

## AMERICA MAKES & ANSI ADDITIVE MANUFACTURING STANDARDS COLLABORATIVE (AMSC)

### ORGANIZATIONAL SPECIFICS

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Standards Organizations:	Various
Technical Committees:	n/a
Other Partnering Organizations:	ANSI, America Makes, National Center for Defense Manufacturing and Machining (NCDMM)
Government Organizations:	Various
Industry Sector(s) / Technology:	Additive Manufacturing
Program / Activity Website URL(s):	<a href="https://www.ansi.org/standards-coordination/collaboratives-activities/additive-manufacturing-collaborative">https://www.ansi.org/standards-coordination/collaboratives-activities/additive-manufacturing-collaborative</a>

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### STANDARDS DRIVEN PUBLIC-PRIVATE PARTNERSHIP (PPP) OBJECTIVES

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#### PPP Drivers:

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Formally launched in March 2016, the [America Makes & ANSI Additive Manufacturing Standardization Collaborative \(AMSC\)](#) was formed because several standards-developing organizations (SDOs) were engaged in standards-setting for various aspects of additive manufacturing (AM), prompting the need for coordination to maintain a consistent, harmonized, and non-contradictory set of AM standards.

Work of the AMSC resulted in three standards roadmaps, several gaps progress reports, and technical events. Gaps progress reports are typically issued twice per year after the publication of a full roadmap. The 2023 roadmap (v3) was initiated following a 2022 survey about the use of the roadmap. The AMSC advisory group – comprised of industry, government, and standards developing organization (SDO) representatives – concluded that it was time to update the document to ensure it remains relevant and aligns with current practices and stakeholder needs.

[America Makes](#), ANSI's partner in AMSC, was founded in 2012 as the Department of Defense's national manufacturing innovation institute for AM and the first of the [Manufacturing USA network](#). America Makes is based in Youngstown, Ohio, and managed by the not-for-profit [National Center for Defense Manufacturing and Machining \(NCDMM\)](#). America Makes was and continues to be ANSI's funding partner for AMSC efforts.

#### PPP Goals:

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AMSC is a cross-sector coordinating body whose objective is to accelerate the development of industry-wide AM standards and specifications consistent with stakeholder needs and thereby facilitate the growth of the AM industry.

The roadmap revision process will consider the previously identified gaps and priorities, including progress by SDOs and others to address the recommendations. It will also identify potentially overlooked issues. A new working group will be established to address data throughout the AM lifecycle. Gaps will be considered as they relate to different industry sectors, material types, process categories, and qualification and certification.

#### Public Sector Role & Participation:

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For roadmap version 3.0, approximately 300 individuals from 150 public- and private-sector organizations supported the roadmap's development, including representatives of U.S. federal government agencies and national laboratories, SDOs, industry, academia, and others.

From its formation onward, all AMSC members offered their technical knowledge about issues, existing standardization activities, regulatory and policy activities, qualification and certification activities, and research and development (R&D)

needs. There was no distinction between the roles of the public and private sector. Some representatives engaged in AMSC as a member and others served in leadership roles. However, outreach efforts always targeted and advocated for both private and public sector engagement.

**Implementation Methods:**

To develop the roadmap, the AMSC held workshops and ultimately established a working group (WG) structure which typically held online meetings twice a month. The roadmaps evolved to expand the scope based on the needs and applicability that AM had at any given point (from roadmap v1 to v3). During the first few years of AMSC, more face-to-face events (with hybrid capabilities) were facilitated. These events served more as plenary meetings. WG meetings took place more often and as web-based meetings.

To maximize the effectiveness and relevance of the AMSC work, an Advisory Group (AG) was established. The AG membership included the WG chairs as well as standards organizations, government, consortia, and others to give a balance of presentation. The AG offered guidance and strategic direction as well as leveraged their networks to ensure the technical expertise in the WG was sufficient to ensure technical and market relevance.

