# AC 2008-353: SUSTAINABILITY AND INTERNATIONAL STANDARDS

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# Sustainability and International Standards


## Abstract

This paper describes the need for courses that link standards and sustainability and reviews an Oklahoma State University Environmental Science graduate course in Sustainability and International Standards. The course conveys the importance of voluntary international standards, such as from ASTM International or the International Organization for Standardization (ISO), to sustainability. The curriculum uses an innovative experiential learning approach whereby students research and develop a standard using the ASTM International process. One driven student joined ASTM International and worked to see her class project catalyze the publication of ASTM E 2348 *Guide for Framework for a Consensus-Based Environmental Decision-Making Process*.


## Introduction

In 2004, the Oklahoma State University Environmental Institute established a graduate-level course covering sustainability and international standards that addressed a need to improve standards education. The following reviews standards, relates sustainability to standards, assesses standards education in engineering and the role of engineers in the standards setting process, and discusses the Sustainability and International Standards course curriculum design. This paper concludes that standards and sustainability education for engineers, and more broadly most disciplines, should be strengthened. The Oklahoma State University Sustainability and International Standards course serves as a model for that purpose.

## Standards Overview

Standards are described and their importance conveyed by the American National Standards Institute (ANSI) in the following:

> "When the formal U.S. standards system was established nearly a century ago, standards were primarily developed to support manufacturing and mechanical processes. In the present day, standards offer benefits to all segments of business and industry, government and consumers. They simplify product development, reduce unnecessary duplication, lower costs, increase productivity, promote safety, and permit interchangeability, compatibility, and interoperability. They help to advance scientific discovery, and keep people safe by minimizing injuries and protecting key environmental resources.
>
> A **standard** is "a recognized unit of comparison by which the correctness of others can be determined." Another definition is "a set of characteristics or qualities that describes features of a product, process, or service."
>
> The term **standardization** actually encompasses a broad range of activities and ideas – from the actual development of a standard to its promulgation, acceptance

> and implementation. It also includes the methods of evaluating whether products, processes, systems, services and personnel comply with a standard – this evaluation is known as **conformity assessment**." [1]

Standards are developed through stakeholder consensus setting processes conducted by non-governmental organizations commonly referred to as 'standard development organizations' (SDO) or 'standard setting organizations' (SSO). Most SDO are industry/discipline sector specific such as the American Petroleum Institute, though umbrella SDO that work across all sectors play a key role such as ASTM International. Stakeholders include anyone or organization that meets the participation requirements of the SDO (typically membership) and are typically businesses, industry and professional associations, non-government organizations (NGO), and government agencies. SDO have been established throughout the world and the International Organization for Standardization (ISO) with 94 member countries is a key organization for guiding harmonious international standard setting.[2] It is estimated by the U.S. Department of Commerce (DOC) that approximately 80 percent of world trade is influenced by voluntary international standards and international treaty organizations such as International Telecommunications Union (ITU) often endorse and/or establish standards. Standards differ from governmental regulation because they are voluntary. However, governmental regulations are sometimes termed standards and often reference standards. For example, the U.S. Code of Federal Regulations reference standards from 335 SDO with ASTM International, a major SDO, with 2,592 standards referenced.[3] As a result, standards are commonly referenced as voluntary international standards.

**Sustainability and Standards**

Standards increasingly guide and direct business and governmental activities, domestically and internationally. Customers, especially from industry and government, rely on standards to ensure goods and services satisfy their needs while improving health, safety, environmental, and social equity aspects. Standards identify and evaluate technologies, thus plays a vital role in determining which technologies are adopted and how they are deployed in industry and products.[4] Engineers that understand that role will be more effective in incorporating standards in their work so that sustainability is improved. Moreover, standards encompass activities beyond the scope of commerce. Consequently, standards shape the sustainability of a wide array of market and non-market activities.

