



PATHFINDER CHALLENGE

ARCHITECTURE, ENGINEERING AND CONSTRUCTION

Digitalisation for a novel triad of design, fabrication, and materials

CHALLENGE GUIDE

EIC Work Programme reference: HORIZON-EIC-2023-PATHFINDERCHALLENGES-01-02

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The EIC will hold an Info Session on this Pathfinder Challenge call on February 2nd between 11:00 and 12:30 CET. Participants can access the meeting as guests [here](#). Participation in the meeting, although encouraged, is optional and is not required for the submission of an application. A recording of this Info Session will be made available on the same URL. Notifications of additional dissemination events can be found at [Events \(europa.eu\)](#).

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1. About this document

The Challenge Guide serves as guidance and background for the common understanding, participation rules and obligations for the EIC beneficiaries that are involved in the Challenge Portfolio. Contractual Obligations are further detailed in the [EIC Work Programme 2023](#).

The Challenge Guide is a guidance document accompanying a Pathfinder Challenge call topic for proposals to provide further information about how “Portfolio Considerations” will be taken into account in the evaluation of proposals for that topic.

The Challenge Guide is prepared by and under the responsibility of the relevant EIC Programme Manager (information about the EIC Programme Managers is available on the EIC Website (https://eic.ec.europa.eu/eic-communities/eic-programme-managers_en)). It complements the Scope, Specific Objectives and/or Specific Conditions set out in the EIC Work Programme by a description of the portfolio considerations and how a portfolio will be built. The presentation provided by the Programme Manager during the Info Day gives applicants a further opportunity to understand the background of the call, and to ask questions to the Programme Manager. In no case does the Challenge Guide contradict or supplant the Work Programme text.

Following the selection of a proposal to be funded under the Challenge, the Programme Manager will work together with the consortia of the selected projects to develop a common roadmap with a strategic plan for the Challenge. This roadmap/ strategy plan will integrate the activities and milestones of the individual projects into a shared set of objectives and activities across and beyond the projects. The roadmap serves as a common basis for the project portfolio and may affect the project implementation - including possible adjustments, reorientations, or additional support to projects. The roadmap will be updated in light of emerging results or issues during the implementation.

2 Scope and objectives of the Challenge as defined in the Work Programme

This section is a copy of the Challenge call in the EIC Work Programme text. Proposals to this Challenge are expected to explain how they relate to and intend to go beyond the state of the art, and how they interpret and contribute to the objectives of the Challenge.

EIC Pathfinder Challenge: Architecture, Engineering and Construction digitalisation for a novel triad of design, fabrication, and materials

Background and scope

Life cycle greenhouse gas (GHG) emissions of buildings show a clear reduction trend due to improved operational energy performance. However, Life Cycle Assessment (LCA) analyses also reveal an increase in relative and absolute contributions of GHG emissions embodied in new buildings. Such embodied GHG emissions are caused during all stages leading up to final construction of the building, including in the choice of materials and their subsequent fabrication. Achieving net GHG emission reductions by at least 55% by 2030, and net zero by 2050, will require changes in our built environment and, with that, changes in the Architecture, Engineering and Construction (AEC) value chains.

Moreover, with 70% of the world population projected to live in urban areas by 2050, it is also essential that the construction industry can avail of innovations that will positively impact the quality of life and the human experience in cities and buildings from environmental to social, cultural, and aesthetic points of view.

Decisions taken today by professionals and firms in the AEC sector impact the lives of generations far into distant futures. Initiatives such as the European Green Deal or the New European Bauhaus can offer context and targets in this domain to steer us towards better built environments.

These transformations can gradually interweave numerous scientific and technologic innovations into an interdisciplinary fabric that is interconnected by a common thread of digitalisation.

New digital technologies advance the state-of-the-art in areas such as computational design, algorithmic design, physics simulation, agent-based modelling, topology optimisation, or parametric design. They can open whole new disruptive pathways of design, with higher degrees of system integration, optimisation, and complexity, if they are coupled with the parallel development of advanced digital fabrication and workflow technologies. Moreover, such digital fabrication technologies can in turn materialise such ever more complex designs,

using or reusing known materials, and expectedly introducing more advanced innovative and engineered materials, including new classes of “meta-materials”.

