2022 ATMAE Student Division Robotics Competition (SDRC-22)

OFFICIAL RULES & SCORING RUBRICS

[Revised: April 5, 2022]

Overview

This year's challenge requires teams to design, develop, and demonstrate a semi- or fully-automated robotic system to perform a user-defined function. Design functions are the purview of each team's imagination. Each team must engineer a robotic system to satisfy a non-destructive, team-defined functional requirement. Teams are encouraged to push against the bounds of their abilities and innovation at the edge of the problem space of robotics (e.g., flexible material handling, autonomous guided vehicles, swarm systems, machine vision/learning, etc.). Systems that highlight control autonomy and/or manufacturing innovation will be highly valued. Awards will include *1st, 2nd, 3rd Place Overall, Best Electrical/Controls Design, Best Mechanical/Manufacturing Design, Best Technical Communication Design, Best Innovative Problem/Solution,* and *People's Choice*.

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1. Competition

The 2022 ATMAE Student Division Robotics Competition (SDRC-22) will be held in conjunction with the ATMAE Annual Conference in Louisville, KY, on November 11th – 13th, 2022. Competition teams are encouraged to push against the bounds of their abilities and innovation at the edge of the problem space of robotics (e.g., flexible material handling, autonomous guided vehicles, swarm systems, machine vision/learning, etc.). Specifics of the functional requirements are the purview of each team (i.e., team-defined). However, systems that highlight innovation in control autonomy and/or manufacturing will be highly valued. Teams should approach the design and development of their robotic system with the intent of wowing judges and conference spectators alike.

Each successfully demonstrated objective will be awarded points to contribute to an overall Open-Class Challenge competition score. Failure to successfully demonstrate an objective will constitute a failure of the corresponding objective (i.e., 0 points awarded for that objective). Refer to 1.2 Objectives, 1.3 Criteria, 1.4 Constraints, and 1.5 Scoring for more details.

1.1 Prequalification Safety Protocols

Teams must complete a prequalification safety protocol check to qualify for the competition round (i.e., Open-Class Challenge). Failure to pass all safety checks will constitute disqualification from the competition. A competition judge will conduct the prequalification safety check during the Robot Check-In period of the competition (typically day one of the competition; refer to the ATMAE Annual Conference schedule for details). Violation of any of these safety checks will disqualify a team from the competition.

1.1.1 Emergency Stops

All robots must have a mechanical emergency stop mushroom button (similar to Dayton #30G248) mounted on the exterior in an easily accessible location on the robot. This emergency stop button must control the main power to function as a mechanical disconnect means disconnecting power to all robot components. No loads (e.g., motors, actuators) of the robot are to be energized while the emergency stop is activated. The following technical brief should be used as a design guide: Emergency Stop Push Buttons (Allen Bradley). Teams are required to demonstrate the emergency stop mechanism functionality during the Robot Check-In period of the competition (typically day one of the competition; refer to the ATMAE Annual Conference schedule for details).

1.2 Objectives

Teams that qualify for the competition (i.e., pass the system safety checks) will be judged against the following objectives, each scored by a panel of competition judges. Points will be awarded by the judges based on the degree to which each team achieves each objective. Specific criteria and rubrics for each objective are detailed in 1.3 Criteria section. Judging of each competition objective will occur during the Judging/Public View period of the competition (typically day one of the competition; refer to the ATMAE Annual Conference schedule for details).

Competition Objectives:

1. **Problem/Solution Design Innovation**: Clearly detail team-defined problem space and solution, highlighting robot's functional requirements, viability, desirability, and design process.
2. **Electrical/Control Design Innovation**: Successfully demonstrate robot's electrical and control elements highlighting design sophistication, innovation, robustness, craftmanship, and documentation.
3. **Mechanical/Manufacturing Design Innovation**: Successfully demonstrate robot's mechanical and manufactured elements highlighting design sophistication, innovation, robustness, craftmanship, and documentation.
4. **Technical Communication Design Clarity**: Clearly detail problem and solution space, highlighting robot's design sophistication, innovation, robustness, craftmanship, and documentation.

1.3 Criteria

Each team will be evaluated on criteria associated with each competition objective. A panel of qualified judges will evaluate each robot against each rubric. Rubrics for each of the objectives appear on the following pages.

1.3.1 Problem/Solution Design Innovation

The following rubric will be used to score robot systems during the competition's Judging/Public View period (refer to the ATMAE Annual Conference schedule for details). Refer to 1.5 Scoring for detailed scoring across all categories.

