

STEM EDUCATION · OPEN CATEGORY

STEMATHLON 2027

Middle School

From Human to Artificial Intelligence

The year is 2040. Fast-forward 13 years and look back:
take a problem the world faces today, one the future depends on solving, and
engineer the robotic answer that gets us there.

SUB-CATEGORY 01

Engineer Heroes

SUB-CATEGORY 02

Engineer Legends

Version 1.6

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Open Category — two levels of expertise



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Summary

STEMATHLON 2027 invites teams to fast-forward 13 years and **invent the future**. The mission is simple to state and hard to solve: take a real problem the world faces **today**, one that **must** be solved for the future to thrive and design, build and program an innovative robotic solution for it, staged inside a realistic model of the world it belongs to.

Teams of **2–6 students with a coach** compete in one of two categories that share the theme but differ in ambition and expertise. Both are open to students of every age.

ENGINEER HEROES

A fully autonomous system that interacts realistically with its environment. **2–6 automations in total.**

ENGINEER LEGENDS

Two or more autonomous systems that communicate only with, or through, a central control unit. The central control unit displays the measurements on a dashboard. **3–8 automations in total.**

Key points

- **Categories:** Engineer Heroes and Engineer Legends. Both open to all ages — the category sets the expected level of expertise, not the students' grade.
- **Materials:** No restrictions on construction materials.
- **Programming:** Any language, as long as the code runs autonomously.
- **Artificial Intelligence:** Not only allowed but **encouraged**. Any part built with AI must be declared, and judges may ask about it during the presentation.
- **Model surface:** Maximum 150 × 150 cm.
- **Automations:** Heroes 2–6, Legends 3–8 (see the automation definition in Specifications).
- **Deliverables (15 days before):** a general report and a technical report (submitted digitally *and* brought printed), plus a one-page A4 magazine promo (optional for Heroes, mandatory for Legends).
- **Evaluation:** Project & innovation, robotic solution, use of AI, and presentation. Heroes and Legends use separate rubrics.
- **Ranking:** First 12 Ranking, Gold (3 Teams), Silver (3 Teams), Bronze (3 Teams).

A. Description

2027 → 2040: Today's students, tomorrow's protagonists.

Imagine that we are in 2040. You are no longer students, but adults who live, work, create and make decisions about the future. What does your daily life look like? Where do you live? What do you do? And how do science, technology, artificial intelligence and automation help you in real life?

Imagine, design and build an original solution that presents your own vision of 2040. The category is aimed at students of all ages, grouped by expertise into Engineer Heroes and Engineer Legends, and its objective is to create and present innovative robotic constructions that showcase the exciting transition from human ingenuity to the automated, intelligent systems of tomorrow.

Choose your field

You may choose **any area of your life**, such as:

- Education
- Work, professions and the economy
- Health and wellbeing
- Environment and sustainable development
- Transport and smart cities
- Daily life and the smart home
- Entertainment, sport and culture
- Social life, communication and collaboration

... or any other field you consider important.

The Invitation

Show us how you imagine your life as adults in **2040**, and how STEM and new technology can make the world better for everyone. Let your imagination, your creativity and your ideas become reality.

We do not wait for the future. We create it.

B. The Challenge

Teams begin with research and discovery. First, they identify and study a contemporary problem within the announced thematic pillars, understanding its causes, its consequences, and why it will still matter in 13 years.

Next, they design and propose an innovative, technology-driven solution, and build it as a working system integrated into a **realistic model of its environment (a diorama)**, so that the operation and effectiveness of the solution can be demonstrated live. The autonomous system and all automations must work together toward one common purpose.

What the built system must contain depends on the category. In **every** case the system must be **fully autonomous** and interact realistically with its environment. **Legends** go further, building a centralized, fully wireless, multi-part system with a live dashboard. The exact requirements for each category are in Section C, and the technical anatomy of the system in Section H.

THE ENGINEERING ARC

1. Research a real problem of today → **2. Design** an innovative future solution → **3. Build & program** an autonomous system → **4. Stage it** in a realistic diorama → **5. Present** it to the judges.

C. THE TWO CATEGORIES · CATEGORY 01

C-1: Engineer Heroes

Engineer Heroes is the category for teams ready to prove themselves. It is open to students of **all ages** — the category reflects the **level of expertise** of the project, not the students' grade. Heroes solve a real, tangible problem and bring it to life as an autonomous system inside a believable model.