This Challenge seeks to develop research and early innovations with a breakthrough potential related to design, fabrication and materials for the AEC value chain enabled by novel algorithms and advanced digitalization. In such a digitalized AEC value chain design, fabrication and materials are symbiotic and mutually dependent and enabling.

This combination can enable designers, architects, engineers, and fabricators to imagine, design, optimise and create complex and efficient structures within a digitalisation pathway, in response to ever more ambitious requirements for climate neutral, sustainable, inclusive, aesthetic, and inspiring buildings.

Overall goal and specific objectives

The potential of the digitalised, mutually interdependent, mutually reinforcing, intertwined triad of design, fabrication and materials can potentially exceed our wildest imaginations. This Challenge seeks the realisation of disruptive solutions for AEC in one or more of the following areas:

- Computational design solutions that advance the state of the art of algorithmically generated design, topology optimisation, agent-based modelling, physical simulation, digital representations such as digital twins and nature inspired design. New algorithmic design solutions may enable breakthroughs in functional integration of complex systems. These solutions may also blur boundaries of nano-scale, micro-scale, meso-scale, and macro-scale, and allow for new developments in meta-materials or biomimicry in terms of building structures and patterns.
- Digital fabrication solutions synchronous with a vast potential of the nearly unlimited complexity of computational design. Digital fabrication can relate to all digitally enabled manufacturing technologies, in particular to novel concepts for additive manufacturing such as new 3D printing techniques to realise the highly complex design definitions at voxel level with ever-higher resolution. Beyond advancing and further building on the known practices of layered extrusion and binder jetting, processes such as rapid liquid printing in a carrier suspension can be a promising new pathway for digital fabrication for the AEC. In addition, quality assurance (QA) and quality control (QC) may be enabled by new scanning technologies such as Computed Tomography (CT/ μ CT) to detect defects and build a digital “as built” model, albeit at the dimensional scale and fabrication context AEC needs.
- Alternative materials as a field where the mix with digital design and digital fabrication technologies can be demonstrated by the AEC sector to vastly reduce the use of cement and its CO₂ emissions in the transition to net zero. With a deeper adoption of digitalisation in design and fabrication the potential of adopting alternative materials

widens. Digital design and digital fabrication can enable a widespread adoption of bio-based materials, as for example all known and new timber derivatives, fungal architecture, bamboo, hemp, and others, natural materials such as earth, clay, stone as well as recycled and waste-based materials currently considered as inferior. By a similar token, new pathways for engineered materials can also emerge here, as for instance applications of composites and algorithmically generated “meta-materials”. The adoption of such materials allows the AEC sector to reduce or even remove carbon permanently from the atmosphere and economic cycle.

Projects are expected to target organisations and collaborative endeavours that develop ways to incorporate the digitalised triad of design, fabrication, and materials in the reduction of embodied CO₂ emissions, following principles aligned with key EU initiatives such as the European Green Deal or the New European Bauhaus. In this instance, ideas that are primarily centred on operational carbon emissions and/or operational energy efficiency are not in scope of this Challenge. However, it is important to highlight that innovations envisioning reductions of embodied CO₂ emissions shall be at least as effective in reducing operational carbon emissions as the technologies they substitute by the time of market adoption. Also, projects should consider for the future commercial adoption, the issues of compliance with relevant standards of building operational performance.

Expected outcomes and impacts

Projects must clearly achieve a proof of principle and validate the scientific basis of the breakthrough technology. The development and expression of techno-economic views on geometric and economic scalability of the technology itself, coupled with an entrepreneurial path towards commercialisation and future adoption by the AEC value chain are strongly encouraged.

Proposals are expected to demonstrate interdisciplinary and collaborative processes to create critical interactions between disciplines, economic sectors, and other partners with relevant skills as appropriate. The overall goal is to support the formation of new partnerships with innovative approaches and unique solutions that foster new R&I communities and ecosystems to nurture long term changes in the AEC sector.

