



AMable – Innovation in Additive Manufacturing for Europe

The aim of AMable project is to accelerate the uptake of additive manufacturing technologies; from design to manufacture for functional parts throughout the European Union. AMable is creating a digital framework to provide impartial access to the best European AM knowledge to support this adoption. This knowledge will be offered as advanced and tailored services to assist SMEs in the adoption of AM and include technological, business and training services.

To build a truly pan European initiative, there are several renown research institutes and best-of-breed consulting companies involved in AMable project, from Germany, the UK, the Netherlands, Belgium, Spain, Greece, Finland, Italy, Poland, Denmark and Cyprus, among other countries. These partners will provide the technological backbone for guidance and support in transferring ideas to production in a profitable way and will manage the “AMable service arena”.

Further information about the AMable project is available through project website and Cordis portal.

<https://www.amable.eu/>

http://cordis.europa.eu/project/rcn/211557_en.html

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1 AMable Call for Tenders

1.1 Introduction

Fraunhofer ILT calls for tenders to support the AMable project consortium in the implementation of procedures and tools for the AMable project, which runs under the I4MS initiative of the European Commission to support SMEs and mid-caps in the uptake of new technologies (Innovation for manufacturing SMEs).

The AMable project supports companies that strive to develop an innovative additively manufactured product through a set of selectable consulting services (see Annex). This support begins with the assignment of an AMable tutor who guides the development team through the development cycle. In the course of the development, the team can use the services to get consultation for their work. Some services also offer execution of actual work such as computation on HPC infrastructure or material analysis. The core aim of the support however is to guide and grow the competence of the development team.

1.2 General guideline for applicants

The tendering entity needs to be a legal entity that is registered in one of the European Union's member states. Additionally and according to ARTICLE 13 of Grant Agreement n°768775, the subcontractors must comply with the following requirements:

- Beneficiaries must ensure that the Commission, the European Court of Auditor (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 towards their subcontractors.
- Beneficiaries must comply with the applicable national law on public procurement.
- Beneficiaries will be requested to submit a signed declaration about the lack of any conflict of interest with AMable partners. A template is included in ANNEX IV. This will ensure to prevent any situation where the impartial and objective of the awarding action is compromised for reasons involving economic interest, political or national affinity, family or emotional ties or any other shared interest ("conflict of interest"). Applicants who do not submit this declaration form will be not be awarded.

To be selected for support, the tendering entity needs to bring forward:

- An innovative idea for an additively manufactured product that is economically and technologically viable. The tender needs to describe the product idea, its innovation and a strong business case for the European market (revenue, labour, societal impact).
- Challenges connected to the product idea, which the tendering entity intends to resolve with the help of AMable services. The tender needs to describe these challenges and how they are expected to be resolved by the selected services.
- List of expected expenses to deliver the specifications given below. These expenses need to be split into cost for external goods and services

(consumables, printing, testing) and cost for labour to execute work and prepare deliverables.

The tendering entity will execute the actual work itself. The effort of the entity is split into four major activities:

- Execute work that is recommended by the service to achieve the final solution.
- Provide information about work execution and achievements through the AMable reporting and controlling tools (see annex).
- Provide feedback on the procedures, the reporting and controlling tools.
- Disseminate the product idea and the progress through media and presentations.

Submission of tenders for "Initialisation Experiments"

- File format PDF
- E-mail address call-for-tenders@amable.eu
- Submission Deadline 24.06.2018 24:00 hrs Brussels time

The data that is being submitted to this mail address will be handled under the data protection rules laid out on the web site www.amable.eu

1.3 Specification

Conduction of work on a product idea that is to be additively manufactured with support from one AMable service pack. The proposed product idea needs to have an initial business plan and a work plan that shows how the selected service pack supports the development of the product idea towards the defined goal. It needs to formulate the technological challenge and how the selected AMable service pack is expected to solve the challenges.

The tender therefore needs to contain the following details:

- a) Applicant's background and ambition relating to AM
- b) Description of the innovative product idea
- c) Initial business plan that indicates the potential revenue
- d) The challenge that needs to be solved to realise the product idea
- e) The ambition together with a general development plan containing a time line and a description of the interaction with the selected service pack
- f) Price for the work that is detailed in positions 1 to 5 as specified below.

