Centre for Defence Enterprise

CDE proves the value of novel, high-risk, high-potential-benefit research. We work with the broadest possible range of science and technology providers, including academia and small companies, to develop cost-effective capability advantage for UK Armed Forces and national security.

Themed competition: additive manufacturing for future military equipment

This CDE themed competition seeks projects to show how the performance of future military equipment could be significantly enhanced by using innovative additive manufacturing technologies to create multi-functional structures.

The total funding available for this competition is £750k.

Competition networking event: Tuesday 24 June 2014 at Cardiff City Stadium, Cardiff, 9:30am-4:30pm.

Competition close: Thursday 28 August 2014 at 5pm

CDE: www.science.mod.uk/enterprise

Dstl: www.dstl.gov.uk

SBRI Government challenges, ideas from business, innovative solutions

[dstl] Defence Science and Technology Laboratory

Ministry of Defence

Important information

Proposals for funding must be submitted by **5pm on 28 August 2014** using the Centre for Defence Enterprise portal. Please mark all proposals for this themed competition with “additive manufacturing” as a prefix in the title.

Technical queries should be sent to diet@dstl.gov.uk. Please see guidance under the ’queries and help’ section.

General queries (including how to use the portal) should be sent directly to CDE at cde@dstl.gov.uk.

Additive manufacturing for future military equipment

This Centre for Defence Enterprise (CDE) themed competition seeks projects to demonstrate how innovative additive manufacturing technologies could significantly enhance the performance of future military equipment.

The competition is specifically seeking demonstrations of how additive manufacturing techniques could be used to quickly add functionality to structures (rigid or flexible) so that they can undertake more than one task.

This CDE competition has a 2-phase approach. Following a review of the phase-1 deliverables, promising concepts may be selected for phase-2 funding to increase the maturity of the concept, and produce higher technology readiness level (TRL)[1] demonstrators.

Background

Additive manufacturing is the layer-by-layer deposition of materials using digitally controlled machine tools. The term includes a wide range of techniques, including 3D printing, direct melting techniques (such as laser and e-beam) and wire-feed processes. Additive manufacturing has seen a wide use within the commercial sector and has been identified as a potentially disruptive technology for a broad range of military applications. It is assumed that additive manufacturing will eventually provide MOD with the ability to build, adapt or modify equipment close to the point of use. This competition seeks to understand whether additive manufacturing can also be used to produce materials or constructs with enhanced functionality.

Technology challenges

This CDE themed competition not only seeks to meet technology challenges but to understand how those challenges align to a broad range of military applications. As well as answering at least one of the following technology challenges, successful proposals will make a clear link with military application(s). Examples of military applications of interest are provided later but these are not exhaustive; proposals that explicitly give alternative applications to defence or security requirements will be equally considered.

Proposals should address at least one challenge, could address more than one of the challenges, but do not have to address all the following challenges:

Challenge 1 - embedded sensors

A wide range of sensors are available to most military platforms. Often the practical limitations of integrating sensors using conventional manufacturing techniques have meant they are not used where they could be. This challenge seeks to understand how additive manufacturing could be used to embed sensors into platform structures, giving the potential for sensors to be implemented in a much wider range of platforms.

Challenge 2 - embedded rechargeable power sources

Current portable power sources are often fixed-box and cylinder shapes making them difficult to integrate into military platforms, which are seldom regular shapes. Additive manufacturing could be used to integrate power networks, rechargeable batteries or energy harvesting devices within flexible or rigid structures to combine functionalities and reduce the unused space in the platform.

[1] For a description of technology readiness levels see the Acquisition Operating Framework https://www.gov.uk/acquisition-operating-framework.

Challenge 3 - integrated electronics

A typical electronic system has hundreds of components and wires adding to weight, complexity and volume of the system. By integrating electronic wires, components and systems into structures, additive manufacturing could potentially have a disruptive reduction in these limiting factors.

Challenge 4 - integrated novel camouflage or stealth technologies

Current novel camouflage and stealth technologies are often retro-fitted to systems to enhance their protection. By integrating novel camouflage or stealth technologies directly into or onto structures, platforms will achieve a greater level of protection as well as potentially reducing the weight of such systems.

Challenge 5- Rapidly building, modifying and adapting bespoke military equipment

The current response time to develop and deliver a novel concept to theatre is not optimal. This challenge seeks to demonstrate how additive manufacturing may be used to increase re-configurability in military systems. We want to understand whether additive manufacturing could be used to rapidly build, adapt or modify equipment to provide enhanced functionality. For example, by configuring components such as sensors and navigation systems to produce micro vehicles that are bespoke for mission.

