ASTM, and IEEE. Standards are browseable by publisher. MADCAD promotes their content as being optimized for tablet computers and mobile devices. Individual standards and subscription based services are available for purchase. With a subscription, the platform offers a read-only format that allows for printing portions of standards.

SAI Global
http://infostore.saiglobal.com/store/
> SAI offers access to over one million global publications. A basic search includes searching by current publications and publishers. There are a number of advanced search options, including publication status (e.g., superseded, withdrawn, lapsed), publication date, keywords in abstract, title, and scope. SAI offers Infobase, a subscription platform for searching and accessing standards.

Techstreet
http://www.techstreet.com/
> The Techstreet database carries over 500,000 global publications. Standards can be searched by document number, keywords, or publisher. Through "Shop by Publisher," standards can be browsed by topics, and the publisher's most recent and popular publications. Users can register for an account to access a free tracking service that sends updates on standards selected for alerts. Techstreet offers Techstreet Enterprise, a subscription platform to search and access standards.

Free (or Low Cost) Full-Text Access to Standards

Included in this section are resources that provide free or low cost, full-text access to standards.

ANSI University Outreach Program
https://www.ansi.org/education_trainings/university_outreach
> ANSI's outreach program educates and advises faculty about standards in the classroom and in curriculum. Through this program, faculty and students can get complimentary access to a defined group of ISO or IEC standards for the duration of a course.

ASHRAE Read-Only Standards
https://www.ashrae.org/standards-research--technology/standards--guidelines/other-ashrae-standards-referenced-in-code
> ASHRAE offers free, read-only access to a select number of their "current popular standards" and standards referenced in code.

ASTM Standards on Campus
https://www.astm.org/studentmember/Access_by_Course.html
> For instructors who want to provide affordable student access to standards, ASTM offers Standards on Campus. Instructors choose ten standards from the full ASTM library that students purchase for ten dollars as an ASTM course packet.

Incorporated by Reference (IBR) Standards Hosted by ANSI
https://ibr.ansi.org/Standards/Default.aspx
> This ANSI portal provides free access to select read-only, full-text standards incorporated by reference in U.S. federal regulations.

National Institute of Standards and Technology (NIST) Free Standards List
http://gsi.nist.gov/global/index.cfm/L1-5/L2-44/A-466
> NIST offers a list of standards bodies that make some or all of their standards free, or free with membership.

Standards Education Resources

This section provides links to resources for standards teaching and learning.

American Nuclear Society (ANS) Standards Resources
http://www.ans.org/standards/
> This site provides a historical overview of ANS standards. It also contains articles on many topics, including the standards development process, the life of a ANS standard, and examples of ANS standards usage. Additionally, there is a "What's New" section that gives details on recently approved ANS standards and draft documents that are currently in the standards development process.

ASME - About Standards and Certification
https://www.asme.org/about-asme/standards
> This site provides information on the history of ASME codes and standards, the benefits of standards, and the standards development process. It also includes a detailed 32-page booklet for students, highlighting examples of how ASME codes and standards are used, and an introductory self-study course titled ASME Standards ABC.

ASTM International - Students & Professors
https://www.astm.org/studentmember/index.html
> This section of the ASTM International website provides a variety of educational materials for student and instructor use. The site includes a voice-over learning module series on introductory standards topics and a professor's toolkit consisting of learning videos, handouts, case studies, and standardization related articles.

IEEE Standards University
http://www.standardsuniversity.org/
> This IEEE standards education collection is a mix of freely available content and fee-based resources for students, faculty members, and professionals. The free content includes a self-paced standards MOOC (Massive Online Open Course), short case studies from professors on using standards in the classroom, webinars, videos, presentations, and articles. Students and faculty members can also apply for grant funding on this site to support graduate and undergraduate design projects that incorporate standards.

Intellectual Property (IP) Shield Standards Education
http://www.ip-shield.com/nist.aspx
> IP Shield provides, for free, four short video case studies relating standards to on-the-job scenarios and a self-paced, online course (60 minutes) relating standards to real-world uses in STEM (science, technology, engineering, and mathematics) areas. They also offer fee-based online standards education courses.

ISO Consumers and Standards: Partnership for a Better World Learning Module
http://www.iso.org/sites/ConsumersStandards/index.html
> A freely available, read-through learning module that provides an introduction to standards with a focus on consumer interests. The module topics include standards basics (e.g., what are standards and how do they help society?), national and international standards development, the ISO standards system, benefits of standards to consumers, and consumer participation in the ISO standards process. Self-assessment review questions are incorporated throughout the module.

NIST Standards Services Curricula Development Cooperative Agreement Program Awardees
https://www.nist.gov/standardsgov/nist-standards-services-curricula-development-cooperative-agreement-program-awardees
> The NIST Standards Services Curricula Development Cooperative Agreement program awards funding for projects that integrate standards education into undergraduate and graduate curricula. The program made 27 awards from 2012-2016, totaling over $1.6 million. This site lists awardee names, project descriptions, and contact information for recipients of funding from this program. The curricular materials developed through this program are freely available and can be accessed through the links provided in this resource, or by contacting the award recipients in cases where links are not made available.

Northwestern Standards Management - Strategic Standards Management
http://www.northwestern.edu/standards-management/
> This site provides standards teaching resources with a primary focus on business topics, such as innovation, supply chain, smart systems, and sustainability. The resources include example syllabi, case studies, videos, role-playing exercises, PowerPoint presentations, instructor scripts, handouts, articles, and discussion questions.

StandardsLearn.org Portal
https://www.standardslearn.org/
> This ANSI site contains self-paced tutorials for students and professionals on topics such as an introduction to standards, the history of standards, and the U.S. standards system. The site also includes materials for educators, such as written standardization case studies, K-12 resources, and a database with links to over 180 other standards education resources.

University of Pittsburgh Information Technology Standards Education Resources
http://its.sis.pitt.edu/NIST/
> This site provides standards education resources with a focus on information technology. The materials include eleven learning modules covering a variety of topics, such as an introduction to standards and standardization, security standards, core web standards, standards for big data and data mining, and cellular telephony and wireless network standards. The modules include PowerPoint presentations, videos, readings, and exercises. The site also includes links to freely accessible information technology standards and a bibliography of standards resources.

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