The selection criteria are in the following priority:

- 1) Contribution to the implementation of procedures and tools for the AMable project (50%)
- 2) Innovation of the proposed product in its market (scientific and technological) (30%)
- 3) Business case with impact on the company and the European market (20%)

The work needs to be conducted within 5 months from the starting date to the following specifications (planned starting date is June/July 2018).

No	Title	Due	Effort
1	Elaboration of detailed Business Plan	M2	
1	<p>The contractor needs to elaborate a detailed business plan for the proposed product idea. This business plan related deliverables therefore need to contain</p> <ul style="list-style-type: none"> a) Two business canvases that lay out a primary business case and a fall back case. b) A marketing plan for the primary business case that covers three years after the end of the work c) A revenue plan that lists financial invest and return including staff and infrastructure cost if applicable 		

No	Title	Due	Effort
2	Elaboration of a development plan and risk register	M2	
2	<p>The contractor needs to elaborate a development plan that describes the planned steps to overcome actual technological obstacles. It needs to formulate the questions, which the services shall consult. The development plan shall be structured in three phases: Initialization, Implementation and Validation.</p> <p>For each question in each phase, risks need to be identified and applicable mitigation measures need to be defined to ensure best progress. The deliverables shall therefore contain:</p> <ul style="list-style-type: none"> a) Development plan with definition of challenges, timing, service interaction plan b) Risk register with mitigation measures 		

No	Title	Due	Effort
3	Creation of deliverables in accordance to sample templates		
3	<p>The contractor needs to create deliverables in accordance to sample templates in the Annex (Initialization Report, Validation Report), based on the information collated in positions 1 and 2. In collaboration with the AMable tutor and the AMable services providers, a technology readiness level (TRL) assessment will be conducted collaboratively within two working days either at the contractor's site or one of the RTO's site. The deliverables shall therefore contain:</p> <ul style="list-style-type: none"> a) Reports according to deliverable templates b) Presence, collaboration and report on the TRL assessment session 	M2, M5	

No	Title	Due	Effort
4	Feedback on the usability of the deliverable templates	M2, M5	
4	The contractor needs to give feedback on the usability of the deliverable templates and the controlling tools to increase usability and effectiveness of the controlling. The deliverables shall therefore contain: <ul style="list-style-type: none"> a) Three interview sessions of one hour each b) One written report with three A4 pages in length. 		

No	Title	Due	Effort
5	Dissemination of Results	M4	
5	The contractor shall enable the AMable consortium to communicate about the product idea and its development. Communication material such as video footage and high resolution photos need to be provided for publication together with a story that describes the idea and the driving business expectation. The contractor's intellectual property does not need to be exposed. The deliverables shall therefore contain: <ul style="list-style-type: none"> a) 15 minutes of raw video footage which shows the work on the product idea, the development of sketches, sample implementations, work sessions or alike b) 8 high resolution photos showing the overall idea, the product, its application, work sessions, lab experiments or alike c) Travel of one of the contractor's employees to one European event to present the overall story about the product idea with a 20 minute presentation (minimum of 15 slides, public audience) 		

2 Annexes

2.1 Annex – Selectable Service Packs in the context of this call for tenders

Services Pack S1

308 Modelling, Simulation and HPC

Services Pack S2

306 Design for AM – Design for Manufacture

Services Pack S3

309 Data Analytics – Data analytics applied to AM manufacturing

310 Data Acquisition – Testing of part properties from single build job

313 Quality Assurance and Certification – Understanding the requirements for part certification

Services Pack S4

312 Industrialization – Integration of AM in existing process chain

Services Pack S5

312 Industrialization – Testing and validation of part quality

313 Quality Assurance and Certification - Material qualification

Services Pack S6

307 Visualization – Development of an automated, cloud-based tool

305 AM Decision support / AM Wizard – Support decisions on AM development

2.2 Annex – Services Description

ID 305
Service name
AM Decision support / AM Wizard
Service description
This service supports the process to decide whether AM is a valid option for manufacturing of a product or not. It comprises both technical and economic evaluation steps.
Service offering
Decision support for AM uptake: does AM make sense for manufacturing this particular product by my enterprise? This decision must be made per individual

part and based on technical and economic viability. This service offers a method/model/tool which can assist in making this decision on a fact-based level. The AM decision support model service offered comprises various entry points, branches and outcomes, and is dictated by knockout criteria. Criteria include considerations on engineering design, material, process, product quality and economy (cost and time). A questionnaire is used which operates in an FMEA manner providing weight factors related to the answers in terms of probability and confidence. It is distinguished in three different levels, based on the user experience.

