

EXO TECHNOLOGY CENTER OF EXCELLENCE (ET COE)

ORGANIZATIONAL SPECIFICS

Standards Organizations:	ASTM International
Technical Committees:	F48 on Exoskeletons and Exosuits
Other Partnering Organizations:	Exoskeleton Report, New Stone Soup, Prime Performance, HFES, NSC, SCRA, Smart HLPR, AExG, LiUNA
Government Organizations:	NIST, NIOSH, US Army DEVCOM SC
Industry Sector(s) / Technology:	Exo Technology
Program / Activity Website URL(s):	https://www.etcoe.org/

STANDARDS DRIVEN PUBLIC-PRIVATE PARTNERSHIP (PPP) OBJECTIVES

PPP Drivers:

Established in 2019, the ASTM International [Exo Technology Center of Excellence](#) (ET CoE) is a collaboration between ASTM (and its more than 30,000 members) and consumers, industry, government, healthcare, and academia. The ET CoE seeks to improve the quality of life and participation of the general public through accelerating exo technology research, standards, testing, and training.

PPP Goals:

The ET CoE behaves as an exoskeleton for the global exo community. It augments, enables, assists, and enhances the exo community through initiatives that include:

- identifying high priority needs and sponsoring research & development (R&D) through groundbreaking Research to Standards (R2S) framework;
- providing unbiased high value advice and counsel on exo technologies, including existing standards and those under development around the globe;
- developing and delivering education, training, and workforce development products;
- collaborating and partnering with other organizations passionate about exo technologies;
- testing and evaluating exemplar products, processes, and laboratories to establish a trusted network of testing and certification organizations;
- connecting people and organizations to promote innovation and collaboration;
- providing a neutral venue for stakeholder groups to discuss common challenges;
- curating and sharing knowledge;
- promoting exo technology through various outreach mechanisms

Ultimately, the ET CoE's mission is to accelerate exo technology research, standards, testing, and training.

Public Sector Role & Participation:

The ET CoE initiatives are supported through partnerships. In addition to ASTM, the founding partners are [Exoskeleton Report \(ExR\) LLC](#), [New Stone Soup \(NSS\) VT LLC](#), and [Prime Performance](#). The partners were chosen, in part, because of the diverse expertise they brought to the COE's initiatives. Creating and sustaining a partnership that will ebb and flow as the ET space does is of paramount importance. The CoE also has collaborative, research, and education and workforce development partners as follows:

- **Collaborative Partners** bring their networks and expertise to increase awareness and education about the CoE activities and exo technologies. The [Human Factors and Ergonomics Society](#) (HFES), [National Safety Council](#) (NSC), and [South Carolina Research Authority](#) (SCRA) are collaborative partners.

- **Research Partners** bring their experience and resources to assist with CoE research initiatives. The [U.S. National Institute of Occupational Safety and Health](#) (NIOSH), [National Institute of Standards and Technology](#) (NIST), and [Smart HLPR](#) are research partners.
- **Education and Workforce Development Partners** support education and workforce initiatives for exo technologies the [Automotive Exoskeleton Group](#) (AExG), [Boston Engineering Corporation](#), [LiUNA TriFund](#), and [U.S. Army Combat Capabilities Development Command, Soldier Center](#) (DEVCOM SC) have partnered with the CoE.
- **Research-to-Standards (R2S) Team** is based on the idea that standards should be constructed and integrated with high-quality, objective research. The ET CoE plans to identify, evaluate, and prioritize key topics to form the foundation of a R2S roadmap with input from government agencies, regulators, and subcommittee chairs in ASTM committee F48. The roadmap will help facilitate the development of standards to benefit the global exo community.

ASTM International Committee F48 Exoskeletons and Exosuits: Acting as a separate entity from the ET CoE, this committee supports the standards development activities for this technology. Both public and private stakeholders participate in the [F48 Exoskeletons and Exosuits](#) technical committee, subcommittees, and working groups, serving in diverse roles (including sponsorship, contractual agreements, strategy development, research, technical or content contributions, leadership, voting/abstaining, and monitoring/active participation). Global authorities and industry continue to directly participate in ASTM F48 to maintain and develop new standards.

Implementation Methods:

The ET CoE has an [Advisory Board](#) which is chartered to provide vision and direction of the CoE to ensure that it remains current with the existing and future drivers of the exo technology industry. Its members include industry, government and academia. The CoE supports research and standards related activities through their partners and organizes design challenges through their [Exo Games](#). The [Management Team](#) coordinates the day-to-day management of each function of the ET CoE and ensures activity alignment with ET CoE objectives.

