Autonomous IVD Challenge

2020-21 Challenge Parameters

Updated September, 2020

www.squareonenetwork.org

Introduction

Square One's Autonomous Innovative Vehicle Design (IVD) Project challenges student teams to innovatively re-engineer a "Power Wheels Jeep", creating an autonomous vehicle capable of completing a variety of Autonomous Mission Tasks including obstacle avoidance, parallel parking, and more.

The Autonomous IVD Competition will be held as part of the Annual "IVD Challenge Day" event. This event integrates all of the land-based IVD programs including Full Scale IVD, Mini IVD, Autonomous IVD, and V2X IVD. The 2020-21 IVD Challenge Day is **Wednesday, May 19th, 2021, at Kettering University**, Flint MI. At least five team members and the mentoring teacher must represent each team at the event. This year, we're also introducing an optional preparation day on Tuesday, May 18th, 2021, where teams can set up their pits, get an introduction to Kettering and their programs, and complete some last minute vehicle testing, on the competition tracks! All team submissions (videos, reports, etc) are due by 5 pm on Wednesday, May 5th, 2021 in the team Google Drive.

IVD Technical Council

The IVD Technical Council was established to generate the IVD Guidelines. The goal of the council is to establish safe, fair and challenging parameters for the IVD competition. The IVD Technical Council is available to consult with teams on questions regarding the guidelines throughout the IVD design, build, and competition cycle. The Technical Council also oversees IVD vehicle inspections during IVD competitions.

Square One/ Technical Council Contacts

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Purpose:

- To engage youth in an exciting project that purposely blends engineering, science, math and advancing technologies
- To provide schools with an affordable and unique project focused on engineering, science and technology.
- To link excellent teaching and learning practices with increasing corporate demands for skilled, creative and energetic employees.
- To showcase the creative engineering strengths of today's students at the Square One Innovative Vehicle Design Performance Day in May 2021
- To honor innovation through friendly competition

Corporate Partners & Team Supervision:

- Partnering businesses may contribute guidance and expertise to the team as in-kind support.
- Corporate coaches can participate (if desired) to coach students and teachers in the processes of re-engineering, electronics, mechatronics, and sensor technology.
- **IVD Coaches, Mentors and Teachers (adults) DO NOT build, modify, maintain, operate, or repair vehicles, and DO NOT create intellectual property, write code, or otherwise solve problems….. STUDENTS DO.**

Autonomous IVD Parameters

1. General Parameters

1.1. The intent of the Autonomous IVD Program (AIVD) is for students to re-engineer a Toddler Power Wheels Jeep into a vehicle capable of performing autonomous tasks. The team's goal is to work within the Jeep platform to complete mission challenges with real world solutions in authentic environments.

1.2. Since safety is of key concern these parameters should be considered minimum requirements. These parameters will be enforced and must be maintained during the entire competition.

1.3. These parameters are developed by the Square One Education Network and are designed to promote a safe and fair competition.

1.4. Experimentation, adaptation and innovation are encouraged as long as safety guidelines are adhered to.

1.5. Any questions regarded extensive modification or adaptation should be forwarded to a Square One official prior to modification. Liberal modification of the platform is allowed and encouraged, but safety guidelines must always be observed.

1.6. If a new concept is being attempted that is not specifically addressed in these design parameters, it MUST be brought to the TECH COMMITTEE for approval before proceeding with fabrication or assembly. It would be unfortunate to complete a vehicle and then have it disqualified at a competition.

1.7. IVD teams/clubs should consist of at least 5-10 dedicated high school students, and one dedicated, certified teacher.

1.8. Teams may be composed of a specific class period of students within a curricular program, or may be students involved in an after-school club.

1.9. Teams must develop a well-articulated professional plan toward the solution of the Innovative Vehicle Design Challenge and document execution of that plan in their final presentation.

1.10. All team members must exhibit professional behavior at all times. All behaviors should be in accordance with the team's home school code of conduct that governs student behavior for club events.

1.11. Any vehicle should be able to pass inspection at any time during the competition. Experimentation of design, innovation, and ingenuity are

encouraged, but the intent is for safe competition for the operator and the other participants.

1.12. In the spirit of the competition, improvements and ongoing evolution of the vehicle are encouraged. A continuous improvement program should be instituted. Chassis and systems will be judged on changes and improvements from year to year (for returning chassis)

1.13. An official inspection checklist will be provided to your team for you to conduct your own preliminary guideline and safety checks during the build. If your self-inspection raises any questions as to your vehicle's compliance, please take corrective action or seek answers to ensure that said vehicle will comply with all rules.

1.14. Teams are expected to have their vehicles complete and ready for performance day, but must attend the event regardless of vehicle's status.

1.15. Teams are limited to a $1,000 build budget in addition to the base vehicle. All teams must work within this budget and upload a spreadsheet of general expenses to the team's Google Drive folder along with their video presentation.

1.16. Teams must assign a "garage sale" value to all used or donated parts. This includes parts salvaged from previous IVD build projects. These parts must be calculated into the team budget (typically half current purchase price from Amazon.com).

1.17. No "ready to go" device will be supplied. However, a Quick Start video link is provided to support new teams. Thank you to Neil Schmidgall of Glenbrook South High School for creating this.

1.18. Although some national STEM Competitions explicitly allow adults to actively work on student projects, Square One does not. Partnering businesses contribute guidance and expertise to the team as in-kind support. Corporate coaches can participate if desired to coach students and teachers in the processes of re- engineering, electronics, mechatronics, and sensor technology.

1.19. To that end, adults may...

1.19.1. Advise and answer questions for students.

1.19.2. Interface with Square One Staff and/or judges in the event that the team wishes to question or dispute any compliance or judging issues prior to, or during the competition.

1.19.3. Help students track deadlines, due dates, submissions, etc.

1.19.4. Attend check-in calls or other virtual meetings. We encourage you to have students present, and if present, students should do the majority of the speaking for your team.