Challenge 6 – using additive manufacturing to mimic biological systems

Biological systems are complex and can perform multiple functions. By mimicking such systems, additive manufacturing could be used to combine a wide range of functional and structural properties or develop simulants for the biological systems to be used in testing. For example, bone simulants with in-situ testing capabilities.

Military context

As well as addressing at least one technology challenge, every proposal to this competition must explain how it will add functionality to military equipment and/or processes. Below are examples of military applications of particular interest for this competition. These are not exhaustive; proposals that explicitly give alternative applications to defence or security requirements will be equally considered. The networking event on 24 June 2014, webinar on 4 July and technical email helpline (diet@dstl.gov.uk) provide opportunities to discuss with military practitioners functionality that you consider would be of use to defence.

Maritime environment

The maritime environment can be challenging and threats can develop quickly. There are often extended supply chains, which can cause delays in the delivery of capabilities to counter new threats. Maritime forces often have minimal resources but must be self-sustaining. In particular, they must have the ability to carry out their own repairs to respond to damage and restore fighting capability quickly. The maritime area could benefit from innovation in the following areas:

Reduce the cost, time and complexity of manufacture to allow capabilities to be fielded more flexibly in the future.

The long design and development cycles for military equipment mean delivery of a new capability is often a long process. Could additive manufacture be used to shorten these cycles so capabilities can be more flexible in the future? Examples of how this may be achieved include:

- manufacture of new capabilities within the task group to counter emerging threats (eg based on a design from the UK, the platform manufactures a small unmanned air vehicle in theatre and deploys it the next day).

- the application of additive manufacturing in developing flexible modular mission systems with the quick design, development and manufacture of platforms, systems and sub-systems.

Increasing maintenance instrumentation in maritime platforms and platform systems.

Maritime platforms are often large and complex so that maintenance monitoring across the entire platform is difficult to perform. By embedding sensors into platforms it would be possible to identify maintenance requirements as and when they occur. These can then be prioritised appropriately and help to improve platform and system availability during their lifecycles.

Employ platform and task group level maintenance and repair capabilities to restore the fighting effectiveness of platforms after damage.

Current repair capabilities while a ship is deployed on operations are limited. Additive manufacturing offers the potential to allow specialist repair capabilities to be based on or near the maritime platform so that they can be repaired quickly in theatre.

Support humanitarian and disaster relief missions by allowing the manufacture of components to restore vital life support following disaster.

Maritime platforms play an important role in delivering support following disasters. Some platforms carry a range of disaster relief stores to allow this to happen. Could additive manufacturing on a ship be used to enhance some or all of these stores and deliver better outcomes when military forces do these tasks? For example, could additive manufacturing be used to make bespoke adaptors to connect between UK maritime platforms and civilian equipment?

Land environment

UK forces operate in difficult environments, facing varied threats. Weight remains a major concern for the dismounted soldier. Patrols in Afghanistan have regularly carried excessive weight so many programmes have aimed to reduce this.

Using additive manufacturing to reduce the burden on the dismounted soldier

UK dismounted soldiers carry a wide range of kit when patrolling. Often this kit is heavy and poorly fitting. Could additive manufacturing be used to increase the comfort to the wearer when carrying equipment? Solutions could include:

- additive manufacturing of flexible materials that mould to the user, with integrated sensors, electronics or power sources.
- body scanning and additive manufacturing to design bespoke-to-soldier structures with integrated sensors, electronics or power sources.

Allow unmanned vehicle technologies to be realised

A man-packable, unmanned ground system designed for dismounted troops that carries mixed sensors tailored to the mission could lessen the burden and risk on dismounted soldiers by providing improved situational awareness. This application seeks to understand if additive manufacturing could enable such a system through:

- integrating multiple additive manufacturing technologies to combine capabilities eg novel lightweight structural design with electronics for sensing and communications.
- designing lightweight power sources or energy-harvesting technologies into the unmanned ground vehicle to sustain it sufficiently.

Ballistic testing and injury modelling

MOD uses ballistic testing and injury modelling to develop future protective systems for military staff. Tests on the physiological effects of equipment often rely on basic simulants and improvements to these simulants are required.

