Industrial Legislatures: The American System of Standardization

by

Andrew L. Russell

Introduction

At the beginning of the twenty-first century, a consensus had emerged among most observers of the global mobile telephone industry: Europe got it right, and America got it wrong. The Europeans, thanks to the leadership from the European Union, had rallied industry and government support behind a single digital network standard—GSM—that propelled European firms to global leadership. The Americans, having placed their faith in the wisdom of "the market," had been rewarded by a dizzying array of incompatible network standards, a frenzy of corporate mergers and alliances, and sluggish consumer adoption.

Critics were quick to pronounce the American approach a "great failure," which they attributed to a Reagan-era free market ideology, leadership failures on the part of the Federal Communications Commission, and an industry still reeling from the 1984 breakup of AT&T.[1] In my opinion, these factors were important, but they do not provide a satisfying explanation for why the American industry developed the way it did. In this essay, I attempt to provide a fuller picture of standardization in the American setting, one that locates recent events within longer and broader historical patterns. The American decision to defer to the collective judgment of professionals in the private sector was not, as the critics suggested, a mindless or incompetent act. Rather, it was a recent example of an American approach to industrial standards whose roots lie in the late nineteenth and early twentieth centuries.

Much like the history of the American nation itself, this American system of standardization has strong traditions of voluntarism, local control, meritocracy, rights to represent one's own interests, and a marked preference for private coordination of commercial activity.[2] Americans pursued standardization in a variety of institutional settings in the nineteenth century, and the stable contours of an American system of standardization were in place by 1930. The system consisted of loosely affiliated networks of institutions, featuring government participation but lacking overarching government control, that helped engineers and executives in a wide range of industries reduce inefficiencies and create platforms for further innovation and production.

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[1] Jacques Pelkmans, "The GSM Standard: Explaining a Success Story," *Journal of European Public Policy* 8 (2001), 432-453; Neil Gandal, David Salant, and Leonard Waverman, "Standards in Wireless Telephone Networks," *Telecommunications Policy* 27 (2003), 325-332; John Leslie King and Joel West, "Ma Bell's Orphan: US Cellular Telephony, 1947-1996," *Telecommunications Policy* 26 (2002) 189-203 ("The question is not *whether* [American firms] missed the boat, but rather *how* they missed it given their advantage at the time").

[2] D. Linda Garcia, "Standard Setting in the United States: Public and Private Sector Roles," *Journal of the American Society for Information Science*, Vol. 43 No. 8 (September 1992), 531-537; U. S. Congress, Office of Technology Assessment, *Global Standards: Building Blocks for the Future* (Washington, DC: U.S. Government Printing Office, 1992), 45-46; Samuel Krislov, *How Nations Choose Product Standards and Standards Change Nations* (Pittsburgh: University of Pittsburgh Press, 1997), 83-133.

Today's solutions come from yesterday's problems. I hope that this paper will help readers think about how yesterday's problems—and yesterday's solutions—are still with us today. A focus on partnerships, especially institutional partnerships, is an ideal context for understanding the themes and concepts that emerge from this history.

Standardization in the Nineteenth Century

During the nineteenth century, standardization developed in the in a variety of institutional settings, including federal arms production, private manufacturing, scientific investigations, and government laboratories. In each setting, bureaucrats, entrepreneurs, scientists, and engineers set important precedents for standardization that contributed to the growth of standards committees in professional engineering societies in the early twentieth century.

The first successful American efforts to establish industry-wide technical specifications through an impartial institution occurred within Philadelphia's Franklin Institute for the Promotion of the Mechanic Arts. This group of "philosopher mechanics" applied scientific and mechanical knowledge to practical and commercial problems, such as their investigation of steam boiler explosions in the 1830s and the publication of William Sellers' uniform system for American screw threads in 1864.[3] These activities in the Franklin Institute were early examples of an international trend that saw increasingly strong alliances between science, engineering, and industry.