First level /non-expert approach:

- Are part dimensions compatible to AM technologies today?
- Do AM materials meet the required product quality?
- Are constraints in the way of using AM as a manufacturing route?

If all three can be assessed OK (first order estimation), then stage two, high level approach can be offered.

Second / high- level approach:

Initial design evaluation is not enough for convincingly applying AM technology. To be confident about utilizing AM in a certain application, a high-level approach has been drafted, consisting of five criteria:

- engineering constraints
- material constraints
- process constraints
- economic constraints
- product quality constraints

Each criterion consists of an extensive questionnaire addressing issues to be answered by different types of experts within the company (technologists, purchase officer, marketing, etc.) If one of these experts yields a knock-out, then AM is considered not feasible for that specific application.

Third level/ high accuracy metrics quantification:

This level is supposed to aid users already confident towards using AM by identifying the exact processes/machines capable of manufacturing the specific part. In addition, this level will be providing highly accurate manufacturing time and cost estimation, based on the different types of AM processes available.

Service key benefits

- Expert-based assessment of the viability of using AM as a manufacturing technology for a specific product.
- If AM is assessed as feasible, calculation of a confidence indicator of manufacturability (probability as well as a confidence level).
- Support for selection of suitable AM process and machine.
- Estimation of associated performance indicators (manufacturing time and cost).

ID 306
Service name
Design for AM
Service description
This service will provide the knowledge to enable the creation of an AM-buildable product, while integrating incoming design data (customer scan or other input data) and creating the required instructions (file for build, post-processing, inspection instructions) to ensure the final product matches the design requirement. The design process may include a part consolidation exercise, structural optimisation, design concepts, customisation, reverse engineering or simply the redesign of a component for build-ability through AM processes.
Service offering
This service offers to provide working knowledge of how to design products for manufacture by AM in different applications (e.g. topology optimisation, tooling improvement, Part consolidation to improve lead times and Customer-led product design). Customers will be able to access design tools (hardware and software) and resources through this service, and the service will help them through their first AM design process. This will empower SMEs to do functional design, part consolidation and design based on customer input either through scan data or requirements capture.
Service key benefits
<ul style="list-style-type: none"> • Cost effective designs • De-risking the build • Accessing design guidelines/tools/resources

ID 307
Service name
Visualization/Immersive design
Service description
Immersive design and connection with CAD packages will be developed to enable the user to experiment with variants, allowing quick and affordable pre-assessment of product design.
Service offering

The service focuses at providing the user with a realistic representation of the end result of the AM process through an immersive design environment. The ambition is to create a software module able to directly generate a realistic visualization of a certain part after being Additively Manufactured directly from a CAD file. The tool should be able to take into account surface texture/roughness based on the selected material, process/machine type and/or machine settings (such as layer thickness) and generate an appropriate texture to be mapped on the surface of the CAD model so that the user can have a realistic view on how the part will look right after production. The user should be able to modify selected production parameters as well as the CAD file, to understand how these affect the way the part looks.

In addition, coupling with the modelling & simulation stage would enable the visualization tool to use the distorted "as manufactured" 3D model instead of the user-provided CAD file, so that a "virtual prototype" will be available for the user to decide if his requirements are met or if any further redesign and/or optimization is required.

Service key benefits

- Ability to realistically visualize product
- Direct involvement of customers for feedback during the design phase
- Ability to fully grasp part surface roughness and/or finishing, as AM surfaces usually are not smooth
- Ability to fully comprehend distortion magnitude and effects without redesigning the part, as well as effects of a potential redesign to minimization of distortion
- Enabling product customization

ID 308

Service name

Modelling, Simulation and HPC

Service description

Computer based solutions of thermo-mechanical effects in AM processes will be implemented to reduce expensive and time consuming "trial and error" experimentation.

