AI-BOOST

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AI Open competitions

AGENTIC AI FOR AUTOMATED CAD GENERATION AND AUTONOMOUS SIMULATION

CHALLENGE DESCRIPTION

(Version 2 – 10/06/2026)

1. ANNEX 2: CHALLENGE DESCRIPTION

1 CHALLENGE DESCRIPTION

1.1 Title

Agentic AI for Automated CAD Generation and Autonomous Simulation

1.2 Organisation Description

Organisation name: SIAD Group
Website: https://www.thesiadgroup.com/en/who-we-are
Sector / Industry: manufacturing
Country: Italy

The SIAD Group is an international organization active in four strategic areas: Industrial Gases, Engineering, LPG and Natural Gas, and Healthcare.

With a long-standing tradition and specialized know-how, it offers integrated, customized, and sustainable solutions. Innovation, quality, and the development of people drive every activity.

Synergies among the Group's companies enable it to tackle even the most complex challenges with agility. The Group's identity is built on shared values, motivated people, and a vision focused on global growth.

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1.3 Challenge Description

OVERVIEW

The design and simulation of mechanical components still depend heavily on experienced engineers who can interpret implicit geometric constraints, adapt parts to existing assemblies, define meshing strategies, and conduct convergence studies. This challenge aims to develop an agentic AI system able to autonomously support the workflow from design intent to simulation setup.

Starting from existing CAD assemblies, 2D piping drawings, and natural language requirements, the system should generate compatible and parametric 3D CAD models or components. The solution is expected to interpret geometric relationships, mating logic, tolerances, functional requirements, and assembly constraints, even when these elements are only partially explicit in the input material.

For example, the AI should be able to generate a component or piping model that fits within an existing housing, aligns with predefined holes or connection points, respects dimensional and assembly constraints, and follows requirements described through text prompts or engineering documentation. In addition, the system should support the preparation of structural simulations by generating appropriate meshes and seed strategies, running convergence analyses, identifying critical stress regions, and proposing optimized refinement strategies.

The innovation of the challenge lies in combining generative AI, geometric reasoning, CAD knowledge, and simulation intelligence within a unified agent-based workflow. The long-term ambition is to move from tool-assisted engineering towards AI-driven autonomous engineering processes, while preserving expert supervision and standard industrial validation procedures.

OBJECTIVES

1. Develop an agentic AI system capable of interpreting engineering requirements expressed in natural language.
2. Enable automatic extraction of geometric and assembly constraints from CAD assemblies, 2D drawings, and related engineering metadata.
3. Generate compatible and parametric CAD components or piping models that respect functional, dimensional, and assembly constraints.
4. Support automated mesh generation, seed strategy definition, convergence analysis, and identification of critical simulation regions.
5. Provide outputs that can be validated by technical experts and integrated progressively into existing engineering review workflows.

EXPECTED OUTCOMES AND TRL LEVEL

The expected outcome is a functional Proof of Concept that integrates automated CAD generation and intelligent simulation setup in a coherent workflow. The solution should demonstrate a measurable reduction in manual engineering effort and should be validated against expert-defined CAD and FEA processes in relevant industrial environments.

The target maturity level for the challenge is TRL 5-6, with validation in representative industrial scenarios and with outputs suitable for technical review by experienced engineers.

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1.4 Expected Impacts and KPIs

If successfully implemented, the solution would reduce dependency on scarce high-level engineering expertise, accelerate product development cycles, and lower barriers to advanced design and simulation capabilities, especially for SMEs. It would support the digital transformation of European manufacturing by embedding AI-driven intelligence directly into core engineering processes and by strengthening industrial competitiveness and technological sovereignty.

The following KPIs can be used to assess the impact and technical performance of the proposed solutions:

- KPI1 – Engineering effort reduction (time ratio): AI hours required to generate the piping deliverable / human hours required in the baseline (manual) process. Unit: ratio (or %). Target: < 1 (or % reduction vs baseline).
- KPI2 – Overall size reduction ratio (cost-driven): overall skid/package dimensions of the AI-generated solution / overall skid/package dimensions of the baseline proposal (Vendor Department). Dimensions to be tracked include main piping length. Unit: ratio (or %). Target: < 1 (smaller package vs baseline, with expected cost reduction).

