Context-based Modules for Enhancing Value Recognition and Teaching of Standards and Standardization

Results of a National Institute of Standards and Technology (NIST) Grant

Michael Radnor and Jeffrey Strauss, Northwestern University

Despite the best efforts of NIST, the American National Standards Organization (ANSI) and standards setting organizations, surveys indicate coverage of the strategic importance of standards and participation in standards development remains poor in most US engineering and, especially, business schools. Globalization, increased intensity of competition, the impact and potential of *Big Data* and related knowledge flows, and the emergence and convergence of new technologies and systems are altering standards development processes and raising the visibility of standards within organizations. These developments offer both enhanced need for coverage and opportunities to make standards more clearly relevant to faculty and students.

With this in mind, the U.S. National Institute of Standards and Technology (NIST) recently sponsored a project carried out by Northwestern University that, as it evolved, included

- review of existing materials and approaches and of interest and needs of faculty (review included discussion with faculty teaching innovation, supply chain, operations, engineering design, entrepreneurship, negotiations);
- development of a model course module, and a standards negotiation exercise;
- participation and test use of the exercise in two workshops also supported by NIST but undertaken by the industry-university Global Advanced Technology Innovation Consortium (GATIC) in collaboration with, respectively, Northwestern and UCLA;
- test of the module and exercise in Northwestern graduate and undergraduate management and engineering courses

Design input also came from a workshop conducted in Washington, DC by the World Standards Cooperation (WSC) in partnership with the American National Standards Institute (ANSI) and a grantee workshop held at NIST. This paper summarizes the events, driving considerations and module and exercise content. The materials are available for use upon request.

Workshop input

The first GATIC workshop was conducted at Northwestern University in Evanston, Illinois in March 2013, with a second program hosted in Los Angeles and actively supported by the University of California Los Angeles (UCLA) in June. Together, the programs attracted some 90 participants including over a dozen major industry participants, many smaller firms and faculty representatives from multiple departments in 20 engineering and business schools. The deliberate mix in both workshops was approximately 60% university faculty and 40% industry with an emphasis on participants new to, and not yet actively addressing standards in teaching or practice (a major goal). Separately, the WSC Roundtable held June 25-26 this year, drew over 80 participants including academics, industry as well as Standards Development Organizations

(SDO's) and demonstrated new value through interaction between participating faculty, company managers and SDO's.

All three of the programs sought to attract participants and stimulate discussion by providing application contexts in which the importance of standards is evident. The WSC roundtable broadly targeted innovation and entrepreneurship (although discussion went well beyond these foci.) The March workshop zeroed in on smart systems including equal emphasis to smart (advanced) manufacturing, smart grid, cloud computing, and related supply chain, while the June workshop at UCLA, with active involvement of the Smart Manufacturing Leadership Coalition (SMLC), tightened the focus even further on smart manufacturing with discussion of smart grid and cloud computing as they relate to smart manufacturing. This contextual focus enabled the workshops to attract both faculty and industry participants new to standards (nearly all participants in the WSC program already had significant standards experience.) In fact, in evaluations, particularly for the UCLA program, 53% of respondents cited target contextual domains as what attracted them to attend compared to 20% pointing to the standards content.

Discussion in the WSC Roundtable suggested that systems that are increasingly complex, evolving and call for horizontal suites of standards crossing diverse organizations and technologies could be particularly useful targets. These were noted as challenges to traditional standards developers and processes particularly in the way standards develop in the US.

Drawing from the GATIC workshops and subsequent discussions, Smart Grid, with its well-known potential benefits, offers illustrative standards challenges and value requiring:

- essential common data formats, controls and performance measures across devices, systems, sensors and organizations (including multiple vendors)
- potential consensus selection of development paths
- vehicles for companies to balance individual strategic and operational requirements with implied cross organization/cross-sector, even cross-national environmental and efficiency initiatives
- support for innovation by giving confidence that new products, technologies and processes will be compatible with legacy systems, infrastructure and vendor capabilities, and will be accepted in the market
- support for development of reporting requirements recognizing varying levels of understanding, contexts and proprietary concerns.

The WSC Roundtable pointed to a desired teaching emphasis on a standards perspective (over individual standards) that would include:

- assessing key interrelationships and interoperability requirements across and within systems and identifying and evaluating relevant (and beyond the obvious) stakeholder positions and requirements; recognizing who needs to be at the standards development table (individuals, organizations, expertise) and significance of knowledge gaps/unevenness
- reconciling conflicting standards from converging legacy systems
- considering impact of potential technology and operational changes

- providing confidence to investors and a practical platform for innovation.
- addressing important standards gaps and temporary solutions while standards evolve
- helping companies (and student future managers/planners) ensure standards development accounts for strategic goals and assessment of current and future strengths and weaknesses and competitor positions.

All of these points, as well as the smart grid example, were incorporated into the demonstration course module.

Overall, it was recommended that standards education promotion focus on courses/programs that are inherently broadly cross-disciplinary, and target "low hanging fruit" of systems and domains where stakeholder ecosystems are evident and the need for standards is obvious. This advice was followed in selection of courses for test use of the grant generated course module Not surprisingly, the greatest interest in its use has come from business innovation and new engineering courses in development in analytics, smart grid and engineering law where instructors are already challenged to address emerging problems.