The problem	A challenge at the scale of a neighborhood or community — and above. Real people, a real place, a solvable need.
What you build	1. A fully <u>autonomous system</u>. 2. Realistic interaction with its environment (a <u>diorama</u>).
Complexity	2 to 6 automations (see the <u>automation</u> definition in Specifications).
Deliverables	General report + technical report (submitted and printed). A4 magazine promo is optional .
Artificial Intelligence	Encouraged. Declare any AI-built parts and be ready to discuss them.

C. THE TWO CATEGORIES · CATEGORY 02

C-2: Engineer Legends

Engineer Legends is the category for advanced teams aiming high. It is open to students of **all ages** and expects a higher level of engineering: a networked, centrally controlled system that reports everything it senses to a live dashboard.

The problem	A challenge that affects many people — at least city-wide, ideally global .
What you build	Everything Heroes build, plus a networked architecture: 1. A fully <u>autonomous system</u>. 2. Realistic interaction with its environment (a <u>diorama</u>). 3. <u>Fully wireless communications</u> between parts — the <i>only</i> exception is a serial link to a PC or tablet. 4. A <u>centralized, controlled system</u>. 5. A <u>dashboard</u> that displays all measurements.
Complexity	3 to 8 automations (see the <u>automation</u> definition in Specifications).
Deliverables	General report + technical report (submitted and printed). A4 magazine promo is mandatory .
Artificial Intelligence	Encouraged and formally assessed (see Evaluation).

D. Participants & Teams

Each team consists of **2 to 6 students led by a coach**. A student may take part in only one team, regardless of category.

Both categories are open to students of **all ages and school levels**. The category is chosen by the team according to the **ambition and expertise** of its project — not by grade or age. Specific age eligibility follows the general STEMATHLON regulations.

The team coach must be **21 years of age or older** during the year of the competition.

NOTE — WRO 2027 QUALIFICATION

Teams distinguished in this category are eligible for the WRO 2027 Educational Robotics Olympiad qualifiers. There, a team must have **2 to 3 members**, and the winning teams must **upload a video** of their project to compete.

E. Materials & Equipment

Systems and models may be built from any materials available to the team, with no restriction on the number of passive and mechanical components. Teams are advised to keep spare repair materials on hand, both while preparing and on competition day.

The base station (Legends): It could be a computer or other system able to receive, process and display information; ideally as real-time graphs. Its program should run smoothly and autonomously, without external intervention. When using cloud services, the base station may act as an intermediary, with the display coming from it or another device.

The autonomous system: should carry every automation it needs to collect data and act on its own, without external interconnection or manipulation. Its only external link is to the base station via wireless technology. If a second autonomous system is used, it may communicate with the first **only** through the base station.

AI use: Teams may use AI to help build their project, and the project itself may use AI — for example machine learning for decision-making and control. AI is allowed and encouraged, but it must be understood: students are expected to review every AI-generated part, and to explain both their chosen topic and how their AI behaves.

HW & AI Integration Tools Proposals

Recommended equipment

Equipment provided to schools by the Ministry (or other bodies, e.g. 1821) — see [the STEM Education portal](#):

S1 S2 S4 Nezha ARD:icon Gigo R2

Also allowed: anything based on micro:bit

Important — Engineer **Heroes** may use **ONLY** the recommended equipment listed above. Engineer **Legends** are free to use any equipment.

AI Integration Tools

Machine learning: Teachable Machine

Similar free or open-source software is equally acceptable.

RESTRICTIONS

Measurements: There is **no limit** on the number or types of measurements collected, processed or displayed. (The previous cap of six is removed — the sub-system limits now bound overall system complexity.)

Power: The autonomous system(s) must be powered by portable power source(s) with a maximum total capacity of **10,000 mAh**.

F. Specifications

The model may not exceed **150 × 150 cm**, with the robotic assembly necessarily included in that footprint. Even during operation and demonstration, every component must remain within these dimensions. Any system required to operate outside these limits is considered non-compliant.

The use of any component that may endanger the health or safety of students and judges is strictly prohibited. Power must be supplied safely, eliminating any possibility of short-circuiting through mishandling or other causes. Where liquids are used, **only water** is permitted, up to a maximum total of **1 liter**.