Beginning in the 1860s, British physicists, electrical scientists, and telegraph engineers met under the auspices of the British Academy for the Advancement of Science to establish precise and consistent units of resistance. The leading lights of electrical science participated in the British Academy's Electrical Standards Committee, including James Joule, James Clerk Maxwell, JJ Thomson, and William Thomson (later Lord Kelvin). Their collaborations also included significant contributions from the German Werner von Siemens and the distinguished American physicist Henry Rowland. The topic of standardization drew such an illustrious crowd because control over standards meant control over electrical telegraphy networks used by the British to administer

[3] Bruce Sinclair, *Philadelphia's Philosopher Mechanics: A History of the Franklin Institute, 1824-1865* (Baltimore: Johns Hopkins University Press, 1974); Bruce Sinclair, "At the Turn of a Screw: William Sellers, the Franklin Institute, and a Standard American Thread," *Technology & Culture* Vol. 10 No. 1 (1969), 20-34.

and extend their global empire. In a very real sense, control of the world depended upon control of electrical standards.[4]

These collaborations laid the technical and organizational foundations for international standardization in the International Electrical Congresses that first met in Paris in 1881.[5] At the 1904 Congress in St. Louis, the leaders of these Congresses (including the British inventor and engineer Colonel R. E. B. Crompton, Swedish Nobel Prize winner Svante Arrhenius, Lord Kelvin, and the American entrepreneur Elihu Thomson) created the International Electrotechnical Commission (IEC) as a representative body that could bring the "cooperative spirit that animates electrical workers" into a formal and permanent organization.[6] By this point in the early twentieth century, electrical scientists understood perfectly well that standards were not exclusively technical matters, but rather technically oriented instances of diplomacy, with a heavy dose of international prestige and commercial power on the line.

Another group of powerful institutional actors—government laboratories—also became active in national and international standardization. In 1887, Germany established the first government institution dedicated to the production of standards through laboratory research.[7] The success of the German Imperial Institute soon stimulated institutional imitators abroad, including the British National Physical Laboratory (founded in 1899) and the American National Bureau of Standards ("Bureau of Standards," founded in 1901). The Bureau of Standards focused its efforts narrowly on standards for weights, measures, heat, and optics; but it soon expanded its mission to include electricity research as well as testing of materials quality, and also provided technical assistance and product evaluations for regulatory bodies.[8]

As the Bureau of Standards began to establish its role in the early twentieth century, American engineers in the private sector recognized that they needed to take positive steps in order to keep industrial standardization

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[4] Bruce J. Hunt, "The Ohm Is Where the Art Is: British Telegraph Engineers and the Development of Electrical Standards," *Osiris* 9, 2nd Series, Instruments (1994): 48-63; Larry Randles Lagerstrom, *Constructing Uniformity: The Standardization of International Electromagnetic Measures, 1860-1912* (Ph.D. Dissertation, University of California at Berkeley, 1992), 7-81; Graeme Gooday, *The Morals of Measurement: Irony, Accuracy and Trust in Late Victorian Electrical Practice* (Cambridge: Cambridge University Press, 2004).

[5] Subsequent IEC Congresses met in Paris (1889), Frankfurt (1891), Chicago (1893), Geneva (1896), Paris (1900), St. Louis (1904), and Turin (1911).

[6] William Goldsborough address to the 1904 Electrical Congress, St. Louis, quoted in Jeanne Erdman, "The Appointment of a Representative Commission," *ANSI Reporter: A Commemorative Tribute* (2004), 6.

[7] David Cahan, *An Institute for an Empire: the Physikalisch-Technische Reichsanstalt, 1871-1918* (New York: Cambridge University Press, 1989).

[8] Rexmond C. Cochrane, *Measures for Progress: A History of the National Bureau of Standards* (Washington, D.C.: U. S. Department of Commerce, 1966).

initiatives under their jurisdiction. Consequently, they began to create new institutions to establish standards, and brought with them the strategic, technical, and administrative experiences they gained from earlier standardization efforts in industry, science, and government.