Recognition of this has lead to the development of standards that explicitly establish sustainability definitions, guides, and processes. For example, ASTM E 2432-05 *Standard Guide for General Principles of Sustainability Relative to Buildings* provides direction on how to incorporate sustainability into the design, construction and operation of buildings and would be a relevant standard to guide engineering student capstone projects related to buildings. ASTM International has assembled its standards with sustainability aspects relative to buildings into a compendium to more readily encourage incorporation into building design, construction and operation.[5] Designers of building products would likely reference and use as a guide ISO 21930:2007 *Sustainability in building construction – Environmental declaration of building products*. Most well known, especially to engineers within manufacturing industries, are the ISO 14000 environmental management standards that include standards for a range of activities such

as environmental management systems, life-cycle assessments, carbon accounting and environmental declarations and labeling.

**Standards and Engineering Education**

Despite the growing importance of standards, college curricula, within and without engineering, seldom addresses standards in a direct and substantive way. Standards education, when included in the curricula at all, tends to occur in upper division courses as an adjunct to the main body of the course. The curricula cover the basic aspects of standards and their utilization, and typically not the processes by which standards are developed and adopted. For example, the ABET Criteria for Engineering specifies that curricula include engineering standards in students' capstone projects[6,7],but this is too late in the curricula to effectively convey the role of standards in sustainability.[8] Standards and sustainability need to be linked in core courses to convey the interrelationship. As a result, engineers primarily learn about standards on-the-job and through continuing professional education. Curricula and professional experience falls short in providing engineers that can contribute to the development of standards, much less convey the impact of standards on sustainability.

Contributing to standards development is a critical role and as important as standards utilization and conformity. Many engineers will find themselves thrust, unprepared, into the role of representing their firm, professional organization, government agency or other stakeholder in a standards development process. While their engineering skills are important to developing or modifying standards, engineers without grounding in the standards development process will be less effective contributors. In particular, the ability and extent to which stakeholders make significant written contributions to standards development are important to effectively influencing standard, whereas sheer political skills are not as important.[9] Stakeholders that may hold agendas that conflict with good engineering practice or a particular engineering stake may effectively mute the input of an engineer without preparation in standards development. The consequence may mean that their technical perspectives may not be effectively represented in the standard to the detriment of the stakes they represent (their employer, association, agency, etc.) and/or the quality of overall standard. Relative to sustainability, unprepared engineers may fall short in shaping standards so that they more effectively improve sustainable outcomes.

Consequently, as stakeholder organizations participate in standards development, they have found a dearth of engineers or other professionals that can effectively contribute to the development and application of standards. As a result, the U.S. Department of Commerce in the report *Standards & Competitiveness—Coordinating for Results*[2] and the American National Standards Institute (ANSI) in the report *United States Standards Strategy*[10] call for greater standards education. The *United States Standards Strategy* encourages colleges and universities to develop and offer standards courses so that engineers and other professionals are prepared to participate in standards development and application. Unfortunately, implementation of their recommendation seems to be falling short based on their implementation survey which includes only two university responses, although participation in the survey is self-selected therefore cannot be generalized to the population of higher education institutions.[11]

**Sustainability and International Standards Course**

The Oklahoma State University Sustainability and International Standards course responds to the call of the *United States Standards Strategy*. It integrates sustainability and international standards into a unified curriculum that encompasses the social, economic and environmental dimensions of sustainability. Throughout the course these three dimensions of sustainability are used as a conceptual foundation for identifying, considering and preparing draft standards. The course covers:

- Standards history, role and relation to sustainability.
- Standards setting processes, both generally and with specific focus on selected major SDO such as ASTM International.
- The dynamics of stakeholders in standard setting including the barriers to participation.
- World trade and harmonization of standards
- Trade and human development

The course syllabus is in the appendix.

Central to the course is a student project that involves identifying a need for a potential sustainability related standard and developing the standard following the ASTM International standard setting process. This is an experiential process. The student project is intended to simulate to the degree possible within a semester long course the process of setting a standard. Students work individually to draft standards that are then presented to the class, acting as technical committees that prepare standards.