WHAT COUNTS AS A "SUB-SYSTEM"

A **sub-system** is a group of components working together to accomplish **one specific task**. Multiple sensors and actuators (motors, LEDs, buzzers, etc.) that serve the same task count as a **single** sub-system.

Example: a distance sensor + two motors + a buzzer that together open a gate count as **one** sub-system.

Thresholds: Engineer Heroes: **2 to 6** sub-systems · Engineer Legends: **3 to 8**

G. Deliverables

Each team submits a portfolio **no later than 15 days before** the competition, and brings **printed copies** of the two reports to the event:

- **1. General report (PDF, max 10 pages).** Information about the team, a description of the research, the main principles behind the robotic system, and the solutions it offers. References and citations are required. **Brought printed.**
- **2. Technical report (PDF, max 10 pages + code appendix).** Technical detail on the systems — materials (e.g. LEGO-type bricks), electronic parts (microcontroller, sensors, etc.), and the program that runs the system as an appendix. The 10-page limit excludes the appendix. **Brought printed.**
- **3. Magazine promo (one A4 page).** A single page designed as a feature or advertisement for the project, as if published in a magazine. **Optional for Heroes, mandatory for Legends.**
- **4. Video presentation (video file or online link).** A short video introduces the team, the problem it chose and the robotic solution in operation. **Optional for both Heroes and Legends.**

Note: if a team qualifies for the World Robot Olympiad (WRO), video presentation becomes mandatory.

Note: STEM Education plans to run a webinar later this year on how to film and edit the video, and on tools that can help.

H. The Final System

The final step is to fully develop the robotic assembly and integrate it into a realistic presentation environment (a [diorama](#)), so the team can demonstrate how their solution works and why it is effective. The technical make-up of that system depends on the category.

Required of every team

- A fully [autonomous system](#) — it runs and makes its decisions on its own, without external manipulation.
- **Realistic interaction with its environment** — the system reacts to a believable model of the world it serves.

Additionally required of Engineer Legends

- [Fully wireless communications](#) between the parts of the solution. The only permitted wired exception is a serial connection to a PC or tablet.
- A [centralized, controlled system](#) — the parts are coordinated through a central point rather than acting in isolation.
- A [dashboard](#) that displays all of the system's measurements.

The [base station](#) processes, analyses, stores and displays (or feeds back) the information it receives from the autonomous unit in real time. The **autonomous unit** collects and transmits environmental data and performs the tasks the challenge demands — for example incorporating sensors for environmental measurements, mapping an area, or locating materials. A second autonomous structure is acceptable, but a second [base station](#) is not.

I. Use of Artificial Intelligence

Artificial intelligence is **not prohibited — it is encouraged**. Teams may use AI wherever it genuinely helps researching the problem, designing the solution, generating or reviewing code, analyzing data, running on-device inference, or powering the [dashboard](#).

The rules of engagement

- **Declare it.** Clearly note which parts of the project were developed with AI — in the technical report and at the booth.
- **Be ready to defend it.** Judges may ask questions about the AI parts during the presentation; every member should be able to explain them.
- **Understand and verify it.** Know how your AI works and its limits, and validate the tools, data and sources behind it rather than trusting outputs blindly.

For **Engineer Legends**, the use of AI is **formally assessed** through a dedicated block of the rubric. For **Engineer Heroes**, thoughtful use of AI is **rewarded**. Either way, honesty about what AI did — and understanding of why — counts far more than the sheer amount of AI used.

J. Evaluation

Each team is evaluated to determine the final ranking and to receive feedback for improvement.

Heroes and Legends use separate rubrics. The full **Engineer Legends** rubric is below; the simplified **Engineer Heroes** rubric follows.

Engineer Legends - scoring (max 280)

Project & Innovation	Idea, Quality & Creativity	25
	Deliverables	30
	Research	20
	Innovation	10
	Completeness of the solution	15
Subtotal		100
Robotic Solution	Coherence & operation of all systems	25
	Substantial use of mechanics & programming	25
	Integration of modern technologies	15
	Data collection, processing & analysis	15
Subtotal		80
Artificial Intelligence	Efficient usage of AI	10
	AI solutions understanding	20
	Evaluation & verification of AI sources	10
Subtotal		40
Presentation & Understanding	Pitch	10
	Technical understanding	15
	Team spirit	10
	Interaction with environment	10
	Booth decoration	5
	System design & implementation	10
Subtotal		60
MAXIMUM SCORE		280

How each Legends criterion is judged

Project & Innovation

Idea, Quality & Creativity (25 pts)

Originality and clarity of the future problem chosen and the elegance of the proposed solution. *Example: tackling*

urban water scarcity in 2040 with a self-organizing network of atmospheric water harvesters, clearly scoped rather than a vague “smart city”.