1.20. Adults may NOT...

1.20.1. Create content for video task submissions, presentation videos, etc.

1.20.2. Generate intellectual property for student implementation

1.20.3. Work with tools / parts / hardware.

1.20.4. Fabricate, assemble, or repair the vehicle or parts

1.20.5. Write code for any of the vehicle hardware.

1.20.6. If a school does not have the necessary facilities to fabricate a part, those parts can be purchased from, or donated by, an outside supplier or team coach, but that cost must be tracked in the team budget and included as part of the team presentation.

2. *Square One Education Network Responsibilities:*

2.1. Coordination of the project

2.2. Development and maintenance of these parameters

2.3. Provide necessary insurance policies for performance site

2.4. Align schools with partners as possible

2.5. Support each school as agreed upon signing of district commitment

3. *Vehicle Control Parameters*

3.1. Vehicles must be unmanned and autonomous. They must compete based on their ability to perceive the course environment and avoid obstacles. Vehicles cannot be remotely controlled by a human operator during competition. All computational power, sensing and control equipment should be carried on board the vehicle.

3.2. AIVD vehicles should look, drive and steer in a fashion similar to current passenger vehicles. As an example, Omni wheels and/or "caster" wheels that turn 180 degrees (or more) allowing a vehicle to drive laterally could easily accomplish the parallel parking mission, but are not practically applicable on today's passenger vehicles; therefore, those devices would not support the "spirit of the problem" and would not be high-scoring options for the competition.

3.3. Autonomous IVD Vehicles should "drive like a car," parallel parking in reverse, utilizing conventional steering mechanics. In order to receive

maximum scores, vehicle steering should not allow the steered wheels to rotate more than 90 degrees from "stop to stop" (i.e. +/- 45 degrees from straight forward).

4. *Mechanical Parameters*

4.1. Teams must use the ground vehicle supplied by Square One (propelled by direct mechanical contact to the ground such as wheels, tracks, etc).

4.2. The intent of the AIVD project is to re-engineer a Toddler Power Wheels Jeep into an autonomous vehicle that mimics the operation of a passenger vehicle, not to build a new vehicle. Hence, the jeep platform is provided as a starting point. We encourage innovation and we support modification of the chassis, but not replacement of the chassis. We still expect that most of the Jeep chassis (frame, body, platform, etc) remain intact for the competition.

4.3. The original off-the-shelf vehicle can be structurally re-engineered as long as it can be held to the allowable build budget for this competition. Teams are allowed to cannibalize previous year's vehicles but must assign at least a "garage sale" value to all pieces and parts for budgeting purposes to keep the competition fair. "Structurally re-engineer" provides latitude for students to re-design and replace components of the structure or chassis, but not the entire chassis. Teams may modify the steering mechanism, install new wheels/tires, replace drive components (gears, belts, chains, etc), install new dashboards, install mounting brackets for hardware, etc. but the underlying chassis (i.e. platform, frame, structure, etc) of the vehicle must be the Power Wheels Jeep. Teams may not fabricate a new chassis, platform, or frame and simply "set the Jeep body on top" such that it "looks like" an IVD vehicle or Jeep.

4.4. Teams are encouraged to be innovative and unique in their solution to the challenge, but must work within the Jeep platform, incorporating their technology into the off the shelf vehicle.

4.5. Length: Maximum vehicle length is 6 feet.

4.6. Width: Maximum vehicle width is 4 feet.

4.7. Height: Maximum vehicle height is 3 feet .

4.8. Propulsion: Vehicle power must be generated onboard. Fuel storage or running of internal combustion engines and fuel cells are not permitted.

4.9. Speed: For safety, a maximum vehicle speed of five miles per hour (5 mph) will be enforced. All vehicles must be hardware governed not to exceed

this maximum speed. No changes to maximum speed control hardware are allowed.

4.10. The programmable component of this competition is the responsibility of the design team

5. *Safety Parameters:*

5.1. The safety of students, teachers, parents, other participants, and spectators is of paramount importance, and supersedes any other interests or goals associated with this project and competition.

5.2. The following parameters focus on vehicle safety, and are mandatory minimum requirements for the Autonomous IVD Project. All teams must meet all requirements of this parameter document.

5.3. Key safety concerns are identified below. It is critical that all teams become intimately familiar with all Autonomous IVD Project Parameters and comply with all requirements found herein. Any vehicle that fails to comply with the Project Parameters will be disqualified from any competition or demonstration.

5.4. Safety Inspections - All Autonomous IVD Vehicles are expected to comply with all safety requirements and other project parameters at all times during operation of the vehicle. All vehicles are subject to immediate inspection, at any time, at the discretion of competition officials.

5.5. Safety Glasses - All students and adults working on the Autonomous IVD project must wear OSHA approved safety glasses at all times during fabrication, assembly, testing, operating, or competing with their Autonomous IVD vehicle. It is the responsibility of the project advisor or teacher to prioritize team safety, and to require proper usage of safety glasses at all times.

5.6. Fire Extinguisher - All teams must keep a fire extinguisher immediately accessible during all fabrication, assembly, testing and competing activities associated with the Autonomous IVD project. Teams must bring a fire extinguisher to any Autonomous IVD competition. The fire extinguisher must be readily accessible to the team any time they're operating the Autonomous IVD vehicle. It is the responsibility of the project advisor or teacher to ensure that team members are aware of the location of the fire extinguisher and know how to use it appropriately and effectively.