Students have been challenged to address sustainability issues that have received little attention by SDO, but are emerging issues such as how to classify traditional medicines. Students have selected a broad range of sustainability related concerns to address with their draft standards. The following standards have been drafted by students taking the course:

- Standard Classification for Energy Production Relative to Sustainable Development
- Standard Classification for Degradation, Mobility and Bioaccumulation of Organic Chemicals in the Terrestrial Environment
- Standard Classification for Economic Indicators
- Standard Classification for Genetically Modified Organisms Used in Food Products
- Standard Classification of Traditional Medicines
- Standard Guide for Social Criteria Fundamental to Socially Responsible Investing (SRI).
- Standard Practice for Assessment of Residential Wastewater
- Standard Practice for Managing Corporate Social Responsibility
- Standard Practice for Precautionary Due Diligence in Product Development
- Standard Practice for Principles and Data for Estimating Carbon Footprint using Input-Output Methodology
- Standard Practice/Guide for the Utilization of Wetlands for Stormwater Management
- Standard Specification for Attributes and Representation of Indigenous Cultures

- Standard Specification for Standard Practice for Generic Labeling (Marking) of Recycled Products
- Standard Terminology for Intellectual Property

One doctoral student, working with the instructors, sought funding from Oklahoma State University to propose her draft standard to ASTM International. She was successful in moving the standard through the technical committee and ASTM E2348-06 *Standard Guide for Framework for a Consensus-based Environmental Decision-making Process*, her proposed standard, was published in 2006. This demonstrates how such an experiential learning approach can impact motivated students and lead to an expanded learning experience.

Engineering professors and instructors who develop standards and sustainability courses have several resources they can draw upon. The Sustainability and International Standards course relies extensively on educational materials made available through the ASTM International Campus [12] and Sustainability Standards Development web pages.[13] In addition, ASTM standard templates are used by students to draft their proposed standards.[14] ANSI offers the StandardsLearning.org website that offers four e-learning programs that cover basic standards information.[15] Other sector SDO offer web-based information and learning modules that can be used in a standards and sustainability course. For example, ASHRAE (American Society for Heating, Refrigerating, and Air-Conditioning Engineers) created the Sustainability Roadmap that can be used to in standards and sustainability curricula.[16] Most engineering societies with standard setting involvement will have at least some resources that could be integrated into a standards and sustainability course.

**Conclusion**

Standards influence much of the market and non-market activities across the world that impinges on environments, societies and economies. Standards can determine whether human activities improve or harm sustainability. Therefore how standards are set is critical to whether we move towards or away from sustainability.

Engineers in their roles of technology designers, developers, testers, and implementers have skills and knowledge that are necessary for the development of most technology related standards. The ability of engineers to link standards with sustainability, and then to effectively participate in the development and employment of standards depends on their education and experiences. Unfortunately, engineering education does not often provide standards and sustainability education sufficient for engineers to promote sustainability through the development and employment of standards. Especially, needed is education regarding standards development processes.

The Sustainability and International Standards course at Oklahoma State University is a model course for engineering education programs. By using an experiential learning approach, which is a familiar learning approach for most engineering students, it gives students an opportunity to consider sustainability and standards and simulate how sustainability standards are developed. In a capstone project, such a course might be used to have students draft or modify standards that relate to the project, and not just reference and apply relevant standards. Engineering programs

that adopt such courses might find, as did Oklahoma State University with the Sustainability and International Standards course, that a few of their students may develop standards that form the basis for standards adopted by an SDO.

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## Appendix

## Sustainability & International Standards

In the past decade, standards have assumed new prominence as an essential part of international commerce and the process of globalization. Many view the WTO, a relatively young institution, as one of the greatest engines of change today. The primary tools of this change are international standards. Some view the change as progress; others view the change as catastrophic. Regardless of your perspective, it is critical to understand the hidden life of international standards, how & why they are created, and their implications for sustainable development.

> ***If you have ever tried to install a new piece of hardware on a computer only to be told that "it won't work with your system," tried to screw an American standard bolt into a hole with metric threads, or stared at a recipe while trying to figure out how many milliliters are in one third cup, you know the frustration of non-standardization. Standards affect all areas of life from the minute details of tasks such as cooking and shopping to global investments. It is difficult to imagine a sophisticated society without standards.***

This course reviews the role of standards in the global economy and their potential impact on sustainable development. This is a survey course intended for graduate students. Although the course is primarily intended for students in the fields of environmental management, international studies, and business, it is available to any graduate student interested in this field of study, for example, law students, political science, and industry-sector specific programs. It is intended to provide graduate students with a broad understanding of the cross-functional and interdisciplinary issues associated with standards, the process of standardization and global governance.