Electrical Standardization: American Institute of Electrical Engineers

American engineers in the late nineteenth century created a number of national professional engineering organizations along specialized lines, including the American Society for Civil Engineers (ASCE, founded in 1852), the American Institute of Mining Engineers (AIME, founded in 1871), the American Society of Mechanical Engineers (ASME, founded in 1880), and the American Institute of Electrical Engineers (AIEE, founded in 1884). Within these societies, engineers developed a professional group identity that included commitments to social responsibility and mutual cooperation as well as the objective application of scientific knowledge to advance material and social progress. Standardization presents the clearest expression of the mix of scientific and commercial values at the heart of these professional engineering societies.[9] To illustrate the challenges facing those who wished to promulgate industry-wide standards on a voluntary basis, I will discuss only one of the many examples of early standardization initiatives that occurred within the nascent professional engineering societies. In this example—the AIEE's role in the development of standards for the electrical industry—the proponents of standardization understood that technical specifications would be most effective only through widespread (if not universal) use. To achieve such widespread adoption, engineers and corporate managers needed to be convinced that their self-interest would be served through the adoption of these standards.

The appeal of standardization for engineers and executives in the American electrical industries stemmed from its potential to advance their respective technical and commercial interests. Where engineers such as Charles Proteus Steinmetz at General Electric advocated standardization because it facilitated greater coordination and systematization, executives such as Chicago Edison boss Samuel Insull favored standardization because it helped to simplify factory operations and to reduce costs.[10] The concentrated structure of the electrical power industry also worked in favor of industry-wide standardization: although Thomas Edison and George Westinghouse had locked

[9] For examples of the messy and laborious work of industry standardization, see Bruce Sinclair, *A Centennial History of the American Society of Mechanical Engineers, 1880-1980* (Toronto: University of Toronto Press, 1980); George V. Thompson, "Intercompany Technical Standardization in the Early American Automobile Industry," *The Journal of Economic History* Vol. 14 (Winter, 1954), 1-20.

[10] A. Michal McMahon, *The Making of a Profession: A Century of Electrical Engineering in America* (New York: Institute of Electrical and Electronics Engineers, 1984), 88-98.

horns in the "battle of the systems" between direct current and alternative current, this battle was resolved by 1892 with the introduction of polyphase current systems. By the 1890s, according to historian Thomas P. Hughes, technical relationships in the industry were characterized by a "spirit of flexibility and compromise among the various utility interests, and especially among the manufacturers."[11]

This cooperative spirit, combined with the professional aspirations of university trained electrical engineers, led to the creation of a national electrical engineering association, the AIEE, in 1884. With the International Electrical Exhibition scheduled to be held in Philadelphia later that year (hosted by the Franklin Institute), American electrical engineers wanted to have a formal body in place to receive the scores of prestigious foreign electrical scientists expected to visit. Founding members of the AIEE included the telegraph engineers Norvin Green (who was the society's first president), Elisha Gray and Franklin Pope; telephone engineer-managers Alexander Graham Bell and Theodore Vail; the power engineers Edwin Houston and Edward Weston; and the lighting engineers Charles Brush and Thomas Edison. This distinguished roster of founders hints at two enduring characteristics of the AIEE in its first decades: its close contacts with the business community, and the technical sophistication and elite status of the growing American electrical profession.[12]

In his history of the AIEE, A. Michal McMahon suggested that standards work "held special meaning for the first generation of professional electrical engineers. As Steinmetz and others would argue, the standards process suggested a social standard as well as a technical one. It embodied the early electrical engineer's cherished social value: coordinated activity."[13] This coordination occurred within the AIEE as well as between the AIEE and other institutions active in electrical standardization. For example, the AIEE's first standards activity began after an approach in 1885 from two trade associations, the National Telephone Exchange Association and National Electric Light Association, which sought support for their standard wire gauge. In 1889, the AIEE formed its own Committee on Units and Standards, with Edison Electric consulting engineer (and later Harvard and MIT Professor) Arthur Kennelly as chairman.