1.5 Data Framework

SIAD Group will provide CAD assemblies and components, historical simulation cases including mesh parameters and boundary conditions, engineering specifications, and benchmark validation cases. Real industrial use cases may be tested in different manufacturing sectors.

The core data mainly consists of 2D piping drawings and 3D CAD piping models. The 2D drawings can be used as input material, while the corresponding 3D CAD models can be used as reference outputs for system development and validation. The dataset is not explicitly annotated with OK/KO labels. Relevant information, such as component types and connection logic, is implicitly embedded in the engineering metadata and in the reviewed technical documentation. For this reason, a conventional label error rate is not applicable; data quality is ensured through standard engineering review and approval workflows.

For final evaluation and demonstration, unseen data will be used. Development may be carried out on a restricted group of machine designs or piping subsystems, while validation can be performed on remaining designs or subsystems to reduce the risk of overfitting and data leakage.

DATA RIGHTS (LEGAL & ETHICAL)

The drawings, CAD models, engineering instructions, and related materials included in the dataset are owned by SIAD Group. Where SIAD MI data is involved, SIAD MI holds the necessary rights to share the dataset and grant access for the purposes of the challenge. The dataset must not be shared with external platforms or third parties unless appropriate confidentiality agreements are in place and applicable data-protection requirements are respected.

The dataset does not contain personal or sensitive data. The data is produced internally by engineers and subject-matter experts during the preparation of piping drawings, P&IDs, CAD models, and related engineering documentation. Access to the data and its use by challenge participants will be subject to the applicable Non-Disclosure Agreement, cybersecurity policies, internal compliance requirements, and any AI usage policy provided by the data owner.

Known limitations include variability in drawing and CAD conventions, differences in metadata completeness across projects, class imbalance among component types and connection layouts, and limited historical records of engineering errors or non-conformities. These aspects should be considered when designing, training, and evaluating proposed solutions.

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1.6 Evaluation Metrics and Protocol

The current baseline is the manual workflow performed by experienced technical designers and engineers, who create and validate drawings and CAD models according to established engineering standards and review procedures.
The primary evaluation dimension is performance and time-to-output: the time required to generate a correct 3D CAD piping model or equivalent deliverable starting from the 2D input. The evaluation should also consider the amount of rework required after the AI output, for example the number of corrections or engineering hours needed to reach an approved final design.
Secondary evaluation dimensions include cost impact, reduction in package dimensions where applicable, integration feasibility, explainability, safety, scalability, and trustworthiness. In particular, the system should be assessed not only on its ability to produce a plausible model, but also on whether the output is technically usable, traceable, and aligned with industrial review requirements.
A random split may be used for initial development experiments where appropriate. The final evaluation will include unseen cases and representative industrial scenarios to ensure that results generalize beyond the data used during development.

1.7 Infrastructure

Testing may be supported through a dedicated workstation or a virtual environment on Azure, depending on the proposed solution and security requirements. A cloud-based solution is recommended, provided that it complies with the applicable data-governance and cybersecurity constraints.
The target is to integrate the solution progressively into the piping design workflow. Since the current CAD toolchain does not yet support robust, deep, or fully automated integration in all cases, an initial deployment option may focus on producing a structured 2D output, such as a drawing enriched with connection specifications and constraints. This would allow a technician to implement the 3D model more reliably, following the indications produced by the system and without having to decide independently how to route or connect the piping.

1.8 Responsible AI

Human oversight is required. The final decision and approval of any generated output remain the responsibility of an experienced technical expert within the standard engineering review workflow. The AI system should provide an appropriate level of explainability, traceability, and transparency to support verification and accountability.
No demographic diversity issue is expected for this dataset, as it concerns technical engineering assets rather than personal data. However, participants should address risks related to unsafe or technically invalid engineering outputs, including incorrect connections, missing components, non-compliant dimensions, or simulation setups that could lead to misleading conclusions.
Sector-specific guidelines and internal AI usage policies may apply. Proposed solutions should be designed to comply with the applicable industrial, contractual, and governance requirements defined by the data owner and challenge stakeholders.

1.9 Additional Support Offered by the Challenge Owner

Siad Group and/or Consorzio Intellimech will participate in co-creation and mentoring during the competition phases. It can support dissemination of results through journals and conferences, facilitate collaborative projects between winners and academic institutions, and give visibility to the developed solution within its ecosystem, including associated companies, regional and national clusters, and European partnerships.

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