Virtual ACS 2021 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

Research In-Progress

Abstract Category: Research In-Progress

Universal Segment Connector for the Advanced Modular Manikin

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Introduction: Simulation has gained wide acceptance within the health care education community to supplement and in certain cases replace the traditional training methods on patients. The DoD has funded a series of landmark programs to create Open Source health care simulation tools, such as a physiology engine, BioGears and the Advanced Modular Manikin (AMM). The AMM solicitation stipulated a modular, distributed, interoperable platform that could be expanded from the very simple trainers for first responders to very complex trainers for surgical sub-specialties. To accomplish this, we established open standards for interoperability. A critical component of the open standards is a Universal Segment Connector (USC) that must be used between the segments for them to connect and work as an integrated system

Methods: The development team carefully reviewed competing requirements for the segment connectors. The competing requirements were discussed and evaluated by clinicians, design engineers, manufacturing engineers and simulation technicians to reach consensus on design specifications. The development team considered over twenty alternatives during both phases of the program, tested the most promising ones for performance.

Preliminary Results: The design requirements considered many competing items, such as strength, weight, cost. These were weighed against operational requirements of power, data and fluidics throughput. The design iterations were focused on the balance between performance and cost, engineering creativity allowed us to reduce cost by an order of magnitude without sacrificing performance. The following table documents the test results from the project.

Next Steps: The final design was provided to two vendors for low volume production and provides the physical connection, power and data, as well as compressed air and multiple fluid lines at each segment interface. The Universal Segment Connector for the AMM platform is now available to developers through the AMM web site. It is now ready for potential developers to adopt.

Test Performed	Sub-Test	Connector	Test Spec.	Pass/Fail
Axial Load	Mechanical	Entropic	300 lbs.	Pass
		2nd Party	300 lbs.	Pass
		Hybrid	300 lbs.	Pass
	Electrical	Entropic	200 lbs.	Pass
		2nd Party	200 lbs.	Pass
		Hybrid	200 lbs.	Pass
	Fluid	Entropic	200 lbs.	Pass
		2nd Party	200 lbs.	Pass
		Hybrid	200 lbs.	Pass
Bending	Mechanical	Entropic	100 ft-lbs.	Pass
		2nd Party	100 ft-lbs.	Pass
		Hybrid	100 ft-lbs.	Pass
	Electrical	Entropic	100 ft-lbs.	Pass
		2nd Party	100 ft-lbs.	Pass
		Hybrid	100 ft-lbs.	Pass
	Fluid	Entropic	100 ft-lbs.	Pass
		2nd Party	100 ft-lbs.	Pass
		Hybrid	100 ft-lbs.	Pass
Vibration	Mechanical	Entropic	10 Hz - 1.5 kHz	Pass
		2nd Party	10 Hz - 1.5 kHz	**Fail***
		Hybrid	10 Hz - 1.5 kHz	Pass
	Electrical	Entropic	10 Hz - 1.5 kHz	Pass
		2nd Party	10 Hz - 1.5 kHz	Pass
		Hybrid	10 Hz - 1.5 kHz	Pass
	Fluid	Entropic	10 Hz - 1.5 kHz	Pass
		2nd Party	10 Hz - 1.5 kHz	Pass
		Hybrid	10 Hz - 1.5 kHz	Pass

*This was considered a **failed** test because, during the vertical orientation test, one of the internal screws became unscrewed and fell out of the back of the connector (see figure). The proposed steps necessary to prevent this mode of failure in future connectors is to ensure that Loctite is used when mounting all screws in the connector.