Develop complex muscle and bone simulants for military testing

MOD wants to understand whether improved bone simulants could be developed using additive manufacturing. Is it possible through additive manufacturing to make more realistic bone and/or muscle simulants to perform complex testing on? Can additive manufacturing be used to embed sensors into simulated bone/muscle to better understand the response?

What we want

- Proposals that use innovative additive manufacturing technologies to meet the challenges as stated.
- Solutions that offer greater functionality, not just a 'print on demand' logistics benefit or simple weight reduction.
- Proposals delivering design concepts and a proof of principle, ideally with a working demonstrator.
- Proposals in the proof-of concept stage, working towards technology readiness level (TRL) 2-3.
- Description of how the technology could be applied to the military requirements described in this document.

An outline of what a potential second phase of work would address eg *"a second phase would likely de-risk this aspect by…"*

What we don't want

- Projects where the main output is a literature review.
- Proposals that seek to develop heat exchangers as these have been explored in a previous competition.

Exploitation

This CDE competition will have a 2-phase approach. Following a review of the successful deliverables from this stage (phase 1), promising concepts may be selected for phase-2 funding to increase the maturity of the concept, including the production of higher TRL demonstrators.

For potential phase-2 funding, funded proposals should produce a fully costed phase-2 proposal as part of their final phase-1 deliverable.

Dstl does not commit to fund any follow-on work but will consider the phase-2 proposals at a second decision conference at the end of phase 1.

There is no cap on the value of the potential phase-2 proposals, but it is more likely that at this stage a smaller number of higher-value proposals (eg £200k-£300k) over a timescale of around 24 months will be selected for further funding. It is anticipated that up to £1.5 million will be allocated in total for successful phase-2 bids.

The phase-2 proposals will be assessed by subject matter experts from MOD and Dstl using the MOD Performance Assessment Framework (PAF). Deliverables from contracts will be made available to Technical Partners and subject to review by UK MOD and wider UK government as covered by MOD contracting terms and conditions.

Please note that any phase-2 funding awarded will be contracted using a different contracting mechanism to phase 1.

Invitation for CDE proposals

This competition will be supported by presentations given at the Innovation Network event on 24 June 2014. These will be available to download at the event webpage.

Proposals are invited from industry and academia in the UK and overseas for research that can demonstrate a proof of concept to meet one or more of the challenges for '**additive manufacturing for future military equipment**'.

A total of £750k of funding is available for the first phase of this competition.

There is no cap on the value of proposals but it is more likely that for the first phase a larger number of lower-value proposals (eg £40k—£80k) will be funded than a small number of higher-value proposals.

Proposals should focus on a short, sharp, proof-of-concept phase – typically, but not exclusively, 6-8 months in duration – with phase-1 deliverables completed by 30 June 2015. Proposals should include a descriptive scoping for a second phase programme of any duration but the proposal should be clearly partitioned with a costed proof-of-concept stage, which is the focus of the first phase of this CDE themed competition. Proposals for further work beyond the proof-of-concept stage will only be considered after the proof-of-concept stage has delivered, using the understanding gained to make an informed decision.

Proposals must include:

- a clear statement of what challenge the solution is aimed towards
- a clear description of what is novel and innovative in the solution
- a clear statement of the programme of work that would be carried out and the outputs (deliverables) from the work
- a clear statement of the expected outcome(s), how this will be proven or demonstrated and how it will provide evidence that the outputs can be exploited
- a clear description of the value of the solution to operational capability including the likely saving to through-life costs
- a statement on the anticipated practicality of adopting the proposed solution
- an outline of any data/equipment requirements of the proposal, and how these will be met. Any dependencies on the supply of data/equipment from MOD must be stated
- an outline of what a potential second phase of work would address eg *"A second phase would likely de-risk this aspect by…"*

Proposals that do not include the required information are unlikely to be successful.

Please note phase-1 proposals that do not include an outline of what a possible second phase of work may address will not be funded.

Proposals will be assessed by subject matter experts from MOD and Dstl using the MOD Performance Assessment Framework (PAF). Deliverables from contracts will be made available to Technical Partners and subject to review by UK MOD and wider government as appropriate.

Dstl will be available to provide advice and/or guidance via an appointed Technical Partner throughout the project and provide the interface with MOD and wider government stakeholder community.

Dstl does not commit to fund any follow-on work as a result of any contracts placed via this CDE themed competition, but more promising ideas will be considered for a potential second phase of funding where appropriate.