Expected adjacent impacts of this AEC Pathfinder Challenge are also to inspire an ambition for the AEC sector to create higher quality jobs in a more progressive and appealing business culture that is ready to deliver a transformation of the built environment in line with the European Green Deal and the New European Bauhaus.

3 Portfolio considerations for the evaluation of applications to the Challenge

This section describes how portfolio considerations will be taken into account in the second stage of the evaluation step. For more details of the full evaluation process please refer to the EIC Work Programme pages 29-32.

Portfolio considerations

Computational design, digitalized fabrication, and materials are mutually interdependent, mutually reinforcing and intertwined. A portfolio of projects that addresses one or more of the elements of design, fabrication and materials are expected to mutually benefit from each other. Therefore, this AEC Pathfinder Challenge ideally attracts a diversified range of novel design, fabrication and material R&I developments that can mutually benefit from a portfolio approach and collaborative paradigms during project execution within the EIC.

For building the portfolio of projects to be funded, the evaluation committee will apply the following portfolio considerations:

The objectives of all proposals will be mapped against the three categories of computational design, digitalized fabrication, and materials. It is possible that a proposal targets one, two, or all three categories. The objectives of all proposals will also be mapped against sub-categories as depicted in the table. The evaluation committee will aim to compose a balanced portfolio covering a wide range of these three categories and sub-categories.

Within and among these categories, the evaluation committee will look at shared components or potential complementarities among the projects to identify a clear added value for the development of synergies and collaborations among the projects in the portfolio in order to maximise the overall impact on the expected outcomes and impacts of the Challenge. Shared components or potential complementarities could for example relate to overlap of, and/or the mutual interdependency between production technologies and computational design, material technologies and production technologies, computational design and material technologies.

Starting from the highest ranked proposal, a portfolio of proposals will be selected based on shared components/complementarities, while ensuring diversity among the selected proposals and coverage of the three categories. This implies that if the evaluation committee considers that a highly ranked proposal does not have a shared component/complementarity with other proposals, it will not be selected for the portfolio. To ensure diversification, proposals which the evaluation committee considers to be very similar to a proposal already included in the portfolio will not be selected. Consequently, this means that the projects selected for funding after the second step is expected to differ from the ranking list established from the first step (score based ranking after assessment of each proposal separately).

As a result of these portfolio considerations, the portfolio of projects selected for funding after the second step may differ from the ranking list established from the first step.

Categories/ Subcategories

The three major categories and subcategories are depicted in the table below. The lists of subcategories aim to provide exemplary guidance and considerations for the evaluation committee and are non-exhaustive.

COMPUTATIONAL DESIGN	DIGITALIZED FABRICATION	MATERIALS
Algorithmic design, AI	AM ¹ : extrusion 3D printing	Concrete/cement ²
Topology optimization	AM ¹ : other technologies	Timber derivatives ³
Agent-based modelling	Subtractive manufacturing	Bio-based materials
Parametric design	Weaving, braiding, knitting	Natural materials
Physical simulation engines	Macro-, meso-, microscale	EM ⁴ : fibre composites
Biomimicry	Industrialized automation	EM ⁴ : fabric composites
Macro-, meso-, microscale	Robotics	EM ⁴ : metamaterials
Digital Twin	QA/QC scanning at scale	Discrete blocks, archimats ⁵
Other	Other	Other

¹ AM: Additive manufacturing

² Albeit with the aim of using less for example enabled by computational design and digitalized fabrication or higher performance

³ Enabled or enhanced by computational design, digitalized fabrication

⁴ EM: Engineered materials

⁵ Architected materials

4 Implementation of the Challenge portfolio

Once selected, projects will be expected and obliged to work collectively during the implementation of their projects under the guidance of an EIC Programme Manager. This section summarises some of the key aspects of this pro-active management which applicants should take into account in preparing their proposals.

Proposal preparation and grant negotiations

Applicants may be requested to make amendments to their proposed project to take into enhance the portfolio. Such changes may for instance include additional tasks to undertake common/ joint activities (workshops, data exchanges, joint research, etc) with other projects in the portfolio.