7. *Electrical Systems*

7.1. Battery:

- 7.1.1. Teams must use the original batteries supplied with the base jeep platform for vehicle propulsion
- 7.1.2. All batteries must be sealed lead acid
- 7.1.3. Batteries must not be modified in any way and must have original manufacturer's labeling still attached
- 7.1.4. All batteries must be securely mounted in the vehicle and must remain in their mount in the event of the vehicle overturning or in a collision.
- 7.1.5. Teams may use an auxiliary battery pack to power their electronics, as long as the auxiliary packs comply with the 12V (or less) sealed lead acid requirement

7.2. Electrical Breaker or Fuse

- 7.2.1. The electrical system must include a 15 A breaker or fuse in the main line from the battery. A breaker is recommended, but fuses are acceptable.
- 7.2.2. Here is one option for a breaker… https://www.amazon.com/gp/product/B076LQFJD4/ref=ppx_yo_dt_b_asin_title_o00_s00?ie=UTF8&psc=1
- 7.2.3. Note, under high current scenarios (sudden motor start/stop), a fuse will fail quicker than a breaker, and is more difficult to reset or change.

7.3. Emergency Shutoff

- 7.3.1. Each vehicle must have a main emergency shutoff switch in line with the main power supply.
- 7.3.2. The system must be wired in such a manner that when deactivated, the shutoff switch will disconnect all power to the entire vehicle, including all electrical components.
- 7.3.3. This shutoff switch must be easily accessible and highly visible.
- 7.3.4. The shutoff switch must be rated for current of at least 15 Amps

7.4. Vehicle Wiring

- 7.4.1. All wire connections must be accomplished using a mechanical connection (crimp connector, soldered, screw terminal blocks, etc)

and heat shrink tubing when appropriate. (Our intent is to avoid wires twisted together and covered with tape).

7.4.2. No bare wire may be exposed anywhere on the vehicle, except within 0.5 cm of a termination. Any bare wire must be encapsulated with heat shrink tubing, or other suitable insulation.

7.4.3. Wire terminals may be bare, only where they terminate and attach to a device.

7.4.4. Terminals must be secured so they will not loosen or "short circuit" during operation.

7.4.5. Wiring that passes through a hole with sharp edges or through sheet metal must be protected by an insulating grommet or other suitable protective device.

7.4.6. All wiring to a drive motor or steering circuit must be 14 gauge wire, or larger. This includes the main supply lines from the battery to the motor controllers, and the wiring from the motor controllers to drive motors and steering. Remember, wire gauge numbers are inversely proportional to actual wire diameter, so the wire gauge number for this requirement must be 14 or less. The stock wiring on the jeep platform is 14 gauge wire and is adequate for the drive motors.

8. *Decision of Competition Officials*

8.1. Determinations made by inspectors, officials, and judges will be final, and will be accepted and respected by all teams and team leaders. If you have any doubt, whatsoever, about any of the IVD parameters, it is your responsibility to seek clarification from Square One **PRIOR TO COMPETITION DAY**

9. *Inspections*

9.1. Teams may raise any questions regarding safety, modification or adaptation to the Tech Council at any time prior to competition day.

9.2. On competition day, a Square One official will inspect each platform for compliance with all guidelines and good practices for safety and workmanship.

9.3. Teams must be able to provide evidence of compliance with all guidelines in this document.

11. *Identifications*

11.1. All mobile platforms shall be clearly identified with a competition number determined by the individual team.

11.2. Platform identification numbers will be clearly visible from the top and side of the platform. They may be affixed for the competition and removable but must remain in place throughout the competition.

11.3. All vehicle markings shall be vinyl decals. Under no circumstances may teams use paper taped to their vehicle as signage

11.4. Vehicles may prominently display logos of team sponsors, schools, and partners at their discretion.

11.5. Square One and its partner logos should be clearly visible on team shirts and competition vehicles during competition day.

11.6. Teams are encouraged to dress in team jerseys, shirts, etc. The Square One Education Network logo must appear on any associated team shirts/materials. Teams are encouraged to show their school spirit and dress as a team. Springtime weather conditions might encourage teams to think outside the box on what their team spirit wear will be! (Think vests, hats, lab coats, ties, etc. etc.)

12. *Ambassadorship*

12.1. Each team is required to develop an "Ambassadorship" plan to excite at least 100 younger students about engineering, science and math around the IVD project in their school or community. Promotional materials or evidence of activities must be provided at the competition to demonstrate successful completion of outreach activities.

12.2. Ambassadorship projects must be completed prior to the competition day to be judged. This may necessitate changing your methodology! Consider launching your build season with the ambassadorship rather than concluding with it! Perhaps your outreach includes ideas for the innovation or naming of the vehicle or design of some component!

14. *Milestone Video Submissions*

14.1. The milestone video submissions are intended to incentivize teams to maintain a project timeline, as well as to provide "secondary" judging options, in the event that vehicles are not able to perform on competition day due to equipment failure, inclement weather, etc.

14.2. All teams will be allowed to demonstrate Alpha, Bravo, and Charlie tasks in their Milestone Videos, and on competition day and will receive points for those tasks, both times (i.e. teams that received 5 points for a video, can receive an additional 5 points on competition day, for demonstrating the same task).

14.3. Prototype vehicles are acceptable for the video, but will not be allowed for competition purposes. If a team demonstrates a milestone task using a prototype (a new prototype - not a vehicle from a previous competition), they must demonstrate the same task on the AIVD vehicle at the competition. We strongly encourage teams to use prototypes as part of their engineering process and want to support that practice in the scoring. However, at the competition, only AIVD Jeep Vehicles conforming to the parameters above will be allowed.

14.4. We have a variety of teams, all across the United States and coordinating calendars is virtually impossible. All AIVD dates are firm. Unfortunately, some dates may interfere with individual school district calendars. Please review the important dates early on, and plan ahead. For example, if a milestone video submission is due during one of your school breaks, you should plan to submit the video early, prior to that break.

Challenge Tasks

In the event that in-person competition is not feasible, the 2021 Autonomous IVD Challenge may be held virtually. All mission tasks can be demonstrated by remote video recording or streaming, and presentation videos can be evaluated to determine winning teams.

