

Topic: N182-124

## Propel LLC

### Seamless Knitting for Military Protective Clothing

Seamless or 3D knitting is an additive manufacturing capability has the potential to transform the supply chain for textile products. 3D knitting is to textile products what 3D Printing is to plastic or metal products: instead of executing a coded design using plastic or metal filament, the textile product is made directly from yarns. 3D knitting can improve fit, permit cost efficient gender specific product, enhance comfort, reduce bulk, increase protection, and reduce waste and inventory while saving time with a fast to market supply chain. Propel, a textile technology innovator, is using 3D knitting to rapid prototype new Navy knitwear items. The initial platform is a series of improved Flight Deck Jerseys. With additional SBIR COVID 19 response funding, Propel is also rapid prototyping and field testing 3D knit cloth face covers with enhanced performance as well as a 3D knit/3D Print hybrid N95 mask.

### Technology Category Alignment:

Materials & Manufacturing Processes

None

None

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**SYSCOM:** NAVSUP

**Contract:** N68335-20-C-0279

 Corporate Brochure: [https://navystp.com/vtm/open\\_file?type=brochure&id=N68335-20-C-0279](https://navystp.com/vtm/open_file?type=brochure&id=N68335-20-C-0279)

# Department of the Navy SBIR/STTR Transition Program

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Seamless Knitting for Military Protective Clothing

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## WHO

**SYSCOM:** NAVSUP

**Sponsoring Program:** Navy Clothing and Textile Research Facility (NCTRF)

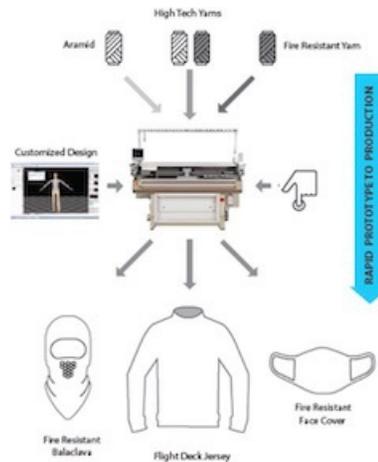
**Transition Target:** PMA 202. NAVAIR Flight Deck Jersey (FDJ)

**TPOC:**  
(508)206-2740

**Other transition opportunities:**

Warfighter clothing including physical fitness uniforms, base layers worn under utility and dress uniforms, environment-specific undergarments, balaclavas, combat shirts. Commercial market protective knitwear applications such as first responder base layers and cloth face covers. Seamless 3D additive design and manufacturing of non-clothing textile components and products: any 3D shape can be knit.

**Notes:** The Seamless 3D knit process schematic shows how a concept solution is coded and knit directly from technical yarns in days or weeks versus the months of the incumbent clothing prototyping processes - saving time and money. Multiple iterations of a prototype knit product can be quickly produced for lab and field test evaluation. Once the prototype is finalized, transition to full rate manufacture is immediate. In less than 4 months from the kickoff of Phase II, Propel designed and delivered 100 field test seamless knit cloth face covers for field testing in. Propel is already engaged with a commercial DoD supplier to 3D prototype unique solutions for environment-specific base layers.



Courtesy of Propel LLC, 2020

## WHAT

**Operational Need and Improvement:** The US Navy is highly interested in introducing advances in manufacturing in order to improve the comfort and technical performance of Sailor clothing. The application of Seamless 3D knitting to Navy knitwear can improve durability, reduce bulk, reduce seams and chaffing and permit for gender specific customization. Development cycle times will be much shorter and the supply chain more efficient and less costly

**Specifications Required:** Seamless 3D knitting permits the design and manufacture of more comfortable knitwear for the Sailor by improving fit, increasing air permeability, wicking moisture away, reducing seams and thereby chaffing, reducing bulk and increasing protection such as flame resistance (FR) and No Melt/No Drip. Seamless 3D knitting allows for rapid prototyping to solve existing and emerging problems at speed. Reduction in waste and supply chain cost is achieved through materials savings with waste as low as 0% as opposed to up to 30% for current "cut and sew" manufacturing methods, shorter production cycles and lower inventory requirements.