Table 1. Problem/Solution Design Innovation Rubric.

Evaluation Criteria	Point Range 0	5	10	15	20	Points Scored
Problem	Problem space not defined	Problem space considered, but not defined	Problem space defined, no qualification / quantification of issues	Problem space defined, with limited qualification / quantification of issues	Problem space clearly and fully defined, issues qualified and quantified	
Solution	Solution not described	Solution partially described	Solution described, no alignment of system functionality to problem issues	Solution described, limited alignment of system functionality to problem issues	Solution clearly and fully described, strong alignment of system functionality to problem space issues	
Viability	Solution expected usefulness <1 year, no consideration of economics or sustainability	Expected usefulness >1 year, limited consideration of economics and sustainability	Expected usefulness ~5 year, moderate consideration of economics or sustainability	Expected usefulness >5 year, thoughtful consideration of economics or sustainability (not both)	Solution expected to be usefulness for >10 years, thoughtful consideration of economics and sustainability	
Desirability	No end user(s) identified and no value defined	End user(s) identified or value defined (but not both)	End user(s) identified and value defined (but no connect between)	End user(s) identified and value defined (with connect between)	End user(s) clearly identified with value linked and justified with supporting data	
Design	No engineering design process	Engineering design process, but process not clear	Engineering design process articulated, no iteration, no data driving solution	Iterative engineering design process articulated, no data driving solution	Iterative engineering design process clearly articulated, data-drive solution,	

1.3.2 Electrical/Controls Design Innovation

The following rubric will be used to score robot systems during the competition's Judging/Public View period (refer to the ATMAE Annual Conference schedule for details). Refer to 1.5 Scoring for detailed scoring across all categories.

Table 2. Electrical/Controls Design Innovation Rubric.

Evaluation Criteria	Rubric Range 0	5	10	15	20	Points Scored
Sophistication	No auto control systems (DQ from Best Electrical)	Small low-end sensors used as major control method	Complex systems with very little sophistication, rudimentary coding techniques	Complex systems but no high-tech components, moderate coding techniques	Complex system, high-tech components & sophisticated coding techniques	
Innovation	System uses many pre-packaged systems, does not innovate, no control/code algorithms	Major off the shelf components visible, some integration, no control/code algorithms	Mixture of off the shelf components and custom integration, limited control/code algorithms	Minor off the shelf components, majority custom fab, moderate control/code algorithms	Unique control/code algorithms and electrical methodology, component usage	
Robustness	Poor real-world choice in methods (component or computing choice)	Majority of components expected to fail in real-world	Balance of suitable/ unsuitable components for real-world	Majority of components suitable for real-world	Electronics / wiring / control choice suitable for real-world	
Craftsmanship	Stray wires, unkempt systems, poor soldering or wire mgmt.	Poor craftsmanship or poor choices in connector / technique	Effort shown to develop finished product, wires unmanaged etc.	Some last-minute wiring additions shown, unfinished final wiring	Robot resembles modern finished product, clean wiring	
Documentation	No schematics available, no code available	Pictorial schematics only, limited code available, documentation unclear	Engineering schematics and code available, no commenting or labeling	Engineering schematics and code documented but messy or non-standard	Engineering schematics and code clear and well-documented	

1.3.3 Mechanical/Manufacturing Design Innovation

The following rubric will be used to score robot systems during the competition's Judging/Public View period (refer to the ATMAE Annual Conference schedule for details). Refer to 1.5 Scoring for detailed scoring across all categories.

Table 3. Mechanical/Manufacturing Design Innovation Rubric.

Evaluation Criteria	Rubric Range 0	5	10	15	20	Points Scored
Sophistication	No sophistication: too much bulk material, no complex super structure	Poor choice in fabrication organization or complexity	Complex design but does not benefit overall perceived performance	Form follows function, minor errors in efficient use of material	Complex super structures and elaborate design (efficiency, etc.)	
Innovation	Robot uses bulk material from kits (DQ from Best Fabrication)	Major off the shelf components visible, some fab by team	Mixture of off the shelf components and fab by team	Minor off the shelf components visible, majority fab by team	Truly innovative use of materials, structures, and techniques	
Robustness	Poor material choice (e.g. wood) or fab technique choice	Materials or fab techniques appropriate for challenge	Both Materials/fab techniques appropriate for challenge	Platform uses modern materials and fabrication techniques	Platform uses industry-grade materials and fabrication techniques	
Craftsmanship	Poor fabrication technique or “rough edges” visible	Poor craftsmanship or poor choices in material technique	Effort shown to develop finished product, poor joins or fab technique	Minor errors visible, unfinished look	Robot resembles finished product	
Documentation	No documentation is provided for materials or technique used	Some MSDS, CAD, processing documentation missing	MSDS, CAD, and processing docs present but nonstandard	Minor errors in MSDS, CAD, or processing documentation	MSDS, CAD docs, and processing correctly documented	

