CAD Standards: 200 Years in the Making

by Kim H. Young, PE

This is the first part of a two-part article covering this year's release of the U.S. National CAD Standard.

Few people know it, but Hitler came within a thousandths of an inch of winning World War II. For a brief moment, that small fraction of an inch - less than the thickness of a sheet of paper - was about all that stood between the Nazis and world domination. What almost caused that disastrous outcome was the fact that U.S. spare parts didn't fit British naval vessels. Specifically, each thread on a standard U.S. bolt differed from those in a standard British bolt hole by about one-thousandths of an inch. Enough to prevent their use. Enough to delay badly needed repairs. Enough to diminish to dangerously low levels Britain's ability to defend herself and the rest of the free world. That tiny difference was due to a lack of an international thread standard and almost cost the Allies the war. The only thing that saved the moment was the Allies' ability to cooperate at a fevered pitch. U.S. factories were quickly retooled to produce British bolts and the rest of the story you already know.

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At least, you know the rest of the war story. What you probably don't know is how the fallout from that moment affects you personally, almost every moment of every day. For example, that moment is responsible for the fact that your credit cards are each 0.76 mm thick. It is responsible for the uniform light sensitivity of the film that produces the ad images you see everywhere. It is responsible for the little fuel pump symbol on your car's dashboard that helps remind you when it's time to fill your tank. Only slightly removed from these daily realities, it also is responsible for this year's release of a U.S. National CAD Standard.

But, as dramatic and important that moment in World War II was, it was not the beginning of the process that led to the latest release of the U.S. National CAD Standard. Surprisingly, the story begins back in the late 1700's with a French professor, mathematician and sometime traveling companion of Napoleon named Gaspard Monge. Besides many other accomplishments, Monge developed a revolutionary method for documenting engineering ideas. He was the first to define and mathematically defend the use of multiple planes of projection to describe the shape of solid objects. Monge called his new method giomitrie descriptive, now known as orthographic projection or more simply, drafting. Every engineering drawing you'll ever see with a front, top and side view of a road, building, plant or ship owes its existence to Monsieur Monge.

The 1800's - standardization within nations

Published in 1799, Monge's new method first appeared in the U.S. in 1816. That year, Claude Crozet brought a copy of Monge's book to the US Military Academy at West Point where he worked as a professor. Five years later, in 1821, Crozet published the first English-language book on drafting. Soon, drafting was part of the engineering curricula of Harvard, Yale and other major universities.

At this point in the story, it is important to recall that the world was a different place in the 1820s. Much of what we take for granted didn't exist then. Most notably, everything was custom made by hand. Everything: clothes, buttons, wagon wheels, pens, boxes, pans, guns and bolts. It was these last two items, guns and bolts, that led to the next important steps in the development of a U.S. national CAD standard.

First: guns. In the U.S., the War of 1812 had recently ended. It had ranged from the capture of Fort Mackinac in Michigan to the Battle of New Orleans in Louisiana. This was the period when the U.S. military realized it needed to improve the design of its weapons. Specifically, it needed guns that could be repaired wherever they broke, without the delay of sending them back to whatever manufacturer had custom built them. This need is what ultimately drove the U.S. military to develop guns with interchangeable parts. One reason the military succeeded was it had a language to describe how each part of a gun was built. It was a language that could communicate complex engineering ideas through simple geometry, dimensions and notes. That language, of course, was drafting. With a universal, portable, durable set of plans, any blacksmith in the country could repair any gun in the U.S. arsenal.

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Second: bolts. The lack of interchangeable parts was not just an annoyance in the U.S. It was just as limiting in Britain where, in 1841, Sir Joseph Whitworth finally succeeded in getting his country to adopt a standard screw thread. The Whitworth thread was a significant milestone and yielded many benefits for the kingdom. Twenty three years later in 1864, the U.S. also adopted a standard screw thread, although not the Whitworth thread. Instead, the U.S. chose the slightly different design from Mr. William Sellers of Philadelphia, known as the Seller's thread. This lack of standardization would almost lose a war for both countries some eighty years later.

Three factors contributed to the process of interchangeable parts becoming a reality, within nations, if not between them. Those factors were:

1. the interest and influence of the military
2. the development of standardized fasteners
3. the spread of drafting and its ability to document, store and transmit engineering designs

In 1876, the first blueprint machine was exhibited at the World's Fair in Philadelphia. This technology made it easy and cheap to distribute engineering plans to multiple manufacturers. This development, along with improvements in banking, finance, transportation, engines and manufacturing, accelerated the growth and spread of the Industrial Revolution that occurred in the late 1800s.

The 1900's - standardization between nations

After the turn of the century, people began to work to set international standards. In 1906, the first such organization was formed. This body was named the International Electrotechnical Commission (IEC). The IEC was formed to prepare and publish "international standards for all electrical, electronic and related technologies." Today, almost 100 years later, the IEC is a successful, active and influential part of the international standards movement.

Founded in 1918, the American National Standards Institute (ANSI) was formed by the combination of five engineering societies and three government agencies. "Throughout its history, the ANSI Federation has maintained as its primary goal the enhancement of global competitiveness of U.S. business and the American quality of life." ANSI does this by encouraging the development, use and integrity of standards set by a consensus of industry experts. Today, ANSI administers over 14,500 American National Standards. From its beginnings as a national standards-setting organization, ANSI now serves as the voice of the U.S. in international organizations dedicated to the development of worldwide standards.