**Technology Developed:** Seamless "3D" knitting is to textiles what 3D Printing is to plastic or metal parts or products, but instead of coding a design and executing using plastic or metal filament, the coded design is made directly from yarns. This new additive capability has the potential to transform the entire supply chain for Navy knitwear but is currently little used in the USA. Propel is using 3D knitting to code and rapid prototype new Navy knitwear items. The initial platform is a series of improved Flight Deck Jerseys. In addition, with added SBIR funding for response to COVID 19, Propel is developing 3D knit cloth face covers and a 3D knit/3D Print hybrid N95 mask, demonstrating the use of 3D knitting to respond with new innovations at light speed.

**Warfighter Value:** Seamless 3D knitwear clothing will fit the Warfighter better, be more comfortable to wear and provide better protection. Multiple yarn technologies can be integrated into a seamless garment allowing for targeted performance that cannot be achieved with traditional "cut and sew" clothing assembly. The technology permits efficient manufacture of a greater range of sizes, allowing for gender specific clothing without increasing cost. Shorter lead times and mass customization will mean that the right organizational gear is always available when needed.

## WHEN

**Contract Number:** N68335-20-C-0279 **Ending on:** March 31, 2023

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Design and Prototyping of Seamless FDJs in 4 Styles and 2 colors	Low	Meets or exceeds performance of incumbent FDJ	4	January 2021
Laboratory Testing of Prototype Seamless FDJs	Med	Meets or exceeds performance of incumbent FDJ	4	April 2021
Production of Limited User Evaluation Field Test Seamless FDJs	Med	Matches quality of prototype FDJ	5	June 2021
Manufacturing Feasibility Assessment (MFA) comparing Seamless to "Cut and Sew" Manufacture for Navy Knitwear	Low	Used by Navy to plan for future Seamless projects	8	March 2022
Completed Field Trial for Seamless FDJs	Med	Field Test Data supports use of Seamless Knitting	7	January 2022
Low Rate (LR) Initial Production of Seamless FDJs	Med	Successful transition to LR production	8	March 2023

## HOW

**Projected Business Model:** Propel expects to sell Seamless FDJs developed under the SBIR Phase II to the Navy. Propel will subcontract to well-qualified US manufacturers for the production of the FDJ at scale. Propel, as the Prime Contractor, will be responsible for testing and quality control in order to ensure that the product meets the NAVAIR requirements for the FDJ. Propel also expects to develop and sell additional knitwear clothing items and other textile products, including subcomponents for the Navy and other services. Propel sees opportunities for reducing bulk in base layers worn under dive suits, chemical biological uniforms and body armor, as well as for balaclavas and other close fitting protective garments. For both the defense and commercial markets, Propel will offer services for the design and development of defense-related prototypes and will license the technical data packages for third-party manufacturing.

**Company Objectives:** Propel's objective is to connect with Navy and other DoD programs in order to explain the technical value of using Seamless 3D knitting to the Navy and other services, so that its advantages can be well understood and can be applied to a wide range of textile products. Propel plans to expand its Seamless knitting capabilities in order to serve as a highly qualified resource for rapid design, coding, prototyping and deliver of re-engineered, improved and new clothing and textile items. We expect DoD applications to extend beyond clothing into new areas where a 3D knit structure can solve problems previously only approached with non-textile materials.

**Potential Commercial Applications:** The commercial opportunities for Seamless 3D knitting technology extend from protective technical clothing to 3D knit structures for integration into composite structures. If a shape can be drawn it is possible to knit it, and this extends the use of yarns and textiles into a huge range of product and component applications. Beyond the textile shapes that can be made, yarns with different technical properties can be strategically placed in a garment or textile item for specific performance enhancement - such as moisture wicking, fire resistance, enhanced abrasion resistance or more. The possible applications for Seamless 3D knitting are only limited by the imagination.

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