1.3.4 Technical Communication Design Clarity

The following rubric will be used to score robot systems during the competition's Judging/Public View period (refer to the ATMAE Annual Conference schedule for details). Refer to 1.5 Scoring for detailed scoring across all categories.

Table 4. Technical Communication Design Clarity Rubric.

Evaluation Criteria	Rubric Range 0	5	10	15	20	Points Scored
Visual Design	No coherent visual design	Poor choice in coloring, fonts, imagery, etc.	Inconsistent visuals across poster	Poster consistent, but does not coordinate with Robot	Color scheme, font choice, and imagery match Robot design	
Technical Design	No Calculations, CAD, 3D Renders, or Schematics	Some Nonstandard Calculations, CAD, 3D Renders, or Schematics.	Major errors in CAD, 3D renders, and Schematics.	Minor errors in CAD, 3D renders, and Schematics.	Calculations, CAD, 3D renders, and Schematics standard	
Production Quality	No Technical Poster submitted	Poster not printed in one piece (glued/ assembled after printing), wrong size	Poor print or cutting poster, rough edges shown	Minor errors in print production: small grammatical errors, etc.	Impressive print material/technique, advanced print processing	
Accuracy	Poster does not resemble Robot	Poster resembles robot approx. 25% (significant changes to Robot)	Poster resembles robot approx. 50% (many changes to Robot)	Poster resembles robot approx. 75% (some changes to Robot)	Images of Robot on Poster match 100%	
Video	No QR Code on Poster or does not link to video (DQ from Best Poster)	Major gaps in final video (missing robot development sections)	Minor gaps in final video (missing robot development sections)	Minor errors in final video (unsmooth edits, poor text/graphics)	Video accurately showcases development of robot	

1.4 Constraints

The following constraints apply to each team's robot system. Violation of any of the constraints will constitute disqualification of the team from the competition.

- Emergency shutoff switch must be fully operational.
- No lithium-ion power sources (i.e., batteries).
- Robot system footprint must be within 72" x 72" x 72" (182.88cm x 182.88 cm x 182.88 cm).
- Robot systems must not damage their environment (e.g., carpet, tables, chairs, etc.).
- Robot systems must not exceed 80 dB.
- No combustible/flammable solid, gas or liquid fuels may be used (e.g., gasoline, rocket fuel, etc.).
- Complete robot system operation/demonstration must not exceed 10 minutes.
- Robot systems must be capable of at least one closed-loop automated function.
- Robot Impound schedule must be adhered to during the entire competition.
- Robots entered in past SDRC events will not qualify for SDRC-22.

1.5 Scoring

Each team will have the opportunity to score points across each competition objective category (refer to 1.3 Criteria for detailed judging rubrics). Per rubric, scores for each team will be averaged across all judges' scores. Overall team scores will be calculated based on the sum of all average rubric scores. Table 5 illustrates the possible overall and per rubric scores.

Table 5. Possible Overall and Per Rubric Scores.

Judging Rubric (Objective Categories)	Per Rubric Score
Problem/Solution Design Innovation	100
Electrical/Controls Design Innovation	100
Mechanical/Manufacturing Design Innovation	100
Technical Communication Design Clarity	100
Overall Score	**400**

1.6 Judging/Public Viewing and Luncheon

Teams must attend and display their systems for both the competition judges and attendees at an assigned table during the Robot Judging and Viewing session (typically Wednesday of the competition; refer to the ATMAE Annual Conference schedule for details). Teams are encouraged to bring a college/university tablecloth, display their system, and be ready to share details with judges concerning the design and development, teamwork, budget planning, bills of materials, project management, schematics, pictures, 3D models, etc. Teams are expected to simulate a technical sales pitch of their system to mock customers and/or employers. Competition judges will score each robot system against each competition objective. Teams should be fully prepared to present and demonstrate their system's functionality during this judging period.

Additionally, teams will be required to present and demonstrate their systems to the conference audience at a conference luncheon (typically day two of the competition; refer to the ATMAE Annual Conference schedule for details), where attendees will have the chance to cast a *People's Choice Award* ballot for all teams.