Service offering

- Weld pool shape prediction by means of analytical high performance models (almost real time) vs. real macrographs.
- Thermo-mechanical models for shape distortion computation (HPC required)
- Use pre-deformed (negative) CAD geometries resulting after thermo-mechanical simulation to limit shape inaccuracies during build-up process

- Path planning optimization to reduce processing times and heat input suitable for processes with larger weld pool geometry, e.g. WAAM or LMD.
- Simulation of post-processing operations (i.e. cutting, machining) and final shape comparison with real manufactured components
- Further specific modelling and simulation aspects under the umbrella of Integrated Computational Materials Engineering (ICME)

Service key benefits

- Estimation and optimization of KPIs:
 - Build time optimization and energy saving suitable for LMD or WAAM
- Selection of appropriate process parameters (power, feed speed) including powder pre-heating temperature
- Secure part quality:
 - Minimization of the process induced residual stresses and shape distortions, compensation of distortion, analyse the effects of post-processes (e.g. cutting, machining etc.) by means of simulation models, analyse shape accuracy by comparing real components with simulation models and ideal CAD geometries by means of CAX tools based on 3D scanning techniques
- First-time-right manufacturing by reducing time consuming and costly experimentation
- Aid the process design by providing feedback from simulation results in the design phase to optimize the AM process (i.e. facilitate pre-heating or path planning optimization to reduce temperature gradients and, thus, excessive and undesirable residual stresses and/or shape distortions)
- Integrated the related CAX tools in an easy to use platform

ID 309

Service name

Data Analytics for AM

Service description

This service supports the deployment of data analytics solutions applied to AM. Data from different sources are processed via dedicated software, apps and tools, with the aim of extracting and visualizing manufacturing, product and business related KPIs that are useful as decision support tools for SMEs.

Service offering

- **Extraction of meaningful knowledge as KPIs** from structured or non-structured information associated with AM manufacturing processes that can help on decision making such as selection of providers, machine certification/approval, selection and optimization of AM parameters, product approval, design approval or benchmarking.
- Provide **access to different types of data** originated from different sources during and around AM processes: AM machine data (embedded sensors,

<p>machine communication), quality control equipment, design data, modelling data, cost data, delivery time data, multi-machine data.</p> <ul style="list-style-type: none"> • Implementation of existing and new data pre-processing (filtering) and data analysis (clustering, dimensionality reduction, feature extraction) solutions as software, apps, tools, cloud services etc. • Access to data visualization wizards (summary statistics, historical data, trends, patterns etc.) • Implementation of analytics approaches (multivariable analysis, learning algorithms)
<p>Service key benefits</p>
<ul style="list-style-type: none"> • Adoption of data-driven strategies tailored to the SME needs to take business, AM technology and process/product quality related decisions better and faster. • Tele-assistance for machine diagnostics and optimization of AM parameters. • Process data retrieval and storage based on KPIs allowing optimization of value chain performance and overall product quality management.

<p>ID 310</p>
<p>Service name</p>
<p>Data acquisition (Build)</p>
<p>Service description</p>
<p>Measurement and consolidation of data throughout the AM process chain with build monitoring systems& metrology data collection.</p>
<p>Service offering</p>
<p>With this service customers can assess the quality of the final product and make sure that the component fulfils desired specifications, requirements and standards. The service also provides information and knowledge to improve the consistency of the AM process and part quality repeatability.</p> <p>To offer quick and meaningful advice to customers with part quality related issues, participants will be able to fall back onto a continuously expanding repository. This repository contains known issues and solutions with regard to different machines, materials, geometries, etc. As work is carried out through experiments and competitive calls, the repository will be constantly updated with new data. Additional insights from large quantities of data can be gained through the Data Analytics service. Specific work that can be provided through this service includes:</p> <ul style="list-style-type: none"> • Quality control consultancy – implementation of (AM) standards and best practices • Process development for QM purposes • Metrology services

- NDT services
- Mechanical testing
- Failure investigation
- Real-time build monitoring system integration

Service key benefits

- Stability of the AM process and practices for the best operation
- Increased understanding of the complete chain of AM and the possible factors causing the flaw
- Links to related services within Service Arena

ID 312

Service name

Industrialization of AM

Service description

Industrialization of AM encompasses the transition from building a few prototypes to full-scale series production of end-use parts. Key concepts of industrialization are establishment of a comprehensive quality management system and seamless integration into existing production lines.

Service offering

This service provides customers with expertise to bridge the gap between prototyping and production through consulting, training, and testing. The primary focus areas for industrialization of AM are enhanced productivity, process repeatability and predictability, and customer relations and support.