READING REQUIREMENTS:

All required reading assignments will be available electronically. Additional recommendations for reading may be made as appropriate to Projects.

- Form and Style for ASTM Standards, "Blue Book" (PDF); last update 04/03; **http://www.astm.org/COMMIT/Blue_Book.pdf**
- Regulations Governing ASTM Technical Committees or "Green Book" (PDF); last update 06/03; **http://www.astm.org/COMMIT/Regs200204.pdf**
- The WTO in Brief; **http://www.wto.org/english/thewto_e/whatis_e/inbrief_e/inbr00_e.htm**
- WTO legal texts (emphasis on Technical Barriers to Trade); **http://www.wto.org/english/docs_e/legal_e/legal_e.htm#tbt**
- *Standardization in a Global Marketplace: Process and Implications*.
- *The Multilateral Trade System: A Development Perspective.*
- *Highlights of the Standards Setting Process in Five Example Bodies; diagrams.*
- *Trade, Gender and Poverty.*
- *The Global Governance of Trade as if Development Really Mattered.*

PAPERS:

Papers will be developed individually; estimate 1000 words. Individuals will be assigned an industry sector topic. Papers shall present an overview of the global market relative to the topic. Papers should discuss the topic in terms of aspects of sustainability (i.e. economic, environmental, social). Papers should include an executive summary and appropriate references/notations. It is expected that the projects will be of significant quality, and worthy of publication in a national or international standards publication.
Industry Sector Topics are as follows:

Agriculture, with an emphasis on:
- Genetically Modified Organisms (GMOs)
- Fair Trade
- Traditional Practices

Consumer Products, with an emphasis on:
- Labeling

Healthcare, with an emphasis on:
- Precautionary Principle
- Traditional Knowledge
- Toxicogenomics

Finance & Corporate Management, with an emphasis on:
- Corporate Social Responsibility
- Investment Screens for SRI
- Corporate Governance (e.g. Transparency of Organizations)
- Privacy of Individuals
- Real Progress Indicators (RPI vs GDP)

Energy, with an emphasis on:
- Climate Change
- Green Power
- Disaster Preparedness and Response

Water, with an emphasis on:
- Watershed Assessment & Monitoring
- Water Stewardship (management)
- Disaster Preparedness and Response

PROJECTS:

Projects will be developed individually. Individuals will be assigned an industry sector topic consistent with Paper Topic. Projects shall develop the following:

- PART 1. Identify existing standards and Standards Development Organizations (SDOs), if any relative to the topic; indicate the SDO and the SDO process, summarize the scope of each standard, and provide an assessment of the appropriateness of the standard in terms of its contribution to sustainable development. Discuss/organize standards in terms of aspects of sustainability.
- PART 2. Draft a standard relative to the topic in support of sustainable development.

- PART 3. Identify key stakeholders; prepare statement for each indicating who they are and why their expertise is appropriate. Indicate how their expertise is pertinent to each of the aspects of sustainability.

SYLLABUS:

**WEEK 1:** **Topic:** Introduction & Overview of Course
August 29 **Discussion:** Sustainability in business, government and non-government organizations. Syllabus review.

**WEEK 2:** **Topic:** Standards Development – Why?
August 29 **Discussion:** Why are standards important? What is sustainable development? What is the World Trade Organization (WTO) & how does it impact national economies and domestic policy. Overview of changing role of international standards in the global market in wake of WTO.
**Powerpoint:** Standards Development - Why
**Assignment:** Reading for next week - *Standardization in a Global Marketplace: Process and Implications*.