Based on first experience, it is advised to foresee in your proposal a dedicated work package for portfolio activities and to allocate at least 10 person-months (see below for the purpose and examples of such activities). You may propose concrete activities or remain generic in your description.

If you fail to do this during proposal time, your proposal will not be scored lower during the evaluation, but in case your proposal is selected for grant agreement preparation, you will be requested to add the portfolio work package to your grant agreement. Please be aware that in that case the maximum grant you receive will not change, and you will need to find the resources for portfolio activities within the foreseen project budget.

Challenge portfolio roadmap/ strategy plan

The portfolio aims at:

1. **Enhancing the opportunities of new computational design methods, new digitalised fabrication methods, and innovative materials in the AEC domain, because of its active participation in the portfolio activities:** Ensuring that portfolio members, can build key partnerships for their future value chains.
2. **Enhancing the commercialisation potential of the individual projects in the portfolio, because of its active participation in the portfolio activities:** Ensuring that portfolio members, can access the right industry partners to explore key partnerships

In order to accomplish the above the Programme Manager needs to develop and agree on a strategy plan for the “Digitalized AEC” portfolio with the portfolio projects.

Portfolio Strategy Plan

Following the selection of a proposals to be funded under the Challenge, the Programme Manager will work together with consortia of the selected projects to develop a common strategy plan/roadmap for the Challenge. This plan will integrate the activities and milestones of the individual projects into a shared set of specific objectives and activities across and beyond the projects. The roadmap serves as a common basis for the project portfolio and may affect the project implementation - including possible adjustments, reorientations or additional support to projects. The roadmap will be updated in light of emerging results or issues during the implementation. The objectives can be revised, for instance based on projects' unexpected achievements, new technology trends, external inputs (other projects, new calls...).

In particular, the Challenge roadmap/ strategy plan will include activities on the transition to innovation and commercialisation, and to stimulate business opportunities. These activities may be reinforced during the implementation with additional funding and expertise through pro-active management.

Non-exhaustive examples of activities towards the above-mentioned aims are:

- Contributing to understand better/improve the current regulatory framework
- Effectively communicate of any key outcome of the research work of the portfolio members collectively and/or an individual project, to early stage private and corporate investors focused on the same field. Such communication might also be addressed to the general public to increase social acceptance for proposed solutions, , or to other researchers and stakeholders through common dissemination activities at scientific conferences or trade-fairs.
- Market analysis: Map the targeted players in a market and exchange the market research analysis results with other the portfolio projects to identify specific players with which the entire portfolio can establish partnership(s) of much higher impact as opposed to that of the individual project.
- Discussions on IP, licensing and business models and commercialisation strategy
- Providing access to Open Innovation Test Beds and other research infrastructure
- Standardisation activities
- Providing access to new markets through multipliers like Enterprise Europe Network

These tasks require the active participation of portfolio members to a series of meetings called for and steered by the Programme Manager. Portfolio projects will be expected to exchange information on the proposed research methodologies, experimental tests, techno-economic input data and relevant results achieved, to collectively use the available resources. This exchange of data between portfolio members can enhance the potential of individual projects, use of results originating from the analysis of common databases, as well as their chances to establish key partnerships. The exchange of information for the purpose of EIC portfolio activities will fall under the conditions and non-disclosure obligations as specified in the EIC Work Programme 2023 (Annex 6, section 2).

Tools through which projects can receive additional support

Projects in the portfolio may be offered additional support, either individually or collectively, in order to reinforce portfolio activities or explore the transition to innovation. Such additional support includes:

- Booster grants of up to €50k (see Annex 5 of the EIC Work Programme)
- Access to additional EIC Business Acceleration Services (see https://eic.ec.europa.eu/eic-funding-opportunities/business-acceleration-services_en)
- Access to the Fast Track to the EIC Accelerator, which would follow a project review (see Annex 3 of the EIC Work Programme)
- Access to the EIC Market Place, once operational, to connect with innovators, investors and other selected partners
- Interactions with relevant projects and initiatives outside the portfolio, including other EU funding initiatives as well as those supported by national, regional or other international bodies.