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[11] Thomas Parke Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore: The Johns Hopkins University Press, 1983), 127. See also Paul A. David, "Heroes, Herds and Hysteresis in Technological History: Thomas Edison and 'The Battle of the Systems' Reconsidered," *Industrial and Corporate Change*, Vol. 1, No. 1 (1992), 129-180.

[12] McMahon, *The Making of a Profession*, 28-9. See also Edwin T. Layton, *The Revolt of the Engineers: Social Responsibility and the American Engineering Profession* (Cleveland: Press of Case Western Reserve University, 1971), 38, 85.

[13] McMahon, *The Making of a Profession*, 79.

The AIEE's standardization initiatives pushed it into an already crowded institutional field, where several other organizations were engaged in the cooperative and competitive social relations needed to establish uniform standards for nomenclature, designs, and components. Since leading engineers from the most powerful firms in the industry—such as Steinmetz at GE and Charles Skinner at Westinghouse—were also influential members in the AIEE standards committees, the combination of the prestige of the AIEE and market power of the large firms helped the AIEE's efforts to disseminate industry standards. In this sense, the AIEE served as venue to enhance the power and status of concentrated electrical industries, and AIEE standards helped the dominant firms maintain control and police the boundaries of the electrical industry.

By 1906, AIEE members had achieved substantial success in their various standardization projects. These were not primarily technical achievements, but rather administrative and diplomatic. The AIEE had established a dominant presence in the national engineering community, aided in the creation of the National Bureau of Standards, and emerged as a powerful presence in international electrical standardization. The AIEE's growing role in the International Electric Congresses was evident from its role in planning the 1893 Chicago Congress and the 1904 St. Louis Congress. In 1904, by virtue of their collective efforts through the AIEE, American engineers felt they had arrived as a peer with their colleagues (and rivals) from Britain, Germany, and France. The symbolic status of Americans in international electrical standardization was complete when Elihu Thomson, the American President of the 1904 St. Louis Congress, became the second President of the International Electrotechnical Commission upon the death of Lord Kelvin in 1908.[14]

The AIEE quickly became the largest technical society in the United States, with 7000 members in 1910. In his history of the Institute, McMahon also celebrated the AIEE's status as a model technical society and standard-setting body: "AIEE engineers would be able to declare on the eve of World War I that their standardization efforts provided an ideal model of the cooperative spirit in action."[15] In 1963, the AIEE merged with the Institute of Radio Engineers to form the Institute of Electrical and Electronics Engineers (IEEE), and has grown in size and influence ever since. Today the IEEE has over 365,000 members in over 150 countries, and is a world leader in publications and standard-setting for the electronics, telecommunications, and information technology industries. It is safe to conclude that this organization has been successful in its multifaceted mission that began in the late 1800s—to

[14] Lagerstrom, *Constructing Uniformity*, 131-189 and 221-242; Erdman, "The Appointment of a Representative Commission."
[15] McMahon, *The Making of a Profession*, 78-9.

provide a high-status forum for American electrical engineers, and to direct a spirit of cooperation toward commercial applications of electricity.

