

EDF-2022-DA-MATCOMP-SMT: Smart and multifunctional textiles

Budget

The Union is considering a contribution of up to EUR 20 000 000 for this topic under the call EDF-2022-DA

Number of actions to be funded: Several actions, addressing different solutions, may be funded for this topic

Objectives

General objective

Soldier equipment needs to allow for activities that are often physically demanding, while bringing protection, situational awareness and preserving capacity to act, endurance, and mobility. The garment is an integral part of that equipment and must meet this challenge. Smart and multifunctional textiles are a new generation of materials and systems with multifunctional properties which, given their ability of being integrated into uniforms, have drawn the attention of the defence community. Smart textiles are defined as textiles able to interact with their surroundings: they respond and adapt to a given stimulus. Functional textiles provide an additional and specific function through their composition, their

construction and/or their finish. Typically, these functions encompass enhanced mechanical resistance, water and/or dirt repellence, fire retardancy, antibacterial properties, protection against ultraviolet radiation, pest or chemicals, thermal isolation, etc.

Smart and multi-functional textiles pave the way to multiple possibilities for developing high-tech garments responding to multiple needs in an elegant solution. These materials enable to integrate different components and devices, in a comfortable and ergonomic way, providing a wide range of functionalities that can improve the safety, performance and wellbeing of the soldiers. Moreover, those textiles also offer new integration opportunities with platforms and systems.

Specific objective

An example for a challenge linked to the physically demanding work in harsh environmental conditions is the management of heat stress. Non-compensable heat stress can lead to physical and cognitive performance losses as well as life-threatening heat-related illnesses. Root cause are conditions specific to the military service: Soldiering is hard physical work, often in protective clothing due to complex threats (e.g., ballistic body armour, Chemical Biological, Radiological and Nuclear (CBRN) protective gear) whose insulating properties impede or even prevent the dissipation of work-induced metabolic heat build-up. Heat dissipation is especially impaired in hot climate zones.

Another key challenge in the defence context is to ensure that soldiers will have the best chances of survival through fast and life saving medical treatment when seriously wounded in a military conflict or battle situation. In case of a large number of severe injured soldiers, it is necessary to have a fast and precise assessment of the critical status of the victims to calculate the number and treatment priority by triage through an emergency physician. If vital signs like pulse rate, blood pressure, oxygenation and other vital information like blood loss, trauma and electrocardiogram can be determined fast and transmitted from the incident by the use of wearable sensor systems wireless to the emergency physician who performs the triage and first medical treatment, the effectiveness of care and chance for survival can be improved.

The soldier of the future will need technological solutions to sensor and monitor information coming from both its surrounding (such as threats) and its physiological state (parameters associated with the stress experienced by the soldier and its health condition, etc.). Another important aspect is the ability of knowing their location with a high level of precision, as well as being able to receive and provide information related to their present situation. Furthermore, these additional functionalities will also mean more information exchange between the soldier and its equipment. Innovative human-machine interface (HMI) directly integrated into the textile will therefore enable to control the implemented functionalities or to get feedback from them while preserving or even enhancing mobility and ergonomic aspects. Furthermore, smart textiles will have to ensure the safe operation of wearable electronics and enable safe communication, considering the importance of protecting electronic equipment, data and soldiers against electromagnetic radiation.

Smart and multi-functional textiles enable to integrate different components and devices in uniforms and soldier systems and to widen their range of functionalities. To respond to challenges such as the ones listed above, functionalities can include monitoring of the environment and of the soldier's physiological state, localization, communication, energy management, protective functionalities (e.g., protection against the environment, signature reduction, including thermal radiation, fire protection, electromagnetic radiation protection and neutralization of dangerous chemicals).

Scope and types of activities

Scope

Though single technology demonstrators have been developed in the EU, further efforts are necessary on the way to an integration of smart and multi-functional textiles as one module of performant soldier systems, which would require, amongst other, standardized connectors.

This topic targets the integration of smart and multi-functional textiles and other components into a modular and ergonomic set of equipment adapted to defence applications. Standardized interfaces and protocols are a key aspect to enable modular and flexible integration of components providing different functionalities.

The scope of the topic encompasses necessary adaption of materials and technologies, development of a system concept, design of soldier equipment adapted to different use-cases, the development of a prototype and testing.

All innovative solutions should preserve soldier mobility, comfort and ergonomic aspects should therefore be considered with great care. Besides, all weight reduction opportunities, washability and maintenance requirements compliance will play a key role in making these solutions of interest. In order to minimize environmental impact, eco-design and life cycle analysis tools should be used as much as possible.

Solutions should be in line with ongoing and past projects in the field of smart textiles (e.g., EDA project STILE) and soldier equipment to avoid unnecessary duplication. Proposals should give a particular focus to potential inclusion of technologies developed in R&D activities targeting civil applications. Solutions should take into account interoperability aspects, e.g., connector standards developed in relevant international frameworks.