1. **Alpha Task: Autonomous Motion** (MILESTONE TASK - SEE RUBRIC)
   - Vehicle starts when initiated by an operator, moves 3 meters forward, turns right, moves forward 3 meters again, and then stops.
   - Distance tolerance is +/- 0.5 meters for both measurements. Vehicles traveling less than or beyond prescribed tolerances will be penalized per the rubric
   - Method for "initiated by operator" can be determined by individual teams

2. **Bravo Task: Obstacle / Crash Avoidance** (MILESTONE TASK - SEE RUBRIC)
   - Vehicle should move forward until it senses an obstacle (such as a team member, or judge) and stops. The obstacle will move into the path after movement begins at a distance between 3-10 meters. After the obstacle is removed, the vehicle will resume travel for at least another 1 meter. If no obstacle is sensed the vehicle should run at least 10 meters. Vehicle must complete three course runs for full points.

3. **Charlie Task: Lane Assist** (MILESTONE TASK - SEE RUBRIC)
   - Highly reflective tape will be used to define lanes (of proportional accuracy to the vehicle and real world). The course will include approximately 3-5 meters of straight-away followed by 3-5 meters of S-turns, etc.
   - Lanes will be 2-3 meters wide (distance between tape lines, measured perpendicular to lines)
   - Team vehicles must indicate with visual, auditory, or tactile cues/warnings if straying too close to "edge of road" and steering adjustments are made by the vehicle ("encroachment indicators")
   - Here is a link to the tape that will be used during the competition.
   - The course will be established the morning of the final event, but video submissions can be completed on a course the team creates, using straight and curved sections, similar to that described above.

4. Delta Task: Parking Shark

- Teams are challenged to autonomously parallel park their vehicles.. The parking spot will be 3 meters by 1 meter. The other spots will have vehicles simulated with other jeeps, storage totes or something similar.
- Vehicle must start at least 3 meters behind the designated parking spot.
- Vehicle must indicate when it considers itself "parked." This could be by emitting a sound or some visual signal.
- For full points the vehicle must park as current passenger vehicles do - pulling forward parallel to, but past the designated "parking space", then moving in reverse to fit within the chalked out space without hitting the car parked in front of and behind the outlined space.
- Points awarded for parking with sensors, less for dead reckoning.
- Vehicles that allow the steered wheels to rotate more than 90 degrees from "stop to stop" (i.e. +/- 45 degrees from straight forward) will be penalized, per the rubric. This penalty may be multiple points, will depend on the specific vehicle, and will be determined by the judges on competition day. All decisions by competition officials will be final and will be respected.

5. Echo Task: Parking Garage

- The vehicle should demonstrate its awareness and attentiveness to its surroundings. The vehicle will enter a darkened "garage" structure, sense that it is within a parking garage, stop before hitting the back wall, and turn on its lights. When the door is opened at the other end, the vehicle will continue its travel.
- The walls, doors, and ceiling of the "garage" will be ⅛" pressed hardboard (or some other hard surface), hanging on a PVC pipe frame.
- The "parking garage" will be 6' square X 4' tall, with a "front door" that is at least 4' wide X 3' tall
- Teams may use distance sensing devices to park near the back wall, but must use light sensing devices (solar panel, photoresistor, camera, etc) to activate vehicle lights

6. Foxtrot Task: Station Navigation

- Navigation is a practice that is thousands of years old. It is used on land by hikers and soldiers, on the sea by sailors, and in the air by pilots. Procedures have continuously improved from line-of-sight to moss on trees to dead reckoning to celestial observation to use of the Global Positioning System (GPS).
- This task is for vehicles to use GPS and autonomously travel from a starting point to a target destination (a waypoint), given only the coordinates of the target in latitude and longitude.

- The waypoint will have a circle of 2 meter diameter around it.
- Points will be deducted for vehicles that are not completely within the circle per the rubric. One point will be deducted for each meter (or partial meter) that the furthest point on the vehicle is away from the outside edge of the circle. For example, if a vehicle stops approximately halfway outside of the circle and the point of the vehicle that is furthest away from the circle is measured to be 1.2 meters away (measured perpendicularly to the circle), 2 points would be deducted. 0 - 1 meters away = 1 point deduction, 1 - 2 meters away = 2 point deduction, etc.
- Teams will have 3 trials to have their vehicle stop completely inside the circle. The highest score of the 3 trials will be the final earned score.
- Vehicles must indicate when they've reached the end point. This could be by emitting a sound or some visual signal.
- Coordinates will be given in decimal degrees format before the start of the task, teams may enter the coordinates into their control system prior to their trial.
- Each vehicle must complete this task within 3 minutes.

7. Golf Task: Fleet Transport

- The armed services are at the forefront of autonomous vehicle research and development. The ability to platoon military vehicles into danger zones will save human lives. Teams are challenged to work cooperatively with each other to apply the ability to platoon this year's cadre of Autonomous IVD vehicles.
- Teams may practice prior to the competition by utilizing previous year's jeeps or find another AIVD school to team up and participate in this challenge.
- Square One encourages teams to designate a communication specialist to be a part of this potential online or virtual community of Autonomous vehicle specialists and decide how the Fleet Transport will be accomplished.
- Follow vehicles must successfully follow lead vehicles over a distance of at least 10 meters including straight and curved portions of the undesignated route
- Reductions for "failure to follow" will be determined by judges and may be multiple points
- This task is very "open ended" when compared to the previous mission tasks. *HOW* to accomplish this task is largely up to partner teams.

8. Mobility Exhibition (NEW for 2021)

- This open-ended challenge provides AIVD Teams the opportunity for out of the box, innovative mobility demonstrations. Use your expertise in Connected and Autonomous Vehicle (CAV) Technology to demonstrate advanced mobility functionality, not seen in the other AIVD Missions. Teams are free to use whatever

sensor technology they feel is appropriate. Teams must integrate the AIVD vehicle as part of the demonstration, but may also develop and demonstrate auxiliary equipment to simulate other devices (traffic signals, DRC units, emergency vehicles, etc) or other objects (buildings, pedestrians, etc) in their environment that interact with the AIVD vehicle. This exhibition is intended for teams that have successfully completed all the other AIVD Missions ("Alpha" through "Golf"). The scoring for this exhibition will only be used in a "tie-breaker" scenario.

