GAIA Competition Rules 2022-23

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These rules are preliminary, with a final version to be released in January.

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1. Overview

The Global Action Impact Association (GAIA, after the Greek goddess of the Earth) is a national competition that empowers college teams to conceive, design, prototype, and execute high-impact solutions for global sustainability.

GAIA aims to create meaningful, measurable impact on a global scale and uniquely emphasizes the necessity of both rigorous engineering processes and systemic social considerations.

The contest has a new theme each year, focusing on different aspects of the UN Sustainable Development Goals. The contest consists of phase 1 (design and prototyping, occurring in fall and spring semesters), phase 2 (implementation, occurring in summer), and phase 3 (continuation, occurring in subsequent years). In all phases, teams partner with disadvantaged communities to ensure their solution meets community needs.

The program aims to (1) leverage students' abilities and insights to maximize the positive impact on people in need and (2) grow students' interest, experience, and commitment to impact-focused careers in global development and sustainability.

2. Eligibility

2.1. Team size

Every team must consist of a minimum of 2 students, although at least 5-10 students is recommended. There is no maximum team size.

2.2. Academic level

Teams may consist of undergraduate and graduate students, and must contain at least one undergrad student. Students in part-time post-graduate or professional programs who are simultaneously employed full-time may not participate.

2.3. Advisor participation

Students must take full ownership over their design decisions, prototype manufacture and testing, team management, and documentation submissions. Professors, GAIA mentors, and outside professionals may be consulted for advice but must not make decisions for students. Teams must list all advisors they consult with, and each advisor must sign an acknowledgement on compliance with this rule. Teams violating this rule will be disqualified.

2.4. Registration process

To register, teams must submit their application through the website before the deadline. There is no fee to register. GAIA organizers will select as many teams as possible to participate within

our capacity to run the competition. If more teams apply than we have capacity for, we will accept/reject based on the team's ability to succeed as demonstrated by the registration application.

3. Contest Structure

3.1. Timeline and deadlines

The following is a tentative competition timeline. Specific dates will be announced later.

Early December	Competition registration opens and information session held
Mid January	Yearly problem statement and updated competition rules announced
January to April	Phase 1 work period
Early April	Phase 1 deliverables due (virtual submission)
Mid April	Phase 1 competition (in person): presentations, prototype demonstrations, phase 1 scores announced, awards ceremony
May to August	Phase 2 work period
Mid August	Phase 2 deliverables due (virtual submission)
Late August	Phase 2 scores announced

3.2. Overview of each phase

In phase 1, teams evaluate community needs, develop requirements, and conceive, design, prototype, and test a solution. In phase 2, teams refine, execute, and evaluate their solution, striving to make a direct positive impact on communities in need. In phase 3, teams expand the impact of their solutions, continuing the activities of phases 1 and 2 as needed.

Phase 1 scores are based on how much impact the project *could make*, while phase 2 and 3 scores are based on how much impact the project *actually makes*. Impact is quantified using a framework outlined in section 4.

3.3. Phase 1 (Design + Prototyping)

3.3.1. Problem statement and community need

GAIA organizers will issue a new problem statement each year. The problem statement will broadly describe a common challenge faced by resource-poor communities, for example, inconsistent electricity, lack of access to clean water, or air pollution from cooking over an open fire.

Teams can choose which aspect of the problem to address (for example, if the year's topic is clean water, teams can choose to focus on water purification, sanitation, desalination, rainwater

collection, or others, based on the needs of the community partners and the team's analysis of solution impact).

GAIA organizers will connect teams with partner NGOs who have points of contact in disadvantaged communities. GAIA organizers and teams will collaboratively meet with the NGO and community partners to understand their needs. In future years of the competition, teams will likely be expected to take more responsibility for this process, but NGO connections will be organizer-driven in the 2023 contest for simplicity.

3.3.2. Feedback and stakeholder engagement during design

Teams can receive feedback throughout the design phase in a variety of ways:
- GAIA organizers and GAIA mentors (professionals in industry and academia with expertise in global sustainability) will hold monthly office hours.
- GAIA organizers will coordinate monthly meetings where teams can continue to engage with NGO and community stakeholders throughout the design process for feedback and refinement. It will be teams' responsibility to ask questions and thoughtfully engage at these meetings.