Course module and exercise content

The intention of the module is to enable faculty with little if any standards experience to easily add attention to the subject in a range of course contexts. Although instructors are free to pick and choose slides and introduce varying examples as fits their courses and the capabilities of students, the module can be self-contained and used "as is" with the provided guiding notes. 79 slides are included. The module includes broader background on standards developers, trends and challenges but has a slant toward innovation and management. It also is presented from a corporate perspective more than a policy or societal one. Healthcare and smart grid are used as examples. Reading are suggested (standards specific and some broader) with summaries, links to internet sources and some discussion guidance. Using the module can take between two and three 90-minute class sessions (depending on nature and extent of discussion.)

The module includes a simplified standards negotiation exercise developed by Northwestern University as part of the NIST grant. This was developed because users of existing related exercises found them to be difficult to incorporate in courses as they lacked foundations in business decisions, required too much prior understanding of standards, and took too long.

Use of the exercise requires adding a minimum of 90 minutes to the module. The exercise was tested in multiple offerings of undergraduate and graduate management courses and will shortly be used in engineering courses at Northwestern as well. A number of other institutions, including ISO, have expressed interest in adapting the exercise. It was also employed in the LA GATIC workshop test. There the goal, more than teaching negotiation per se, was to further stimulate discussion, engage participants and, particularly, enhance recognition of subtle issues in standards development best achieved through experience. As also stimulated in use of the exercise in the course module, guided discussion brought out variation from how negotiation is

traditionally covered in business schools. This includes the long-term platform potential of standards and inherent multiple perspectives for participants in negotiation (corporate/ organizational goals, national interests, what's best for industry and field, personal). Moreover, parties in standards working groups are often very mismatched in types of organizations, level and standing of individual representatives, agendas, relevant knowledge and experience, and culture understanding. It was also pointed out that "success" of standards development is generally measured by acceptance and implementation of the standard in the market and not just that achieved by consensus in negotiations.

As further refined based on its test use, the exercise divides users into 7 groups including 6 fictitious countries (identified as A-F) with varying objectives and concerns (laid out in confidential role descriptions) based on the global market position of their industry (producers and consumers), established international relations (including with others among the 6 countries), level of development and other concerns including product safety. The final group is a moderating "Chair" which, with some discretion, applies/ enforces ISO rules and seeks to maximize the likelihood a standard is achieved. Instructors may choose to not use all groups and instead summarize unused positions.

The focal technology, "NUZIP" is only described as usable in a range of industries depending on how it is configured. It was originally developed by Country A which continues to lead its market and evolution. To date, it has been applied in basic industries where it only needs to be run at a low speed setting. Here it has performed very well for years, is widely manufactured (well beyond Country A) and used and is fully accepted in the global market.

Recently, advanced industries (such as in Countries D and E) with applications running at a higher speed have pushed for further development of NUZIP that could support their applications and, in fact, manufacturers in Country C - using a different, and incompatible approach - as well as in Country A have developed prototypes which could support and even enhance such applications. This high-end market is expected to be more lucrative than low-speed.

Unfortunately, when the lower speed models were ramped up significantly in the past, they became unstable. Only one manufacturer – in Country A – has demonstrated an approach that has performed in the lab without problems at high speeds and this has now been patented and is being launched. Country C is, however, close. In fact, though not yet clear, their approach may have technical advantages. The high speed NUZIP (both Country A and Country C approaches) is indicated to be backward compatible (usable in lower speed applications) although future versions may not be. Country A and Country C approaches are not compatible with each other requiring potential significant switching cost to change later.

Initiated by Country A, negotiations are planned to develop a new standard for the technology (now only a de facto/market determined standard exists.) It has been agreed that the ideal standard, if one is established, would be based on only one of the following:

- the low-speed version already accepted in the market,

- medium-speed which would enable some broader application but would not push toward the technology's full potential,
- high-speed which would allow top end application. This could be generic but could also be explicitly based on Country A's approach. Country A has offered very low cost (potentially even free) licenses if the technology is incorporated into the standard.
- very high speed to "pull" accelerated development.

The negotiations are carried out in the following stages as instructed:

1. **15 minutes preparation within groups**
   Use this time to review role assignments and consider strategy. You may select a spokesperson or any one of you may speak during the negotiation. While you cannot embellish or change the technology, you can and should be creative in anticipating other parties' positions (refining assessment as negotiations proceed), how you can address them (you may, for example, offer training – although this, of course, carries a cost, safety inspections etc.) and how they might respond. What is critical to you? What will you reveal - or not – and when about your interests and thinking? What do you need, how urgently? Who might be allies? Who might be enemies?
2. **20 minute formal negotiation: each group will make brief opening statements and then offer further comments and counterpoints/questions with permission of moderator.**
3. **15 minute break** *(you may use this time for informal interactions with other groups)*
4. **15 minutes formal negotiation**
5. **15 minute break** *(you may use this time for informal interactions with other groups)*
6. **10 minutes final formal negotiations** (if necessary)

Following negotiations, discussion is moderated first with participants staying within roles and then stepping outside of the roles to consider strategic implications of standards and participation in standards development more broadly.

Notes for instructors using the exercise suggest that, for varying teaching objectives and course contexts, discussion might delve into deeper issues in emerging technologies/systems, as well as broader marketing, finance, political, organizational, design etc. considerations. Role descriptions might also detail varying culture-driven negotiating behavior.

Conclusion

The course module and exercise have been well received in test settings and offer potential to significantly enhance faculty and student awareness of, and attention to, standards as a key facet of strategic planning particularly in complex evolving problem contexts. We will continue to improve their design based on feedback from further use within and increasingly beyond Northwestern. Our thanks go to the workshop participants, faculty and students who provided such valuable feedback and input and to NIST for supporting this endeavor.