From Industry Standards to National Standards: the American Engineering Standards Committee

By the first decade of the twentieth century, then, we can already see a spectrum of standard-setting organizations that in many respects resembles our situation today: a decentralized and pluralistic constellation of institutions, each pursuing standardization to suit their own objectives within a dynamic and competitive international context. Standards committees (in groups such as the AIEE, ASME, and ASCE) multiplied quickly throughout the first decade of the twentieth century. By World War I, over 100 private organizations—including the engineering societies mentioned above as well as trade associations and international bodies such as the IEC—were creating and disseminating industrial standards. In several cases, however, this proliferation of standards committees ironically began to undermine their underlying purpose of providing greater cooperation and organization. This confusion was especially acute in technologies where four or five different committees issued standards, for example in electrical machinery, screw threads, and pipe threads, without any systematic or formal channels of communication or coordination.[16]

American engineers, inspired by the benefits of cooperation that they experienced during the First World War, devised an organizational solution to meet these challenges of technological coordination. In 1918, members from the four leading engineering societies—the AIEE, ASCE, ASME, and AIME—combined with the American Society for Testing Materials (founded in 1898) to create the American Engineering Standards Committee (AESC). Comfort Avery Adams, a longtime member of the AIEE Standards Committee and Harvard professor of electrical engineering, was elected as Chairman. One year later, the AESC appointed a full-time secretary, Paul Gough Agnew, who would serve in that position for nearly thirty years. Agnew's dedication and character were key factors in the survival and success of the AESC—and American and international standards more generally—from the 1920s through the 1950s.

[16] Comfort A. Adams, "Industrial Standardization," *Annals of the American Academy of Political and Social Science* Vol. 82, Industries in Readjustment (March 1919), 292-6; Sinclair, *A Centennial History of ASME,* 55.

The development of specific standards occurred within one of the AESC sectional committees that were organized along industry lines.[17] AESC committees were designed to be open to representatives from all walks of industrial life—including engineering societies, government departments, trade associations, state legislatures, insurance and safety organizations, and private companies—as a way to ensure that all opinions could be heard before a definitive national standard was published. AESC Secretary Agnew coined a political metaphor to describe this aspect of the standardization process: "Each of these sectional committees… is essentially a miniature industrial legislature organized upon a subject basis instead of upon a geographical basis."[18]

This federation of "industrial legislatures" was an organizational strategy as well as a manifestation of a democratic political philosophy. In a 1926 article printed in *The New Republic* entitled "A Step Toward Industrial Self-Government," Agnew argued that this method of standardization had "all the directness and vitality of elementary local self-government." He continued,

> We do not leave to Congress, or to the vote of 110,000,000 people, the decision whether a bridge shall be built in the city of Oshkosh. We leave it to the people of Oshkosh, who will walk over it and ride over it, and who will have to pay for it. Why should not the very limited groups directly interested in each of the innumerable industrial problems with which they are faced, themselves solve these problems through coöperative effort?[19]

The AESC put this principle of self-government to work through its sectional committees. When a sectional committee finished its work on the "Recommended Practice" or "Tentative Standard," it would submit the proposed standard to the main committee of the AESC. The main committee did not pass judgment on the technical content of the proposed standard, but instead only checked to see if the sectional committees followed a fair and representative process that addressed the concerns of all interested parties. Once the main committee concluded its

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[17] By 1922, the sectional committees were organized as follows: A. Civil Eng and Construction; B. Mechanical Engineering; C. Electrical Engineering; D. Automotive; E. Transportation; G. Ferrous Metals and Metallurgy; H. Non- Ferrous Metals and Metallurgy; K. Chemical Industry; L. Textile Industry; M. Mining; O. Wood Industry; P. Pulp and Paper Industry; X and Z. Miscellaneous (safety, symbols, general purpose combustion or testing, terminology, film).

[18] P. G. Agnew, "Work of the American Engineering Standards Committee," *Annals of the American Academy of Political and Social Science*, Vol. 137, Standards in Industry (May, 1928), 13-16.

[19] P. G. Agnew, "A Step Toward Industrial Self-Government," *The New Republic* (March 17, 1926), 95.

evaluation, the proposal required 90% of the main committee votes in its favor to be published by the AESC as an "American Standard."