CoE [projects](#) are led by partners and several of the projects have resulted in standards development. The standards development is conducted through ASTM F48. ASTM technical (main) committees are divided into subcommittees which manage portfolios of standards on focused technical areas. Subcommittees form task groups (TGs) which work on individual drafts of standards. ASTM F48 on Exoskeletons and Exosuits is divided into [nine technical subcommittees](#) (seven technical and two administrative), each with an executive subcommittee which sets its strategic and technical direction.

Section **F48.90.01 on Research & Development** resides under the F48.90 Executive Subcommittee and serves exclusively as an information conduit between the ASTM ET CoE and ASTM Committee F48. It does not develop standards. Its primary function is to provide feedback on:

- standardization needs (either new standards, supporting work items under development, or updating existing standards);
- recurring R&D SOWs/proposals (focusing on specifically enumerated standards deliverables) under consideration by the ET CoE, including recommendation of an F48 subcommittee of jurisdiction;
- the possibility of any corollary program deliverables (training, PTP, certification, etc.);
- any additional technical information they deem relevant to the proposals under consideration.

F48.90.01 meets at least twice a year and face-to-face during biannual F48 meetings and as often as needed via teleconference and is closed to non-members. F48.90.01 is typically chaired by an executive member of Committee F48. Proposals for F48.90.01 leadership may be submitted to ASTM staff and shall be considered by the ET CoE's Advisory Board and the ET CoE's Management Team.

Exo Games: The Exo Games is sponsored by the ET CoE and aims to enhance student involvement and education in the dynamic field of exo technologies, with a special focus on first responder applications. The Exo Games provides a unique

platform for university teams of students from various institutions to connect with exo industry professionals. This competition is designed to foster lifelong working relationships with the standards community, offering participants hands-on experience with the latest exo standards.

Working collaboratively, student teams embark on the challenge of designing, building, and testing a self-contained exoskeleton based on a provided project specification. Their design solutions will be rigorously evaluated against the predefined standards established by ASTM's exoskeletons and exosuits committee ([F48](#)). The competition not only promotes innovation but also mirrors the actions of first responders, making it a truly impactful experience.

NIST is partnering with the ET CoE to support the Exo Games through a CRADA agreement and develops the underpinning metrology for exoskeletons and promotes student STEM involvement.

Measurement of Success:

The ET CoE initiative is still in its early years. However, efforts have already started to produce standards and the Exo Games have helped expose emerging professionals to standards. One success story is related to the CoE project "Rapid Development of Exoskeleton Test Method Standards." The following list of standards topics (identified in the F48.03 on *Task Performance and Environmental Considerations Roadmap of Standards to Develop*) have been supported by the CoE, four of which are approved and two others which are in development. When ready, completed drafts will go to ASTM ready for evaluation and testing.

- Approved - [F3528 Test method for exoskeleton use: gait](#)
- Approved - [F3581 Test method for exoskeleton use: hurdles](#)
- Approved - [F3582 Test method for exoskeleton use: gaps](#)
- Approved - [F3584 Test method for exoskeleton use: obstacle avoidance: Walking](#)
- [WK76431 - Test method for exoskeleton use: stairs](#)
- [WK83509 - Test method for exoskeleton use: crawling](#)

Key Takeaways:

1. ASTM International was able to respond to industry needs very quickly. Bringing the relevant stakeholder population into the discussions during early stages of project development helps drive a rapid response and prepare stakeholders to maximize their productivity.
2. The implementation phase of activities is just as important as the development phases. To ensure this, especially with a collection of stakeholders relatively new to the development process, education and training (both early and ongoing) is critical.
3. Going to where the stakeholders are greatly improves the chances of their participation. For international acceptance, meetings (of both the COE & standards development arm via F48) should be held in a variety of locations. Additionally, co-locating meetings with industry events where members already plan to attend can help increase participation (especially for task group meetings).

Advice for Others:

In this PPP, there was a significant reliance on active participation from industry, government, academia, and trade associations/professional societies. While some participants have restrictions on the level of interaction they are permitted to undertake, this is often mitigated via proactive hosting of training/educational programs. The success of any standards activity is predicated upon the buy-in from & contributions by stakeholders – while funding can be a motivator, it is not a guarantee of success.

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