CDE proposal submission process

Key dates

	24 June 2014	Competition networking event at Cardiff City Stadium
	4 July 2014	Post-launch webinar
Phase 1 projects	28 August 2014	Phase 1 competition closes at 5pm
	By 15 October 2014	Phase 1 contract placement initiated and feedback provided
	By 30 June 2015	Phase 1 proof-of-concept research complete
	On or before 31 October 2015	Phase 1 project showcase
Potential phase 2 projects	With phase 1 final deliverable before 30 June 2015	Phase 2 proposals due
(dependant on successful phase 1 deliverables)	Estimated December 2015	Phase 2 contract placement initiated and feedback provided
	Estimated 31 October 2017	Phase 2 research complete
	Estimated December 2017	Final project showcase

Proposals for funding must be submitted by 5pm on 28 August 2014 using the CDE portal. Proposals must be clearly marked with "additive manufacturing" as a prefix in the title.

Please plan the timeline for submitting your proposal carefully. If you have not used the CDE Portal before you will need to become familiar with the guidance, including how to open an account starting with the Quick Start Guide.

Other information and guides are available on the CDE website:

- General CDE advice: www.science.mod.uk/engagement/cde/working_with_cde.aspx.
- Contract & IPR guidance: www.science.mod.uk/engagement/cde/funding_contracts.aspx.
- Using the portal: www.science.mod.uk/engagement/the_portal.aspx. The portal is optimised for proposals based on physical sciences and engineering and we are aware that proposers sometimes struggle to adapt to using it with social science-based proposals. The key points (rather than the detailed questions) that are sought under the main headings still apply and further advice can be obtained from CDE.
- Presentation material giving advice on creating effective CDE proposals: http://www.slideshare.net/MOD_CDE/cde-creating-effective-proposals-part-1-of-2-final-na-u http://www.slideshare.net/MOD_CDE/cde-creating-effective-proposals-part-2-of-2-final-na-u.

Common errors in preparing and submitting a proposal include:

- **Character limit** – there is a limit of 1000 characters in each individual descriptive paragraph within the proposal; when completed they must be added to the document; additional paragraphs can be added if 1000 characters is insufficient.
- **It is a web-based tool** – please save your work regularly to avoid 'time-outs' that lose work.
- **Attachments fail** – They must be Word 97-2003 format, portrait format, should have generous margins with no material overhanging the margin and a max size of 1 MB. Please note that attachments should only be used for supplementary information, the main points of your proposal should be written into the online form. Care should also be taken to make sure that attachments are placed in the relevant section (eg technical information should not be attached to the commercial section).
- **Failing to properly submit** - **publish is not the same as submit**. You have **not** completed the submission process if your proposal is at the FINAL/PUBLISHED stage (in the status and published status columns respectively); CDE has no sight of the proposal at this stage. To complete submission you need to press 'submit' under the 'Tasks' column. This changes the status of your proposal to 'SUBMITTED'; it will then change (normally after a few days, often sooner) to 'RECEIVED' indicating that the proposal has been accepted by CDE for assessment.

For a proposal to be accepted for assessment:

- the standard terms and conditions of CDE must be unequivocally accepted
- there must be at least one deliverable against which payment can be made
- the commercial section of the proposal must be completed.

Do not leave submission of your proposal until just before the deadline. Past experience has shown that the portal becomes heavily loaded near the competition close resulting in slow operation (up to one hour to publish rather than a few minutes) and that, with the pressure of the deadline, mistakes are made that mean proposals are not submitted or accepted.

All proposals and content placed on the portal must be UNCLASSIFIED.

Queries and help

As part of the proposal preparation process, queries and clarifications are welcomed:

- **Technical queries** about this specific themed competition should be sent to diet@dstl.gov.uk with 'additive manufacturing' as a prefix in the title.

  Capacity to answer these queries is limited in terms of volume and scope. Queries should be limited to a few simple questions or if provided with a short (few paragraphs) description of your proposal, the technical team will provide, without commitment or prejudice, broad yes/no answers. This query facility is not to be used for extensive technical discussions, detailed review of proposals or supporting the iterative development of ideas. While all reasonable efforts will be made to answer queries, CDE and Dstl reserve the right to impose management controls when higher than average volumes of queries or resource demands restrict fair access to all potential proposal submitters.

- **General queries** (including using the Portal) should be sent to CDE at cde@dstl.gov.uk.