- AM best practices documents and technical guidelines can be provided to customers with the aim of defining fully approved AM processes and products.
- Trainings to implement and work according to industrial standards (ISO, ASTM, EN, etc.), best practices and guidelines are offered
- Testing is carried out to ensure desired part quality and production speed can be achieved, specifically with regard to workflows and operational management
- AM production chain automation and integration where Additive and Subtractive technologies are integrated in a (semi-) automated chain
- Consultancy on ICT services which enable industrialization of AM (CAx, M2M and reconfigurable MES, data analytics and closed loop monitoring tools to be integrated in production infrastructure)
- Industrialization pilot trials both at RTD and customer

Service key benefits

- AM parts manufactured according to industrial standards and compliance with regulatory requirements.

- Balanced and optimized AM production flow with optimal production speed and quality
- Integration of AM processes into existing process chains allowing seamless production flows

ID 313

Service name

Quality assurance and certification

Service description

Guidance on quality assurance and certification of parts manufacture by metal AM

Service offering

The offering will be to provide SME's and midcaps with goal based certification guidelines on the materials and manufacturing development processes for metal parts produced by AM.

Service key benefits

- A route to certification of a metal AM part
- Alignment to regulations, codes, and standards.
- Suitability of the manufacturing process for an identified part

2.3 Annex – Template for tendering

AMable “Initialisation Experiments” Information about the tendering entity	
Legal Name	
Type of entity (SME, LE)	
PIC number (optional)	
VAT registration number	
Business register number	
Business register location	
Country	
Legal Address	
Name of legal signatory	
Type of Activity	
Sector	
Previous expertise with AM (new / intermediate / expert)	
Role (USER / SUPPLIER of AM technologies)	

Applicant’s background and ambition relating to AM
Please describe your current position in relation to AM and how you plan for the future. What is your ambition, what is your roadmap with respect to AM and your overall business objectives.

Description of the innovative product idea
Please describe your product idea. What is innovative, which properties are challenging, where can it be used, why does it need AM. Type of product, properties, innovation, industrial sector

Initial business plan
Please describe the business case behind the realisation of the product idea and the requirements for entering the market. Include a resource allocation plan (investments, goods, personnel, machines, digitalisation). Relate your revenue analysis to actual market figures.

Challenges towards the implementation of the product idea
Please describe challenges that need to be solved to realise the product idea. Cluster by technology, science, skills, design as appropriate.

Ambition and development plan
Please describe the goal of the development, provide a time line for the execution. Provide a reason for the selection of the service pack and link the challenges to the service pack’s services.

Spec #	Description	Personnel	Consumables	Travel	Sub Total
1					
2					
...					

Tender valid until:

Total price excl./incl. VAT:

Date, Place

Signature of the authorized representative and stamp of the legal entity

2.4 Annex – Declaration of lack of conflict of interest

Declaration of lack of conflict of interest to be printed on company paper, signed and stamped

LACK OF CONFLICT OF INTEREST ASSESSMENT

Legal company name: _____

Address: _____

Country: _____

VAT registration number: _____

Business registration number: _____

I herein confirm that the company I represent has not any economic, social or political conflict of interest with AMable project partners which are listed on the web site (www.amable.eu).

Name: _____

Position: _____

Date and place: _____

Signature of the authorized representative and stamp of the legal entity

2.5 Annex – Sample deliverable content

Sample content of the initialisation report

Business case assessment
Business canvas, market analysis, risk factors, production cost scenarios, resource scheduling, demand variability.

Commercial objectives
Objectives directly connected to the product idea and adjacent to the production and sales. Overall ambition of the company with regard to the product.

Aims and Objectives from User perspective (<i>specifying/guiding partner</i>)

Aims and Objectives from Supplier perspective (<i>active development partner</i>)

Technology Gap Analysis

Experimentation Plan
Activities, interaction with services, time line

KPI monitoring plan
Identification of four key performance indicators, measurability, monitoring approach

Risk register
Risk description, impact, probability, mitigation measures

Sample content of public part of the validation report

Summary of executed tasks

Description of main results (Final designs, printed parts, etc.)

Milestones

Review of business case

Feedback of the AM service implementation

Sample content of the confidential part of the validation report (extended part, based on public part)

Summary of executed tasks

Description of main results (Final designs, printed parts, etc.)

Milestones

Review of business case

Feedback of the AM service implementation including difficulties arisen and objectives not achieved or partly achieved

Report of KPI achievements

Dissemination plan

Market entry proposal (<i>related to financial support sources</i>)