3.3.3. Phase 1 deliverables

Phase 1 documentation must be submitted according to the report guidelines. More specifics will be published later. Sections include:
- Introduction and Background
- Problem definition
  - Assessment of user needs and local context/regulations
  - Assessment of team strengths, capabilities, and strategic scoping
  - Functional and design requirements
- Proposed solution
  - Design specifications
  - Materials analysis: sustainability and local supply chain
  - Local manufacture, assembly, maintenance, and repair analysis
  - Cost analysis
  - Prototype design drawings, bill of materials, photos
  - Prototype test procedure and preliminary results
  - User acceptance feedback and analysis
  - Failure modes effect analysis
- Proposed implementation
  - Implementation plan and timeline
  - Impact analysis
- Conclusion

3.3.4. Phase 1 competition

At the phase 1 competition, teams will give a 1 hour technical design presentation and a 10 minute non-technical pitch to judges about their design, and will do a live demonstration of their prototype. If a live demonstration is not possible due to the nature of the solution, individual arrangements can be made for a virtual recorded demonstration or another way to demonstrate the effectiveness of the proposed solution. During the live demo, any key parameters relevant to the design effectiveness (i.e. flow rate and water quality for a water purification device) will be independently measured by judges to confirm teams' claims.

3.3.5. Scoring

The phase 1 score is broken into three parts:
- 25% documentation quality
- 25% presentation quality
- 50% expected impact rating (EIR)

Documentation and presentation quality are subjective rubric-based scores awarded by judges. The expected impact rating (EIR) is a formula conceived by GAIA organizers to measure the impact, risk, and cost-effectiveness of a proposed solution.

$$EIR \ = \ \frac{impact\ of\ solution\ if\ executed\ *\ probability\ of\ execution^{2}}{cost\ of\ solution}$$

Note that the numerator of EIR is similar to the expected value of impact (impact * probability), but the probability is squared instead of simply multiplied. This squaring ensures that between two solutions with equal expected impacts, the least risky one is preferred and will have a higher EIR. The denominator of EIR normalizes by cost to ensure fairness across teams with different resources and to encourage cost-effective solutions.

Impact, probability, and cost will be determined according to the framework of section 4.

3.3.6. Awards

Winners of phase 1 receive prize money that can be used to fund their activities in phase 2.

First place: approximately $1,000-5,000, depending on the organizers' resources
Second place: 50% of the award given to the first place team
Third place: 25% of the award given to the first place team

3.3.7. Progression to phase 2

Judges have the authority to identify any teams which perform poorly in phase 1 and flag them for additional review before moving on to phase 2. This ensures that any projects which are not sufficiently prepared, place undue burden on the community, or are especially unlikely to produce positive impact are given the opportunity to reassess and substantially modify their

solution before implementation. These teams will work with organizers individually and may or may not be allowed to move to phase 2 depending on their progression.

3.4. Phase 2 (Implementation)

3.4.1. Travel

In the implementation phase, it is encouraged but not required that some team members travel to the partner community. Teams are encouraged to seek funding from their university or other sponsors/grants to cover travel expenses.

Other creative approaches of achieving impact during the implementation phase are encouraged for teams unable to travel. Such approaches include partnering with an organization (academic, nonprofit, commercial, or government) that has a sustained presence in the partner community, or partnering with another GAIA team who will be traveling. It is the team's responsibility to arrange such partnerships, although GAIA organizers will help where possible.

3.4.2. Individualized mentoring

The first place winning team of phase 1 is eligible for weekly advising with GAIA mentors and organizers throughout phase 2. Non-winners can access implementation resources on the GAIA website and will be given basic feedback about their performance in the design stage, but will not receive additional individualized mentoring.

3.4.3. Phase 2 deliverables

The deliverable for phase 2 is a report detailing the process and results of the implementation, including a revised impact quantification reflective of the actual progress made, details on any design modifications that were made since the design phase, and a reflection on what went well and poorly in the implementation. More specifics will be provided later.

3.4.4. Scoring

The phase 2 score is broken into three parts:
- 25% documentation quality
- 25% presentation quality
- 50% actual impact rating (AIR)

$$AIR = \frac{impact\ of\ solution}{cost\ of\ solution}$$

The AIR is based on the actual impact achieved as a result of teams' efforts during phase 2, using the impact framework described in section 4. Teams must provide evidence of impact including number of community members reached, estimates of use rates and product abandonment if applicable, and feedback from users.

3.4.5. Phase 2 winners

Winners of phase 2 will receive prize money that must be used to fund future years' projects (any phase) in the GAIA contest.