Deliverables (30 pts)

Completeness, clarity and professionalism of the general report, technical report and magazine page. *Example: reports are well-structured, cited and printed, and the A4 reads like a real feature from a future science magazine.*

Research (20 pts)

Depth of investigation into the present-day problem, its causes and consequences, and why it will still matter in 2040. *Example: the team cites current data on aquifer depletion and projects the trend forward from credible sources.*

Innovation (10 pts)

How forward-thinking the approach is compared with existing solutions. *Example: instead of copying today's desalination, the team pairs a novel material with an adaptive AI controller.*

Completeness of the solution (15 pts)

Whether the solution fully addresses the problem end-to-end. *Example: the system closes the loop — sensing, deciding, acting and reporting — rather than only detecting the issue.*

Robotic Solution

Coherence & operation of all systems (25 pts)

All parts of the solution work together reliably as one integrated whole. *Example: the autonomous unit, base station and dashboard complete a full cycle with no manual help.*

Substantial use of mechanics & programming (25 pts)

Meaningful mechanical design and non-trivial code, not decorative parts. *Example: a custom gripper driven by a control loop that adapts to sensor readings.*

Integration of modern technologies (15 pts)

Appropriate use of contemporary tech — wireless protocols, sensors, cloud. *Example: sensor data streamed over a wireless protocol to a live cloud dashboard.*

Data collection, processing & analysis (15 pts)

Quality of how data is gathered, processed and turned into insight. *Example: raw streams are filtered, aggregated and shown as trends that drive the system's decisions.*

Artificial Intelligence

Efficient usage of AI (10 pts)

AI is used where it genuinely adds value, not forced in for its own sake. *Example: a small on-device model classifies crop disease from images — a task poorly suited to fixed rules.*

AI solutions understanding (20 pts)

The team truly understands the AI it used, including its limits. *Example: students explain their model's training data, failure modes and why it sometimes misclassifies.*

Evaluation & verification of AI sources (10 pts)

The team checks and validates the tools, data and sources behind its AI. *Example: AI-generated code and facts are verified against reliable references, and every AI tool used is documented.*

Presentation & Understanding

Pitch (10 pts)

Clarity and persuasiveness of the spoken presentation. *Example: a crisp story that makes judges care about the*

problem within the first minute.

Technical understanding (15 pts)

Every member understands how their system works. *Example: any student can answer “why this sensor?” convincingly.*

Team spirit (10 pts)

Collaboration, enthusiasm and shared ownership. *Example: members back each other up and all contribute during Q&A.*

Interaction with environment (10 pts)

How realistically the system interacts with its diorama. *Example: the robot reacts to real changes in the model — light, obstacles, moisture.*

Booth decoration (5 pts)

Presentation of the stand. *Example: a themed future booth that reinforces the story.*

System design & implementation (10 pts)

Overall engineering quality and how well design choices were executed. *Example: clean wiring and a sensible architecture.*

EVALUATION · SIMPLIFIED RUBRIC

Engineer Heroes - scoring (max 200)

Engineer Heroes are judged on a simplified rubric that keeps the spirit of the Legends rubric but drops the criteria tied to Legends-only requirements (wireless, centralized control, [dashboard](#)) and lightens the AI weighting. Criterion definitions match the Legends descriptions on the previous pages.

Project & Innovation	Idea, Quality & Creativity	25
	Deliverables	20
	Research	15
	Innovation	10
Subtotal		70
Robotic Solution	Coherence & operation of all systems	25
	Substantial use of mechanics & programming	25
	Data collection & analysis	10
Subtotal		60
Artificial Intelligence	Efficient usage of AI	10
	AI understanding	10
Subtotal		20
Presentation & Understanding	Pitch	10
	Technical understanding	15
	Team spirit	10
	Interaction with environment	10
	Booth decoration	5
Subtotal		50
MAXIMUM SCORE		200

NOTES ON SCORING

- The **Legends** rubric follows the weights provided by the organizers and totals **280** points.
- The **Heroes** rubric above is a **proposed simplification** for confirmation; the weights can be tuned before publication.
- Although penalties are undesirable, failing to comply with the rules and regulations may lead to point deductions or exclusion from the competition.