The dramatic growth of the AESC membership is a telling indication of the organization's immediate success. In 1919 and 1920, the five founding societies were joined by representatives from trade associations, insurance groups, and three government departments (including the Director of the National Bureau of Standards). Due to the heightened interest in standardization by trade associations, membership grew quickly: of the 350 organizations participating in AESC activities in 1928, almost 300 were trade associations.[20] Throughout this initial decade of rapid growth, the main challenge facing the AESC was to maintain a balance of power between the AESC and its member societies. Such a balance seemed the only way to establish the AESC as an effective and legitimate organization while still preserving the power and prestige of member societies.[21]

A major effort to maintain a workable balance that could sustain a flexible and robust system for creating American industrial standards occurred in 1928, when the AESC reconstituted itself as the American Standards Association (ASA).[22] The immediate introduction of three new faster and more flexible methods in the ASA signaled an effort to meet the needs of the trade associations that represented thousands of private companies. Judging from the surge of financial support from leading industrial firms—in 1928, executives from AT&T and Bethlehem Steel led a fundraising campaign that added $250,000 to the ASA budget within ten years—this reorganization helped to consolidate the ASA's legitimacy and status in the eyes of industry.[23]

Consensus Standardization and the History of the Twentieth Century

What, then, is the historical significance of the AESC? Do their experiences with electricity and steel in the early twentieth century have anything to tell us about our adventures with electronics and silicon in the early twenty-first century? The long-term significance of the AESC lies in its institutional precedents and development of consensus processes. Through the efforts of leaders such as Comfort Adams and Paul Agnew, the AESC embodied a cooperative engineering philosophy that it maintained through a loose and flexible federation of organizations.

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[20] "Standards Group to Broaden Scope," *The New York Times*, July 8, 1928, page 40.
[21] Comfort A. Adams, "How the AESC Was Organized," *Industrial Standardization* (October, 1938), 237-8.
[22] The ASA was renamed in 1966 as the United States of America Standards Institute (USASI), and then again in 1969, when it adopted its present name, the American National Standards Institute (ANSI).
[23] See "Scientific Events: Industrial Standardization," *Science*, New Series, Vol. 70, No. 1803 (July 19, 1929), p. 60; William J. Serrill, "President's Report," 1930 Year Book, 9-10; See also "Milestones of the ASA," *Industrial Standardization*, December, 1943, page 330.

The AESC pioneered an inclusive process designed to foster a national "consensus of those substantially concerned" with the scope and provisions of a proposed standard.[24]

Thanks to the AESC's institutional experimentation and reform in the 1920s, by 1930 the American Standards Association had achieved legitimacy and stability in the eyes of the leaders of American industry and government. With the "consensus principle" as its pole star, the fundamentals of the ASA's structure and process remained intact during the subsequent eras of heavy government intervention in the American economy, including the New Deal, World War II, and the creation of the Cold War military-industrial complex. This state interventionism peaked by the late 1970s, with officials under Presidents Jimmy Carter and Ronald Reagan taking an active role in "deregulating" the American industrial economy, thus leaving the actors in the private sector to devise their own solutions to economic stagnation.

By the 1980s, a renewed focus on collaboration in the private sector—combined with a relaxed attitude on the part of American antitrust officials—led American policymakers to look anew to the sort of private collaborations that had been fostered since the 1920s by voluntary consensus standardization. As the historian David Hart has noted, a federal focus on "industrial competitiveness" in light of competitive threats from Japan and the prospect of a unified European economic bloc led the American Congress and Reagan administration to initiate a new round of associative programs (or "public-private partnerships" in the new policy jargon), most notably in the shape of Cooperative Research and Development Agreements (CRADAs), the new Advanced Technology Program within the National Bureau of Standards, and the SEMATECH consortium for semiconductor manufacturing.[25]

With this broad ideological support in the background, American advocates of voluntary consensus standardization advanced their cause with tremendous success from the late 1970s through to the present day. For example, the Office of Management and Budget has maintained rules since 1976 that call for the use of voluntary consensus standards in federal procurement; the Office of Technological Assessment in the United States Congress issued an influential 1992 report underlining the importance of standards as the "building blocks" of the global