9. AIVD Cyber Security Challenge (IN DEVELOPMENT)

- While still under construction, this mission challenge will launch our students into the world of automotive cyber security, a high demand skill set now and in the future!

Showcase Awards:

General award information:

- Any single team can only win one award from the "Judged Award" category. This restriction applies to any given "team" not a given "school". For schools that have multiple IVD teams and multiple vehicles, each of the schools' teams would be considered separate entities and be eligible for awards as specified.

Summary of Awards

Performance (Any team can win)

(1st-3rd) Challenge Tasks - Overall Performance

Judged Awards (Any team can only win one Judged Award)

(1st only) Innovation
(1st only) Engineering
(1st only) Innovation
(1st only) Engineering
(1st only) Excellence of Execution
(1st only) Craftsmanship
(1st only) Design
(1st only) Presentation
(1st only) Ambassadorship
(1st only) Public Relations

Unlimited Judged Awards (Any team may win any or all of the unlimited awards)

(1st only) Square One Award
(1st only) Diversity Award (Optional)
(1st only) CAD & Manufacturing Award (Optional)
(1st only) Remote Control & Sensing Award (Optional)

Judged Award Descriptions

Innovation Award – 1st Place

Innovation is a primary objective of this IVD Challenge, and all Square One Events. Innovation is a technology (hardware or software), style element, or design that is unique, out of the ordinary, something used in an unexpected manner or that sets one team's vehicle apart from another.

Each vehicle will be judged for Innovation, as demonstrated during their video presentation.

Innovation is defined as: NOUN

1. the action or process of innovating.
2. *synonyms:* chang e · alteratio n · revolutio n · upheava l · transformatio n · metamorphosis · reorganizatio n · restructurin g · rearrangemen t · recastin g · remodelling · renovatio n · restylin g ·
3. a new method, idea, product, etc.."technological innovations designed to save energy"
4. Innovation is synonymous with risk-taking and organizations that create revolutionary products or technologies take on the greatest risk because they create new markets. Imitators take less risk because they will start with an innovator's product and take a more effective approach.
5. Innovation can be defined simply as a "new idea, device or method". However, innovation is often also viewed as the application of better solutions that meet new requirements, unarticulated needs, or existing market needs. Such innovation takes place through the provision of more-effective products, processes, services, technologies, or business models that are made available to markets, governments and society.

Although the ability of the vehicles to negotiate and complete the competition challenge missions is the ultimate measure of product quality, the officials are also interested in the innovative elements of processes that teams implemented in completing the mission tasks. "Innovation Award" judging will be conducted separate from and without regard to vehicle performance on the test course.

In addition innovations that never made it onto the vehicle can be presented during the team's presentation for consideration of this award.

Engineering Award – 1st Place

Although the ability of the vehicles to negotiate and complete the challenge tasks is the ultimate measure of product quality, the officials are also interested in the engineering processes that teams followed in completing the mission tasks.

Each vehicle will be judged on the engineering disciplines utilized, understanding of vehicle engineering principles, their engineering processes, decision making, and curation of artifacts, as demonstrated during their video presentation. It is strongly suggested that teams formally document their entire design process, noting decisions made and the data or calculations that drove those decisions. This formal design record may be documented digitally or in hard copy in an Engineering Journal. The work documented in an Engineering Journal is a critical asset in demonstrating your engineering process and would be extremely valuable as part of the team's presentation for this Engineering Award.

> *Engineering: The branch of science and technology concerned with the design, building, and use of engines, machines, and structures.*
>
> 1. *A field of study or activity concerned with modification or development in a particular area.*
> 2. *The profession of applying scientific principles to the design, construction, and maintenance of engines, cars, machines, etc (mechanical engineering), buildings, bridges, roads, etc (civil engineering), electrical machines and communication systems (electrical engineering), chemical plant and machinery (chemical engineering), or aircraft (aeronautical engineering)*

Excellence of Execution Award - 1st Place

The Excellence of Execution Award recognizes the best combined performance on the Connected Vehicle and Autonomous Vehicle tasks, the team's demonstration of sportsmanship, and the teamwork displayed throughout the competition.

Craftsmanship Award - 1st Place

The Craftsmanship Award recognizes outstanding craftsmanship and attention to detail in the structural, mechanical, and electrical fabrication and assembly of the vehicle. Key indicators of Craftsmanship that will be considered will be quality of fabricated parts & assembly, neatness of wiring, clean appearance of wiring and hardware, appropriate selection and use of fasteners, and neatness of finishes (e.g. paint, etc).

Design Award - 1st Place

The Design Award recognizes exceptional work in the aesthetic design of the vehicle and effective use of design technologies (physical models, digital modeling software, simulation software, etc). As part of their video presentations, teams must demonstrate their use of appropriate design tools, and exhibit a vehicle with a pleasing aesthetic.

Presentation Award – 1st Place

** NEW for 2021 ** - **Teams will produce two, five minute videos (instead of one)**. This additional video was added to allow for the new awards added in 2021. The two videos will be focused on the following content:

- Awards Judged from Technical Development Video (#1)
  - Innovation
  - Engineering
  - CAD/Manufacturing (NEW)
  - Remote Control (NEW)
- Awards Judged from Professional Practices Video (#2)
  - Design
  - Ambassadorship
  - Public Relations
  - Square ONE Nation Award (NEW)
- Judged on Competition Day
  - All Performance Awards (Figure 8, Kettering Course, Sensor Missions)
  - Excellence of Execution
  - Craftsmanship
  - Square One Award

Each of the two presentation videos will be judged by a panel of industry professionals. The team's final score for the presentation award will be the average of the two individual video scores.