Attendance to both the Judging/Public Viewing and Luncheon is required for all teams to compete for competition awards.

2. Awards

The ATMAE Student Division leadership will present the following competition awards after SDRC-22. Any team or robot system violating any competition constraint will be disqualified and forfeit any associated awards.

- 1st Place Overall (Grand Prize)
- 2nd Place Overall
- 3rd Place Overall
- Best Innovative Problem/Solution
- Best Electrical/Controls Design
- Best Mechanical/Manufacturing Design
- Best Technical Communication Design
- People's Choice Award

2.1 1st, 2nd, 3rd Place Overall

Overall placing in SDRC-22 will be determined by combined overall points earned from all competition objectives (i.e., judging rubrics). First, second and third place will be awarded to the teams with the highest, second-highest, and third-highest overall scores.

2.2 Best Innovative Problem/Solution

This award will be given to the team with the highest average score for this objective category, as scored by the associated rubric (refer to 1.3 Criteria section).

2.3 Best Electrical/Control Design

This award will be given to the team with the highest average score for this objective category, as scored by the associated rubric (refer to 1.3 Criteria section).

2.4 Best Mechanical/Manufacturing Design

This award will be given to the team with the highest average score for this objective category, as scored by the associated rubric (refer to 1.3 Criteria section).

2.5 Best Technical Communication Design

This award will be given to the team with the highest average score for this objective category, as scored by the associated rubric (refer to 1.3 Criteria section).

2.6 People's Choice Award

This award will be determined by total ballots cast during the competition and will not impact other awards or scoring. SDRC-22 teams and ATMAE Conference attendees may cast ballots.

3. Logistics

3.1 Team Eligibility

Teams competing in the 2022 ATMAE Student Division Robotics Competition (SDRC-22) may be comprised undergraduate and graduate student members. At least one faculty adviser must supervise each team. It is recommended to have interdisciplinary team members (Electrical, Mechanical, Controls, Computer Science, etc.). Faculty supervisors must attest that all members of the team are current students at their respective institution.

Team sponsors are encouraged and should be displayed prominently both as décor on the platform and during the judging/public viewing session. It is expected that sponsors are recognized in the presentation of the system (i.e., technical design documentation and dissemination).

Multiple platforms may be developed at the same institution.

Good Faith
It is expected that every team member will conduct themselves in a professional manner and not deliberately harm competitor performance, sabotage another team's platform, but follow the spirit of competition. Any team or team member who violates this good faith expectation will disqualify their team.

3.2 Registration

There is no cost to register a robot for SDRC-22 but must be completed by October 1st, 2022. However, individual team members must register for the 2022 ATMAE Annual Conference to be eligible to attend and compete. Team and individual registration details can be found at the links below.

- **Robot registration** (by October 1st, 2022): link.
- Individual member **waiver form** (submitted before competition): link.
- **Individual member** registration (ATMAE Annual Conference): link.

3.3 Travel and Lodging

For SDRC-22 venue, hotel, and travel details, refer to the ATMAE 2022 conference information page (link).

3.4 Robot Check-In

Each team must check in their robot and team on the first day of the competition, as indicated on the conference schedule.

Not checking in your robot by the posted time, without prior approval, will eliminate your robot from the competition.

During robot check-in, the competition judges will ask for the following information:

- Faculty Advisor(s) including email and cell phone number.*
- Team project manager(s) name including email and cell phone number.*
- Team members present at conference.
- Take a picture of your robot.
- Take a group picture of your team with the robot.
- Register robot batteries.
- Inspection for safety concerns, including the demonstration of the emergency stop.
- Review robot rules, team requirements, and robot quarantine while at the conference.

*Cell phone will only be used if we need to contact the team during the conference.

3.5 Robot Impound

Once robots are checked-in, robots must stay in the competition area. Each team will be assigned a table to continue fine-tuning and displaying their robot. To ensure teams do not work on their robots in their hotel rooms during the competition, judges will impound robots in a secure room in the conference area from 7:00pm to 7:30am each evening of the competition. Teams can continue working on their robots from 7:30am to 7:00pm each day. Not abiding by this impound schedule will disqualify a team from the competition.

4. Questions and Communications:

If you, your team, or your faculty advisor has any questions concerning the rules of this year's robot competition, please submit your question or concern using the form on the ATMAE robot competition website (https://www.atmae.org/page/RoboticsCompetition).