K. Ranking of Teams

The final ranking is based on each team's average score, awarded **per category**, Heroes and Legends are ranked separately.

The best 12 teams' ranking in each category will be announced and the top three will go to the podium (bronze, silver, gold).

Note: this might change in a later version

L. Special Awards (not final)

Because we love the small details of the students' projects that sometimes aren't reflected on the final ranking we present some special awards:

- Best Diorama
- Most Innovative Idea
- Best AI integration with the project
- Best Team Spirit
- Best Magazine Promo
- AI engineers (Best AI use-case)

Note: more special awards will be added in a later version.

Our goal

As organizers and judges, we care not only about the final result but about each team's journey towards it

the students' enthusiasm and passion, their joy of creation, and their ability to turn ideas into action. Particular importance is given both to the technical excellence and innovation of the solution and to a substantive understanding of the knowledge behind it.

Above all, we want students to show how new technologies including artificial intelligence, can play a meaningful role in their lives and help solve the challenges of today and tomorrow.

Appendix

Vocabulary, explanatory diagrams & a worked example, to accompany the STEMATHLON 2027 Open Category rulebook.

A.1 Vocabulary

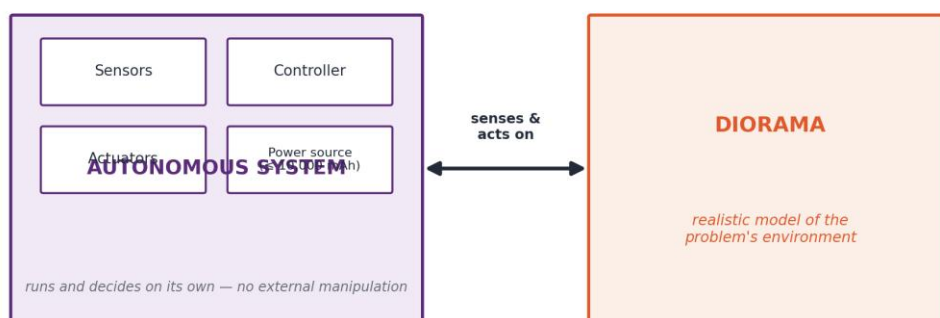
Diorama	A physical model built to realistically represent the environment where the team's solution operates, so judges can watch the system sense and act on a believable version of the real world. Must fit within the 150 × 150 cm maximum footprint, robotic assembly included.
Automation	A group of components — sensors and/or actuators — that work together to carry out one specific task. Example: a distance sensor + two motors + a buzzer that together open a gate count as one automation, not three. Engineer Heroes need 2–6 automations; Engineer Legends need 3–8.
Autonomous system	The physical robotic unit that carries every sensor, actuator and controller needs to sense and act on its own, with no person operating it during the run. Its only permitted external link is a wireless connection to the base station (Legends) — no other external interconnection or manipulation is allowed.
Base station	(Engineer Legends only) A computer, tablet or similar device that receives, processes, stores and displays the data sent wirelessly by an autonomous system. It must run smoothly and autonomously — without someone operating it manually during the run.
Dashboard	(Engineer Legends only) The live, on-screen display — hosted on or driven by the base station — that shows all the measurements the autonomous system is collecting, ideally as real-time graphs.
Centralized, controlled system	An architecture where every part of the solution reports back to, and is coordinated through, one base station rather than acting in isolation. A second autonomous system is allowed, but it may only communicate with the first through the base station — never directly.
Fully wireless communication	Every link between the physical parts of an <u>Engineer Legends system</u> must be wireless. The single exception permitted is a wired serial connection between the base station and a PC/tablet.
Portable power source	The battery or batteries powering the autonomous system(s) on the diorama. Combined capacity may not exceed 10,000 mAh, and power must be supplied safely with no possibility of short-circuiting.
Magazine promo	A single A4 page, designed as if it were a feature or advertisement in a real magazine, that pitches the team's project to a general audience. Optional for Engineer Heroes, mandatory for Engineer Legends.
Declared AI use	Any part of the project — research, code, data analysis, the dashboard, etc. — built with the help of artificial intelligence, explicitly labelled as such in the technical report and explainable by any team member on request.