The Presentation Award recognizes excellence in the production of the team's video presentations. Although the content of the video presentations will be used to evaluate teams for the other "Judged" awards, the quality of the videos themselves will determine the recipient of this Presentation Award.

Note, these are student-driven VIDEO presentations, highlighting all of the design decisions made and addressing all of the components of the other judged awards

(Innovation, Engineering, Craftsmanship, Design, Ambassadorship, Public Relations, etc.) Students should specifically speak to each of the challenges, and each of the awards, during these VIDEO presentations. The video presentation is recommended to be 3-5 minutes long, but cannot exceed 5 minutes.

A student led video production class within their school may assist the team, but the videos shall not be produced by adults or professionals. These videos will be running on a loop on competition day.

All teams will upload their video presentations, project synopsis page and expense sheet to the designated Google Drive by the submission date on page 1. Please adjust your build timeline accordingly.

All teams should have a display mounted at their pit space on competition day. The display board should clearly state the team's innovation and illustrate the ambassadorship project. It may include photos, charts, graphs, etc.

Ambassadorship Trophy – 1st Place

The Ambassadorship Award recognizes a team, deemed by the judges, to be the most **effective in inspiring** younger students in STEM (science, technology, engineering, and math), or promoting IVD and Square One in the school or community as demonstrated during the team's video presentation.

Public Relations Award - 1st Place

The Public Relations Award recognizes teams that most effectively develop a portfolio of marketing assets that are used to promote their team project, their school, and Square One, in their community.

All teams will use the #IVD2021 hashtag for all IVD related resources, assets and activities.

This packet can be uploaded digitally to your team's Google Drive by the submission date on page 1. This includes but is not limited to:

1. Make a presentation to a group of adults (the PTA, school staff meeting, school board, town council, or other community organization). Include photo and detail (who/what/where/when).

2. Social media presence on at least one format: FB, Twitter, LinkedIn, Instagram Please note number of followers and/or posts. Teams should encourage team members and their followers to subscribe to Square One's Facebook and Linked In pages. Follow school district guidelines for appropriate use of social media.
3. Press Release - Write and send out one or more releases to district, local newspaper, tv or radio personalities. Include a copy of the press release and, if published, where it was published.
4. Develop an example of marketing materials--a brochure, flyer, business cards,etc. (Only one is necessary)
5. **Bonus Points: Post a team photo to Square One's Facebook page on the day prior to the competition. The team with the most "likes" by 11:59 pm the night before the competition will receive 10 bonus points to their Public Relations score.**

CAD & Manufacturing Award - 1st Place (NEW for 2021)

Participation for this award is optional

CAD, or computer-aided design (CAD), is technology for design, which replaces manual drafting with an automated process. CAD is an important industrial art extensively used in many applications. 3D printing, or additive manufacturing, is the construction of a three-dimensional object from a CAD model or a digital 3D model. The CAD/Manufacturing award will be presented to the team that introduces the best product, developed collaboratively by multiple team members, including the three components below:

1. CAD Design: comprised of a team developed part, piece, or component for the team's Innovative Vehicle Design project, hereafter referred to as the "product". The product planned should be integrated into the vehicle as a necessary component, not just a "stuck on" or decorative piece such as a hood ornament and is contained in a stationary location during the regular driving cycle and helpful to the operator or the vehicle. It might even be something that all teams would elect to integrate in their vehicle in future competition seasons! Team must show that two or more students worked on the CAD model using free, cloud-based CAD software (EX: TinkerCAD, OpenSCAD, etc.).
2. Additive Manufacturing: The "product" designed above must be manufactured entirely on a 3D printer and cannot be purchased or fabricated by any other means. It can be painted, multiple printed parts may be affixed together utilizing adhesives, screws, etc. if necessary. Teams should demonstrate that

they have gone through multiple (two or more) iterations to arrive at their final "product."

3. Technical Report: The team will submit a one-page technical report to the team's Google drive. The CAD/Manufacturing challenge will be judged as a part of the team's video presentation.

Square ONE Nation Alliance Award - 1st Place (NEW for 2021)

Participation for this award is optional*

Square One's competition day has long been a melting pot, a college campus style integration of students from diverse backgrounds and communities. Diversity and inclusion improve teaching and learning. People learn and enrich their abilities to think critically and creatively as they engage in conversations across differences, especially when all learners' abilities and attributes are embraced. This challenge is intended to encourage students to meet other students and begin having conversations to exercise their own communication skills despite our distances and differences. Teams are challenged to form an alliance and complete a technical challenge.

Two teams that are at least 50+ miles apart will form a Square One Nation Alliance. Square One will make introductions as needed. Alliances will work together to develop a project that demonstrates communication and connectivity (both sending and receiving messages) utilizing a technical component representative of a real-world mobility challenge. Teams should utilize (but are not limited to) the materials provided by Square One (Elegoo, Microbit, sensors, or other)

- Project may be representative of what you've learned of the crossroads where your two teams have met...how can this provide an innovative and meaningful result. (Ex: What mobility challenges face urban and rural communities? Are they similar or different?)
- Demonstrate that the solution came together through multiple iterations.
- Result in one four slide presentation (PowerPoint, other) on your solution, (representing both teams) including a Venn diagram of the Alliance.