**WEEK 3:** **Topic:** Standards Development – What, Who, and When?
September 5 **Discussion:** Are standards minimum requirements? Maximums? What is their purpose and who sets the standards? What are the implications (politically, economically, legally, environmentally, socially) for trade? How do these differ for local/global organizations? For developing/developed countries? What are the implications for sustainable development?
**Powerpoint:** Standards Development – What, Who, and When
**Assignment**: ASSIGNMENT OF PAPERS. Reading for next week: *The Multilateral Trade System: A Development Perspective.*

**WEEK 4:** **Topic:** **"**Harmonization" and Technical Barriers to Trade (TBT)
September 12 **Discussion:** Focus on harmonization of standards – what is it, what are the pros and cons? Focus on TBT as it relates to harmonization. How does this impact developed countries? Developing countries? Local/municipal governments? Consumers? Industry?
**Assignment:** Continue reading: *The Multilateral Trade System: A Development Perspective.*

**WEEK 5:** **Topic:** Trade and Human Development
September 19 **Discussion:** Examination of the current world trade regime through a human development lens while focusing on concerns expressed by developing country governments and a range of civil society organizations. Discussion of trade rules that may allow for diversity in national institutions and standards, including the impacts on local cultures and development priorities.
**Powerpoint:** Making Global Trade Work for People

**Assignment**: PROJECT ASSIGNMENTS. PART 1. Reading for next week – *Highlights of the Standards Setting Process in Five Example Bodies; diagrams.*

**WEEK 6:** PAPERS DUE.
**Topic**: Discussion of Project Assignments.
**Discussion:** Changing society and its standards. Discuss from a variety of perspectives: technological, economic, legal, social. Comparison of standards (type and use) at the start of 20th century to standards today. Overview of the different industry sector topics and current events. What would happen if standards were created on the subjects listed? How might this affect sustainable development?
**Assignment**: Reading for Next Week: *Trade, Gender and Poverty.*

**WEEK 7:** **Topic:** Developed Countries & Developing Countries
**Discussion:** Different socio-economic priorities of Developed Countries & Developing Countries. Are countries homogenous? What is the feasibility of Developing Countries creating and supporting a national SDO system? What is the significance for standards development in ISO? ASTM? What are the unique issues, if any, for island nations? How are these reflected in the SDO process?

**WEEK 8:** **Break, no class**

**WEEK 9:** PROJECT - PART 1 DUE.
**Topic:** Standards Development – How?
**Discussion:** This is the mundane part of the course. However, it is necessary to understand the rules of the game in the new 'post-WTO' climate, so we will review USA standards development organizations (SDOs) and the International Organization for Standardization (ISO). How does the SDO process affect the potential for sustainable development?
**Powerpoint:** Standards Development – How?
**Assignment**: PROJECT ASSIGNMENTS. PART 2.

**WEEK 10:** **Topic:** Project Assignments.
**Discussion:** No lecture/discussion class; meetings w/instructors by appointment. Instructors to schedule time to focus on Projects – Part 2.

**WEEK 11:** **Topic**: Standards Development in ASTM International
**Discussion:** Overview of types standards and their uses. Presentation of sample standards related to sustainable development.

**WEEK 12:** **Topic:** Project Assignments.
**Discussion:** No lecture/discussion class; meetings w/instructors by appointment. Instructors to schedule time to focus on Projects – Part 2.

**WEEK 13:** PROJECT - PART 2 DUE.
**Topic:** ISO Tags and ASTM committees

**Discussion:** Real world examples of the ISO process and the ASTM process from the perspective of USA industry.
**Assignment**: PROJECT ASSIGNMENTS. PART 3. Reading for next week: Regulations Governing ASTM Technical Committees or "Green Book".

**WEEK 14:** **Topic:** Resolution of Negatives
**Discussion:** Review of consensus process in SDOs and the required negotiations. What are the fundamental issues in each industry sector? Are there similarities? What stakeholders share common perspectives?
Presentation of Projects to class for "ballot" and adjudication.

**WEEK 15:** PROJECT - PART 3 DUE.
**Topic:** Resolution of Negatives (continued)
**Discussion:** Review of consensus process in SDOs and the required negotiations. What are the fundamental issues in each industry sector? Are there similarities? What stakeholders share common perspectives?
Presentation of Projects to class for "ballot" and adjudication.
**Assignment:** Reading for next week: *The Global Governance of Trade as if Development Really Mattered.*

**WEEK 16:** **Topic:** Review and Conclusions
**Discussion:** What is the big picture? How do the global governance institutions impact sustainable development? How are standards involved? What SDO processes can best promote sustainable development? What SDO process can most harm sustainable development? What industry sector topics most need standardization? What industry sector topics should NOT be standardized?