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A strange and sad chapter in the standard setting story began in 1926 when the International Federation of the National Standardizing Associations (ISA) was formed. (This is not the same ISA organization as today's Instrumentation, Systems and Automation Society.) Although the IEC still held the record as the oldest international standard-setting organization, its focus on "electrical, electronic and related technologies" left a lot of fields untouched. The ISA represented the best opportunity to address that deficiency on a global scale. Unfortunately, even though its name promised a wider scope of interest, the ISA addressed little beyond local European issues, and that chiefly in the field of mechanical engineering. Although it had its accomplishments, World War II prevented the ISA from convening its 1942 meetings and, according to its own constitutional rules, the ISA ceased to exist. Still, this would not be the last the world would hear from the ISA.

This was the period in World War II when Britain's need for spare parts was almost as great as the U.S. reluctance to enter the "War in Europe." President Roosevelt provided those spare parts, in an attempt to appease depression-era isolationists while fulfilling some of the obligation he felt to assist Britain in its war efforts. Roosevelt felt, rightly, that Churchill was fighting for the safety of the U.S., too.

There were a great many problems with the initial shipments of those spare parts. Many simply did not fit British ships, planes and trucks. The problems were quickly identified and solved and soon U.S. factories were producing British parts to British specifications.

Britain could scarcely afford any additional delay in repairing its fleets. Although the difference between the Whitworth and Seller's threads had always been an annoyance in peacetime, this episode brought the need for international standards into sharp focus for both the U.S. and Britain.

In 1944, the United Nations Standards Coordinating Committee (UNSCC) was established by the U.S. ("America"), Britain and Canada, the so-called ABC countries. One of the first accomplishments of this new body was to define a single screw thread standard for the member countries.

Although the UNSCC was truly international in scope and highly motivated to resolve life-threatening issues, it delineated a sharp rift between standard-setting organizations. Apparently, the world was going to have two types of "worldwide" organizations, one devoted to imperial units of measure and the other devoted to metric units. This rift is still visible today. Fortunately, the "B" and "C" countries have successfully completed their conversion to the metric system.

The UNSCC was a short-lived, if powerful, organization. Having addressed its key needs, the UNSCC initiated a movement to create a single, worldwide body to handle all non-EIC standards, whether measured in imperial or metric units. Essentially, the UNSCC volunteered to help form its replacement.

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In October 1946, many countries sent delegates to a meeting in London to lay the groundwork of such an organization. Axis countries were not allowed to attend. In an apparent attempt to appease everyone and be as inclusive as possible, the organizers convinced the final officers of the defunct ISA that they could indeed participate in the meeting. The hope was that the UNSCC (representing powerful, imperial-unit ABC countries) and the ISA (representing powerful, metric-based countries) would join together into a single, large organization. The effect on other countries would likely be something reminiscent of the Pied Piper of Hamelin, with the rest of the world's countries joining together in harmony.

Unfortunately, someone forgot to make sure the ISA knew its part in the fable. On the first day of the London meeting, October 14, the former Secretary-General of the ISA attempted a power play to have the ISA exist as an independent body with him as its head. The other delegates declared the ISA to be defunct and promptly liquidated the organization. So, before noon of the first day, the recently-resurrected ISA was declared legally dead. The remainder of the meeting proceeded according to plan and without incident. The London meeting ended October 26 after successfully forming the ISO.

The International Organization for Standardization (ISO) officially began some four months later in February, 1947. According to the ISO, its mission is considerably broader than its sibling, the IEC. The ISO mission "is to promote the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological and economic activity." With 140 member nations, the ISO truly is "a worldwide federation of national standards bodies, one from each country." The ISO maintains over 13,000 standards, including the ISO 9000 family of standards.

Significantly, of those 13,000 standards, only ten are listed under the heading of "ISO's Achievements." One of the achievements mentioned, due to its "clear benefits to industry, trade and consumers," is this:

"The diversity of screw threads for identical applications [once represented] an important technical obstacle to trade. It caused maintenance problems, and lost or damaged nuts or bolts could not easily be replaced. A global solution is supplied in the ISO standards for ISO metric screw threads."

2000's - standardization comes to CAD

The last two centuries have seen a wealth of change. Monge formalized drafting and gave us the written language of ideas. Drafting fostered the development of interchangeable parts which, in turn, led to the rise of mass production. World wars, the need for self-preservation and simple economics fostered the development of international standards.

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Today, the world has come to another important moment in this flow of history. Since the 1960s, the essence of drafting has mutated, growing into the broader, more potent language of CAD. After 40 years of mutation, the time has come to tame this new beast. Just as the standardized language of drafting stimulated massive social, political and economic changes, so too does CAD hold great potential. The key to unlocking this potential is standardization. But now, instead of striving for interchangeable parts, the world is seeking after interchangeable data. The release earlier this year of the U.S. National CAD Standard is a major milestone in the process of achieving that goal.

Next month, the second part of this article covers the powerful forces behind the U.S. National CAD Standard and the revolutionary changes to come

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Links

U.S. National CAD Standard
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