Remote Control & Sensing Award - 1st Place

Participation for this award is optional*

The Remote Control & Sensing Award leverages team's experience with micro-controller and sensor technology, to simulate Connected & Autonomous Vehicle (CAV) scenarios involving connectivity at a distance. This challenge can be completed by teams working virtually. Teams are challenged to design systems that achieve two way communication with their vehicle, to provide innovative functionality. Examples might include remotely controlling a vehicle, turning vehicle systems or devices on or off, collecting vehicle data and displaying on a website in real time, etc. The "reach" of the communication used will be considered for judging (i.e. global communication via the internet will score higher than local communication using bluetooth). It's critical that you consider all other design parameters when planning for this challenge. For example, in Full Scale IVD, remote control of vehicles is not allowed, so Full Scale Teams would need to focus on the data collection aspects of this challenge. Remote control is allowed and encouraged for Mini, Autonomous, and V2X. Teams will demonstrate and discuss their remote control and sensing technology in their "Technical Development Presentation Video" for judging purposes, but are also encouraged to demonstrate and use their systems at the IVD Challenge Day.

Square One Award - 1st Place

The Square One Award is given to the one team deemed best in the convergence of all performance challenges and judged categories, representing overall excellence in Innovative Vehicle Design. This team may or may not have achieved a first place ranking in any of the award categories or performance awards, but may have demonstrated solid outcomes in all facets of the IVD Design Challenge.

Exclusive Opportunities

Autonomous IVD team members in the Class of 2020:
Square One and industry partners will offer one $500 scholarship to be awarded at the IVD Challenge event, exclusively for a high school senior participating in Autonomous IVD. Scholarship application and criteria will be available on the Square One Education Network website beginning JANUARY 1 with a deadline for submission of March 1.

All Autonomous IVD team members:

Square One Autonomous IVD Certification (Digital Badge) - Digital applications are available in the Autonomous IVD Team Google Drive. Accepted applicants will be invited for in person interviews in March and April. Awardees will be announced at the IVD Challenge Day. There will be a limited number of certifications awarded.

Elements of the AIVD Digital Badge

1. Explain what it means for a vehicle to be Autonomous.
2. Describe how you will use your experience from Square One.
3. Describe a future career that you are thinking of pursuing and what skills you will need to succeed in that position.
4. Explain how you have applied and grown in the following skills:
    - Presentation – how well you can convey thoughts and ideas… both written and verbally
    - Technical expertise – the skills that you apply to specific situations
        - Software
        - Hardware
        - Organizationally – scheduling, timelines
    - Punctuality – on time for meetings, attended group events and meetings
    - Teamwork – worked well with a team as a lead or as a member and helped avoid conflict while resolving any items that may have arisen
    - Problem solving – figuring out how to perform a task… able to explain why a task was done in a certain way
    - Critical thinking – finding innovative ways to attain a desired result.

Required Documentation

Digital Letter of Intent (DLI) – Electronically signed by lead teacher or coach and building administrator, committing to following the guidelines within the letter and in the Project Parameters, providing necessary resources & support to successfully complete the project, recruiting student team members, completing the project within the timeline, and attending and participating in the competition day, in person or virtually, as health and safety guidelines allow, **whether or not the project has been successfully completed**. A link to the DLI will be shared in the Team Google Drive. Team registration will not be complete without the DLI Note, terms of the letter are included for reference below

Expense Report (Accountability) – Each team must submit an excel spreadsheet of general expenses to their team folder in the designated Google Drive along with their video and project synopsis form. General expense categories such as Hardware, Mechanical, Electronics, etc.

Project Synopsis Form (Metrics) – Each team must submit the project synopsis form to their folder in the Google Drive along with video and expense sheet. This will include the number of student participants, number of teacher participants, number of students reached via Ambassadorship and number of teachers reached via Ambassadorship.

Please NOTE: Overlapping programs – If a school participates in more than one IVD project, they cannot count students more than once. This pertains to ambassadorship projects also.

REFERENCE - Letter of Intent - Terms

- This document serves as a letter of intent to participate in the Square One Education Network Innovative Vehicle Design (IVD) Challenge (Full Scale, Mini, Autonomous or V2X Challenge), and adhere to the terms of the letter of intent, and to the detailed parameters of the IVD challenge.
- For the purposes of this document and other Square One documents, the terms teacher, coach, mentor, volunteer, etc are all synonymous with "coach"
- All persons associated with an IVD team (including but not limited to students, coaches, and administrators) are responsible for being attentive to all rules and regulations of the IVD program as outlined in this document and the official project parameters.
- The administration of the school and/or district will lend necessary support including assignment of staff members, recruitment of student participants, purchasing support, facility use for team and project assembly, transportation, release time, etc. Furthermore, administration agrees to address and meet additional needs as they arise.

((Terms continued on next page))

REFERENCE - Letter of Intent - Terms (cont.)

- School administration agrees to pay the established registration fee associated with their program to the Square One Education Network, unless granted a fee waiver by Square One. This registration fee provides for participation in the Kickoff Workshop, ongoing technical support throughout the year, and participation at any mid-season competitive events and/or the final IVD Challenge Day Competition.
- Each team will work within the specified project budget to procure base vehicles, parts, equipment & materials. The Ambassadorship Outreach component (shared learning with 100 younger students.) must also come from the specified project budget.
- Team members and coaches are expected to be present at the full-day competition event, whether the event is held in-person or virtually, even if their project is incomplete. Teams should complete the challenge and be prepared to demonstrate and present their vehicle on Performance Day (even if it is not fully functional). Schools that do not complete the project and/or do not attend the competition may not be allowed to participate in future Square One Education Network related programs.
- Team coaches will be expected to stay in communication with Square One staff and respond to Square One inquiries in a timely reliable manner. Participants will be asked to complete a brief impact survey, including team demographics. This may be in the form of independent research analysis.
- The ambassadorship component that is a shared learning activity with 100 or more younger students must be completed **prior to performance day.** Anything projected for completion after that date will not be scored.
- A maximum of two teams is allowed per school, unless explicit written approval is obtained from Square One. EACH team is required to complete an ambassadorship reaching at least 100 younger students, and will be responsible for the specified registration fee.
- Additionally, there is a **required** kickoff training for teachers. Important details, skills, and project timelines are provided during this professional development workshop. Those schools without representation at the kickoff may be waitlisted. Electronic / virtual options may be made available for those at great distances.
- If this school received funding or materials from Square One and is unable to complete the project through staff changes or unforeseen circumstances, all remaining **cash grant/materials must be returned to Square One.**