A.2 System Architecture — Explanatory Diagrams

Both categories require a fully autonomous system that interacts realistically with a diorama. Engineer Legends adds a wireless, centralized layer on top of that base.

Engineer Heroes

ENGINEER HEROES — System Architecture

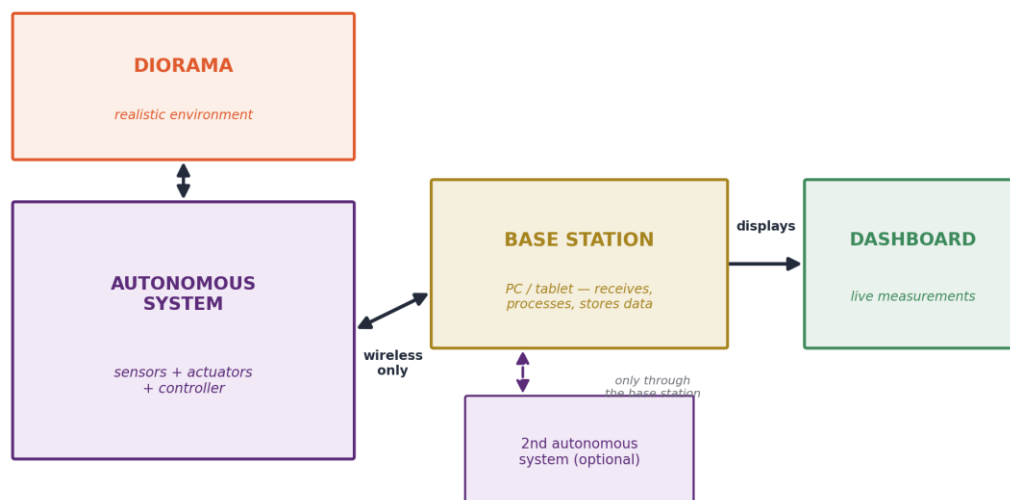


The autonomous system is entirely self-contained on the diorama: it senses its environment and acts on it without any outside help.

Engineer Legends

ENGINEER LEGENDS — System Architecture

Only permitted wired link in the whole system: base station ↔ PC/tablet (serial).



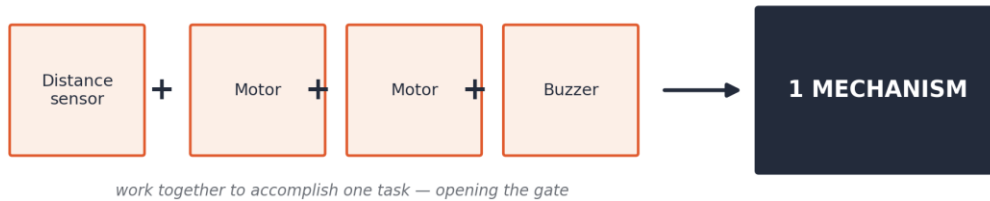
The autonomous system still senses and acts on the diorama alone — but now reports wirelessly to a base station, which drives a live dashboard. A second autonomous system, if used, may only talk to the base station, never directly to the first.

A.3 What Counts as an “Automation”

An automation groups every sensor and actuator that serves one single task. Counting automations, not individual parts, is what sets your complexity band.

WHAT COUNTS AS A "MECHANISM"

Example: an automatic gate



Thresholds — Engineer Heroes: 2 to 6 mechanisms · Engineer Legends: 3 to 8 mechanisms