First place: approximately $2,000-$10,000, depending on the organizers' resources
Second place: 50% of the award given to the first place team
Third place: 25% of the award given to the first place team

3.5. Phase 3 (Continuation)

Phase 3 will not be offered in the first GAIA Competition (2023). This phase will be offered in subsequent years (starting 2024) as an opportunity for returning teams to continue work on their previous years' projects. Returning teams can choose to simultaneously participate in Phase 3 for their prior years' projects and Phase 1 & 2 for a new project related to that year's new theme.

Phase 3 can include monitoring, maintenance, and repair of the previously implemented solution; strategic design improvements for scale-up; and expansion of the implementation of the solution to other communities. This phase will be scored using the AIR metric. More comprehensive guidelines for Phase 3 will be released in the 2024 competition rules.

4. Impact Framework

4.1. Overview

Scores for all phases will be determined by a panel of outside judges including engineers, researchers, and potential users. Mentors will not be judges to maintain fairness.

All phases are scored independently. For example, if the phase 1 winning team does not execute their solution well despite the additional resources, they will not score well in phase 2.

GAIA organizers will later release more detailed guidelines about the calculation of impact, including a full worked example. Refer to Appendix 1 for a sample judging rubric.

4.2. Impact

4.2.1. Impact metrics

The impact term in the EIR/AIR is determined by combining the specifications of the solution (i.e. cost, lifetime, technical performance, sustainability) against design targets and against the status quo solution currently available in the community. Then, estimates from teams' analysis and/or global development literature are used to associate each of these improvements to a certain improvement in global development indicators such as the 232 UN Sustainable Development Goals indicators (https://sdg-tracker.org/).

For example, a team may estimate that the cost and flow capacity of their water purification device will let them reach 1000 people who previously lacked safe drinking water. This directly

ties to UN SDG indicator 6.1.1: proportion of population using safely managed drinking water services.

4.2.2. Timing of impact

The EIR/AIR will be calculated assuming that the time frame of the *intervention* (teams actively installing/distributing/communicating/implementing their solution) is the 3-month period of phase 2. However, the time frame of *impact* need not be confined to phase 2.

For example, a team may create a device with an expected lifetime of 5 years. If the team can convincingly estimate the impact over the course of the device lifetime, for example with product abandonment rates, then the cumulative impact over the 5 years can be counted.

Impact will be weighted so that impact occurring sooner is weighted more heavily than impact occurring later. The exact form of this weighting will be released in a future revision of the rules. The latest time frame of future impact considered will be 2030, as this is the target date of the UN Sustainable Development Goals.

4.3. Probability

The probability of execution is the likelihood that the team will actually reach their calculated impact. In the water purification example, it is the probability of actually providing safe water to 1000 people given the many constraints (time, resource, engineering, socio-political, etc).

This is influenced by the content of the team's implementation plan and timeline, the appropriateness of the proposed solution given the team's strengths, the end user's satisfaction with their design, the degree to which relevant location-specific considerations were incorporated, and the reliability and performance of the prototype during the live prototype demonstration.

4.4. Cost

The cost term in EIR/AIR will be heavily based on teams' actual expenses, but will include modifications to ensure a level playing field across teams. For example, if one team has free machine shop access through their college and another team must pay a commercial shop, all teams will be required to include the equivalent cost of machining in their cost calculation. More detailed cost guidelines will be released later.

Costs to be Included	Costs to be Excluded
Raw materials, manufacturing, and labor required to create **the implemented solution**	Raw materials, manufacturing, and labor to create and test **initial prototypes**
Travel, lodging, permitting, and shipping required for onsite implementation	Internal team administrative costs (university space rental, T-shirts, software licensing, etc)

Appendix 1: Sample Judge Score Sheet

JUDGING CHECKLIST	Total Points	TEAM 1	TEAM 2	TEAM 3
Documentation Quality ● Professionalism ● Comprehensiveness ● Clarity ● Technical rigor	25			
Presentation Quality ● Professionalism ● Pacing ● Clarity ● Engagement	25			
Expected/Actual Impact Rating (EIR/AIR) Impact ● Technical specifications vs design targets vs status quo ● SDG indicators ● Scope ● Creativity and innovation Probability of execution ● Implementation plan and timeline (including consideration of alternatives and scale) ● User reception of design ● Degree to which relevant location-specific considerations were incorporated ● Reliability and performance of prototype during the live demonstration Cost ● Implementation cost according to provided guidelines	50			
Total	100			