To develop the third version of the roadmap, AMSC utilized online meetings only. AMSC members were divided into nine WGs, which also resulted in nine chapters of technical content. The WGs included:

- WG1 design
- WG2 pre-cursor materials
- WG3 process control
- WG4 post-processing
- WG5 finished material properties
- WG6 qualification and certification
- WG7 nondestructive evaluation
- WG8 maintenance and repair
- WG9 data

Some WGs were chaired by industry and others by the government. WG meetings only take place when the roadmaps are in development, but the AG meetings are held at least twice a year or more as needed.

**Measurement of Success:**

Roadmap efforts (and their resulting publications) help increase awareness about existing standard efforts and future standards needs. A deep quantitative analysis of the various standards over several years is challenging as work is constantly evolving. ANSI analyzed the numbers of standards identified, general and specific AM, from roadmap versions 1 through 3, which shows that the knowledge of standards activities, and the activities themselves have significantly increased (see table below). Additionally, feedback from the survey and outreach to industry stakeholders has shown that the roadmaps are leveraged to determine where to invest resources for standards at a company and committee planning level.

Roadmap	All Identified Supporting Standards & Guidance			AM Specific Identified Supporting Standards & Guidance		
	Published Standards	Draft Standards	Total	Published Standards	Draft Standards	Total
Roadmap v1.0 (2017)	242	39	281	24	25	49
Roadmap v2.0 (2018)	456	80	536	47	61	108
Roadmap v3.0 (2023)	513	155	668	144	126	270

On July 17, 2023, America Makes and ANSI announced the publication of the [Standardization Roadmap for Additive Manufacturing, Version 3.0](#), developed by the AMSC. The roadmap describes the current and desired future standardization landscape for AM and focuses on industrial market sectors using AM technologies. A total of 141 standardization gaps (including 60 new gaps) are identified with corresponding recommendations across the AM lifecycle areas of design; precursor materials; process control; post-processing; finished material properties; qualification and certification; nondestructive evaluation; maintenance and repair; and data. The hope is that the roadmap will be broadly adopted by the user community to facilitate a more coordinated approach to the future development of AM standards.

In June 2018, the [Standardization Roadmap for Additive Manufacturing \(Version 2.0\)](#) was published. Some 320 individuals from 175 public- and private-sector organizations supported the document's development. The document considers the life cycle of an AM part, from initial design to materials and process selection, production, post-processing, finished material properties, testing, qualification, and maintenance. It describes the AM standardization landscape and identifies 93 "gaps" – 18 are high priority, with several of the new gaps involving polymers. In 65 of the 93 gaps, additional pre-standardization R&D needs are identified.

In February 2017, after a year of work, the [Standardization Roadmap for Additive Manufacturing \(Version 1.0\)](#) was published. Federal agencies, including the National Institute of Standards and Technology (NIST), Department of Defense (DoD), Federal Aviation Administration (FAA), and others, as well as several SDOs, were instrumental in the formation of this collaboration. More than 260 individuals from over 150 public- and private-sector organizations actively supported the document's development with substantial representation from the aerospace, defense, and medical industries. The roadmap provides a snapshot of the current AM standards landscape and identifies 89 "gaps" – 19 are high priority. In 58 of those cases, additional R&D needs are identified. Topical areas include standards for design, process, and materials (subdivided into precursor materials, process control, post-processing, and finished material properties), qualification and certification, nondestructive evaluation, and maintenance.

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### Key Takeaways:

1. A clear scope of what technical areas should be addressed as a whole, as well as the WG level is important to not overwhelm or slow efforts.
2. A balanced representation of expertise in each of the technical working groups is necessary to ensure market relevance and unbiased recommendations.
3. Allowing for public review of drafts before publications helps ensure broader input from directly and indirectly impacted stakeholders.

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### Advice for Others:

Standards roadmap development requires a significant investment of resources – both expertise and time – of stakeholders. It is important to have alignment on the scope and timeline. As standards are always evolving, theoretically a roadmap is out of date at time of publication or best described as a living document. Participants should focus on the priorities and high-level descriptions and not solve the issues. Development of the standards will take place as a result, and separate initiative, from the roadmap development. Updates on standards work can be provided post roadmap and future versions can be developed to maintain visibility of current work and needs over time.

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