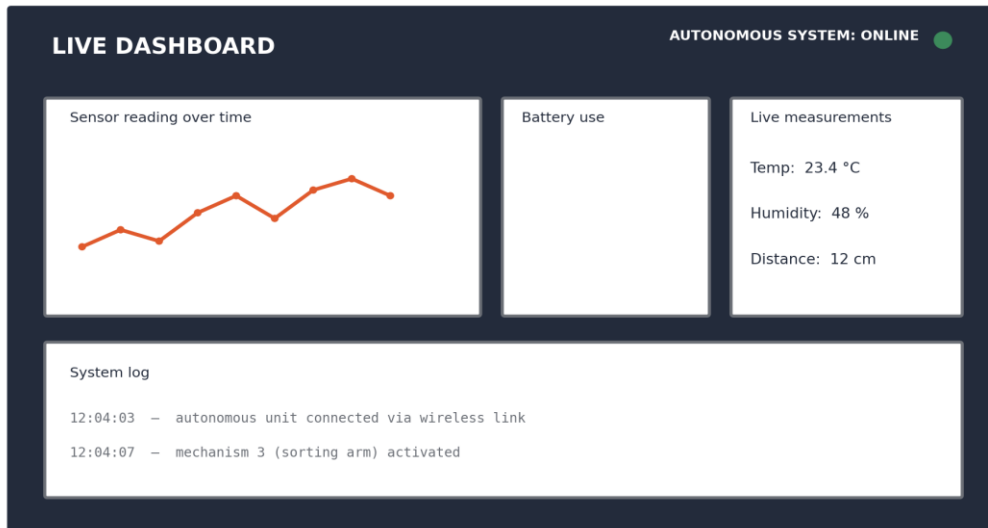
A distance sensor, two motors and a buzzer that together open a gate are one automation — not four separate ones.

A few more examples:

- A light sensor + one servo that opens a window shade → 1 automation.
- A moisture sensor + a pump + an LED status light that together water a plant → 1 automation.
- Two unrelated tasks — a sorting arm and a separate alarm system — count as 2 automations, even if they share a controller.

A.4 The Dashboard — Explanation & Example

Required for Engineer Legends only. The [dashboard](#) is where the [base station](#) shows everything the [autonomous system](#) is sensing, live and without manual intervention. It can run on the [base station](#) itself or on a separate connected screen; cloud services are allowed as an intermediary.



Illustrative example only — teams design their own dashboard content and layout.

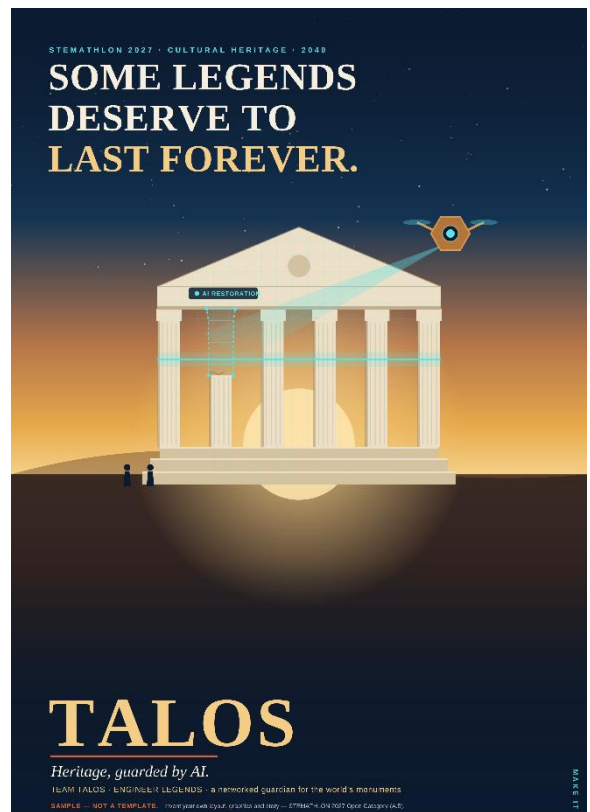


A strong [dashboard](#) usually includes a mix of:

- Real-time graphs of sensor readings over time, not just single numbers.
- Clear status indicators — is the autonomous system online, idle, or mid-task?
- A short log of recent events, so judges can see the history of a run, not just its current state.
- Enough labelling that a judge unfamiliar with the project can read it briefly.

A.5 Magazine Promo Example

A single A4 page, designed as if it were a real feature or advert. It should be readable by someone who has never seen the project — sell the idea, don't just describe the build. Optional for Engineer Heroes, mandatory for Engineer Legends. Team Aegis and their harbour buoy are fictional, for illustration only.



SAMPLE — for illustration only. Replace with your own project, photos and story.



See you in the future.

STEMATHLON 2027 · Invent the Future