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[24] "Procedure," *American Engineering Standards Committee Year Book, 1928* (New York: American Engineering Standards Committee, 1928), 68.
[25] David M. Hart, "Herbert Hoover's Last Laugh: The Enduring Significance of the 'Associative State' in the United States," *Journal of Policy History*, Vol. 10, No. 4 (1998).

economy; and the Congress has continually passed and revised laws that sanction and encourage the development of voluntary consensus standards without fear of antitrust prosecution.[26]

There are striking similarities between the challenges that faced proponents of industry standardization in the 1920s and those who aimed to advance the cause of consensus standardization in the late twentieth century. Both historical contexts are marked by constant jurisdictional conflicts, complex technical problems, a competitive international economy, and the continual need to negotiate boundaries between government, market activity, and private collaborations. For our present purposes, then, the lasting historical significance of the AESC and ASA came through their translation of the traditional values of engineering cooperation into effective institutions that operated under principles that require openness, balance, transparency, consensus, and due process.

In the 1920s, as in more recent times, these principles were advanced and protected by leaders and liaisons in the standards process—those who ensure the smooth operation of voluntary consensus process, and those who cross over the boundaries of different organizations. Two early protagonists in the AESC, Comfort Adams and Paul Agnew, are excellent examples of these types of individuals who were active in the 1920s. More recently, one might view the vastly experienced engineers Thomas Haug (a leader in the development of European cellular standards) and Vinton Cerf (a pioneer of Internet standards) as similar sorts of figures who are widely respected not only for their technical achievements but also for their organizational and administrative achievements. Haug, Cerf, and many others who worked alongside them in the standardization process all played key roles in the development of global industrial legislatures that maintain standards for the networks that sustain our digital world.

Conclusions

Having revisited some key aspects of the ideology and history of voluntary consensus standards in the United States, let us reconsider the decision of American regulators to leave the standardization of digital cellular networks to actors in the private sector. In order to advance the political and economic goals of European

[26] "Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities," Office of Management and Budget (OMB) Circular A-119, Revised February 10, 1998; *Global Standards: Building Blocks for the Future* (Washington, DC: United States Congress, Office of Technology Assessment, 1992); "Standards Development Organization Advancement Act of 2004," Public Law 108-237, June 22, 2004, 118 Stat. 661. For commentary on these developments, see Roger B. Marks and Robert E. Hebner, "Government/Industry Interactions in the Global Standards System," in Sherrie Bolin, ed., *The Standards Edge: Dynamic Tension* (Ann Arbor: Sheridan Books, 2004), 103-114; and Carl Cargill, "The Role of Consortia Standards in Federal Government Procurements," in Sherrie Bolin, ed., *The Standards Edge* (Ann Arbor: Sheridan Books, 2002), 389-422.

integration, European regulators mandated the use of GSM in European digital cellular networks in 1987. In the same year, the American FCC also could have chosen to mandate a single standard for American cellular networks. To understand why they declined to do so, the FCC's recent history is important. In late 1983, the Bell System was on the verge of divestiture and many Americans were concerned that their world-class telecommunications system would fall into a state of disrepair. As the FCC contemplated how to ensure the technical coordination of the national network, it decided to turn to a new industry group called the Exchange Carriers Standards Association (ECSA). The ECSA's legitimacy was in part a function of its size: firms in the ECSA served 95% of American customers. In response to an FCC proceeding on standards in the post-monopoly world, the ECSA volunteered to sponsor a committee that would follow ANSI guidelines for openness, due process, and balance of interests. With the approval of the FCC and the industry, the ECSA created committee T1 in February 1984.[27]