Types of activities

The following types of activities are eligible for this topic:

Types of activities (art 10(3) EDF Regulation)		Eligible?
(a)	Activities that aim to create, underpin and improve knowledge, products and technologies, including disruptive technologies, which can achieve significant effects in the area of defence (generating knowledge)	No
(b)	Activities that aim to increase interoperability and resilience, including secured production and exchange of data, to master critical defence technologies, to strengthen the security of supply or to enable the effective exploitation of results for defence products and technologies (integrating knowledge)	Yes (optional)
(c)	Studies , such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)
(d)	Design of a defence product, tangible or intangible component or technology as well as the definition of the technical specifications on which such design has been developed, including partial tests for risk reduction in an industrial or representative environment	Yes (mandatory)
(e)	System prototyping of a defence product, tangible or intangible component or technology (prototype)	Yes (mandatory)
(f)	Testing of a defence product, tangible or intangible component or technology	Yes (mandatory)
(g)	Qualification of a defence product, tangible or intangible component or technology	Yes (optional)
(h)	Certification of a defence product, tangible or intangible component or technology	Yes (optional)
(i)	Development of technologies or assets increasing efficiency across the life cycle of defence products and technologies	Yes (optional)

Among other tasks that the applicants deem necessary, the following tasks should be performed as part of the mandatory activity ‘Study’:

- Eco-design study to assess compliance with EU current legislations and foreseeable coming regulatory rules.

Among other tasks that the applicants deem necessary, the following tasks must be performed as part of the mandatory activity ‘Testing’:

- the testing in a controlled environment;
- the testing in an uncontrolled environment;
- evaluation of the impact of the added functionalities on signature reduction of the prototype

- evaluation of the impact of the added functionalities on mechanical resistance of the smart and multifunctional textile solution;

Functional requirements

The solution to be developed should meet the following general functional requirements:

- modularity of the equipment to adapt it to mission's requirements
- integrated system's approach, ensuring the integration of the sensors and interfaces in the soldier's system
- overall complementarity and interplay of functions
- practical, comfortable and ergonomic solution for the soldier, in particular with limited weight
- Solutions should ensure that added functionalities remain compatible with:
 - signature reduction function
 - ballistic and protective functions
 - textile mechanical properties
 - washability or other maintenance and durability
 - ease of movement and ergonomic functions

The solution to be developed should meet the specific functional requirements in the following areas of priority:

- In the field of thermoregulation:
 - active or passive regulation of body temperature in case of extreme weather conditions (hot or cold)
 - consideration of both static and dynamic missions as use cases for thermoregulation.
- In the field of monitoring of the environment and functionalities regarding the soldier's physiological state:
 - Monitoring of various physiological data for dedicated use cases.
 - Drug delivery and/or emergency care to act on blood loss and other traumas, using data collected through monitoring
 - Acquire localization data
 - protection of medical collected data all along the process to comply with confidentiality
 - compliance of processing and utilization of medical data with ethical rules
 - protection of the data collected for environment and equipment monitoring
 - data formats corresponding to relevant standards and connection with relevant

interfaces.

- In the field of Energy management:
 - Integration of energy conversion and distribution through textiles, with consideration of soldier architecture in particular to replace heavy and bulky cables and connectors

Moreover, the solution to be developed should additionally meet functional requirements in at least one of the following areas (Applicants must clearly indicate in their proposal, which of these functional areas they chose to address):

- In the field of protection from environmental hazard:
 - resistance to mechanical damage
 - fire resistance of external layers,
 - protection against mosquitos and other parasites
 - alternative solutions to textile treatments that are incompatible with current and coming regulations (e.g., alternatives to Per- and polyfluoroalkyl substances (PFAS) treatments)
- In the field of Energy management:
 - innovative capabilities of energy storage, e.g., novel high-performance textile- based batteries and supercapacitors
 - innovative solution for energy harvesting, e.g., by textiles and fibrous chargers.
 - compatibility of the energy management system with textile characteristics (flexibility, elasticity)
- In the field of electromagnetic protection and electromagnetic interference protection:
 - Safe and reliable operation of wearable electronics and safe communication between the components in environments with broad-spectrum electromagnetic radiation, e.g., in the case of high power electromagnetic (HPEM) or other-Directed Energy Weapon (DEW) attacks
 - Protection of the soldier against electromagnetic radiation of high intensity
- In the field of human-machine interfaces:
 - Full integration of innovative HMI solutions in soldier clothes
 - Ease of access to information, presentation of information adapted to the operational situation
 - adapted interaction functions with the equipment, e.g., new ergonomic interaction functions, adapted actuators, touchscreens.
 - Communication functions
- In the field of monitoring of the protective equipment:
 - Monitoring of the functions of the smart multifunctional textile
 - Monitoring of the protective capabilities of the uniform for analysis and recording
 - Provide location data on the equipment

Expected impact

- Enhancement of soldiers' capacity to perform their demanding tasks during military operations
- Increased safety and well-being for the soldier
- Increased interoperability of smart and multifunctional components for EU Member states and Norway defence forces
- Improvement of industrial and technical know-how on smart and multifunctional textiles in the EU Member States and Norway
- The capacity of technology and industry actors in the EU Member States and Norway to develop soldier equipment that is compliant with EU specific regulatory and ethical requirements