By 1988, this new reliance on voluntary partnerships in the private sector clearly had worked well enough for the FCC to once again turn to the industry to set standards for cellular networks. This time, skeptical of its own abilities to make the right decisions in such a fast-moving industry, the FCC turned to two trade groups—the Telecommunications Industry Alliance (TIA) and the Cellular Telecommunications Industry Alliance (CTIA)—to coordinate the development of industry standards. The CTIA had just been formed, but the TIA was a direct descendant of the venerable Radio Manufacturers Association, which was formed in 1924 and renamed the Electronic Industries Association in 1957. These organizations earned the trust of the FCC and the industry due to their longstanding service in the industry (in the case of the TIA) and their adherence to the ANSI consensus process. In contrast to the critical appraisals of this situation as an organizational failure or market free-for-all, the coordination of cellular standards in the United States occurred within mature, sophisticated, inclusive, and trusted coordination mechanisms.[28]

The cellular industry's dependence on voluntary consensus standards is one example of a new liberalized and pluralistic regime that scholars have observed in standardization for electronics, telecommunications, and information technology.[29] In addition to the institutions mentioned above, the other major players in standardization

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[27] Ian M. Lifchus, "Standards Committee T1—Telecommunications," *IEEE Communications Magazine*, Vol. 23, No. 1 (January 1985), 34-37; and Arthur K. Reilly, "Defining the U.S. Telecommunications Network of the Future," in Brian Kahin and Janet Abbate, eds., *Standards Policy for Information Infrastructure* (Cambridge: The MIT Press, 1995), 579-593.

[28] *Report and Order*, Gen. Docket 87-390, 25 FCC Rcd. 3d 7033 (1988).

[29] William J. Drake, "The Transformation of International Telecommunications Standardization: European and Global Dimensions," in Charles Steinfield, Johannes M. Bauer and Laurence Caby, eds., *Telecommunications in*

for these technologies—including the Institute of Electrical and Electronics Engineers, the Internet Engineering Task Force, and a variety of industry consortia such as the World Wide Web Consortium—also rely upon consensus-based procedures that differ little from the procedures developed decades ago in the AESC and ASA.[30]

Standards build partnerships, but we also need to pay attention to the partnerships that build standards? Taken together, the consistent emphasis on the consensus principle across each of these organizations demonstrates the enduring spirit of voluntary cooperation that has characterized the American system of standardization since the late 1800s. The United States has never established a centralized, overarching authority responsible for creating and enforcing standards. Instead, the United States has consistently followed an approach that, according to the economist Jay Tate, is "by far the most institutionally heterogeneous and fragmented of all advanced industrialized countries."[31] What may appear to the untrained eye to be chaos is in reality a dynamic and flexible system, albeit one that suffers a persistent state of controversy and conflict. These conflicts should be expected, however, in a system lacking an absolute authority and is designed to allow all interested parties to express opinions and defend their own interests. After all, the commitment to governance by consent of governed will always guarantee some degree of conflict. If this model of jurisdictional cooperation and competition continues to become the dominant mode of standardization in the twenty-first century's global economy, we would be wise to reflect on where we have been as we contemplate where to go next.

Transition: Policies, Services, and Technologies in the European Community (Thousand Oaks, CA: Sage Publications, 1994), 71-96; and Paul A. David and Mark Shurmer, "Formal Standards-Setting for Global Telecommunications and Information Services," *Telecommunications Policy*, October 1996, 789-815.

[30] Charles Vincent and Jean Camp, "Looking to the Internet for Models of Governance," *Ethics and Information Technology*, Vol. 6 (2004), 161-173; and Andrew L. Russell, "'Rough Consensus and Running Code' and the Internet-OSI Standards War," *IEEE Annals of the History of Computing*, Vol. 28, No. 3 (July-September 2006), 48-61.

[31] Jay Tate, "National Varieties of Standardization," in Peter A. Hall and David Soskice, eds., *Varieties of Capitalism: The Institutional Foundations of Competitive Advantage* (New York: Oxford University Press, 2001), 463.