IVD Project Synopsis (Limited to One Page) Turn in on Google Drive

School Name and City: _____

Team Leader Name: _____

Number of Students Participating in Total: _____

Number of Students Participating @ Event: _____

Signature Series Project: _____

Brief Description of Innovative component:

Brief Description of Ambassadorship component:

We reached # students and # teachers via our ambassadorship

Our team motto is:

A couple of quotes from our team: (What I liked/learned while a part of this project/What I might change about this project)

A quote from our team mentor:

(Advice, suggestion, revelation, you name it)

The significance of our car's identification number:

Judged Award Rubrics

Innovation Award			
	Extent of Modification		
	Teams clearly demonstrate that first year vehicles are significantly modified from stock, or returning vehicles are significantly modified from the previous year's iteration. Modifications have been done in an innovative way	Vehicles have clearly been modified from prior years or from stock, but in unimaginative, non-innovative ways, or modifications are only moderate.	Little or no modification from stock (for new vehicles) or from last year's configuration
	5	**3**	**0**
	Use of Materials, Equipment, and Components		
	Innovative Materials, Equipment, and Components are used in new or unique ways, and teams clearly demonstrate their efforts at optimization	Teams primarily used innovative materials, equipment or components, but largely in a conventional manner, or used traditional resources in innovative ways	Teams conveyed little or no innovation
	5	**3**	**0**
	Clarity of Innovative Concept		
	The Team's innovative features were, in fact, new and innovative. The team clearly conveyed the overall concept of their innovation. The extent of the innovation is easily memorable	The team clearly conveys their concept, but the level of innovation, or departure from the traditional is only moderate.	The team does not clearly convey any attemp at Innovation, or is a largely unchanged vehicle from a previous year. Their vehicle may perform very well, but lack any non-traditional design or engineering features.
	5	**3**	**0**

Innovation Award (cont.)			
	Risk Taking		
	Teams clearly convey significant risks taken by the team in attempting to implement new and innovative features or design elements. Teams specifically address the risk factor and how they assessed the level of risk	Teams only convey a moderate level of risk taken, or poorly convey how they assessed the risk level	Teams do not address risk, or did not convey any risks taken
	5	**3**	**0**
	System Approach (Were innovations integrated into the overall vehicle design)		
	Teams clearly convey their systems level engineering process. All vehicle systems are designed or selected to work in harmony. Systems are well placed and incorporated in the vehicle. Innovations are seamlessly integrated into the vehicle	Teams do not address systems engineering. Some systems seem disjointed or awkward. Innovations may seem like "add-ons" rather than integrated elements of the vehicle	Systems seem haphazardly selected. There is no apparent effort in systems level engineering
	5	**3**	**0**

Engineering Award			
	Engineering Knowledge		
	Multiple team members clearly convey deep understanding of autonomous vehicle control algorithms, applicable computer science concepts, and relevant engineering principles. Multiple members also convey deep understanding of the appropriate connected vehicle technologies.	Engineering knowledge and understanding is surface level, or only deeply exhibited by one team member	Engineering knowledge is addressed by one team member and understanding is minimal. Team may appear to be addressing engineering simply to "check a box"
	7	5	3
	Evidence of Reasoning and Problem Solving		
	All team members can clearly explain a problem they faced and their solution. Team decisions were sound. They can also explain their design spiral including calculations, prototypes, test data, and revision	Some members of the team can articulate problems encountered and solutions proposed. Some team decisions were sound. They can also address some portions of a design spiral	Team struggles to explain their challenges and solutions and demonstrates no apparent understanding of a design spiral
	7	5	3
	Curation of Artifacts		
	Team exhibits a complete set of engineering artifacts including initial design decisions, calculations, test data and refers to these artifacts throughout their presentation.	Team exhibits a significant, but incomplete, set of engineering artifacts, or just refers to the artifacts in passing without demonstrating the critical nature of the Engineering Journal	Team exhibits very limited set of engineering artifacts
	6	4	2
	Engineering Disciplines Addressed		
	Team refers to at least two engineering disciplines that were critical to their design process	Team mentions one engineering discipline or refers to engineering in general without demonstrating "how" they utilized the disciplines	Team does not mention any engineering disciplines
	5	3	0

Excellence of Execution			
	Track Performance		
	Vehicle performed in top third of the field on all driving missions	Vehicle performed at least mid-field on all driving missions	Vehicle performed in bottom third of field on at least one driving mission, or may not have competed in one or more driving missions
	9	5	2
	Team Sportsmanship		
	Team was specifically observed, proactively demonstrating sportsmanship in a tangible way	Team did not demonstrate any negative behavior, but was not specifically observed demonstrating tangible acts of sportsmanship	Team was observed demonstrating poor sportsmanship
	8	4	0
	Demonstration of Teamwork		
	Team was specifically observed, proactively demonstrating teamwork in a tangible way	Team did not demonstrate any negative behavior, but was not specifically observed demonstrating tangible acts of teamwork	Team was observed demonstrating poor teamwork
	8	4	0

Craftsmanship Award			
	Structural / Mechanical Quality		
	Almost all mechanical details are finished to high standards, including high quality welds, appropriate selection and use of fasteners, eased/ground edges, finished surfaces (paint, chrome, etc). All components are neatly mounted/finished and serviceable	Some details are moderately finished, with a few "rough" details. Welds may not be ground, or of poor visual quality. Some surfaces may not be finished.	Most of the vehicle shows little attention to details. Vehicle may appear incomplete or rushed.
	10	6	2
	Electrical Quality		
	All wiring is neat, tidy, and safe. Wires are bundled and enclosed in looms. Wires are run along structural members and are secure. Wires are appropriate length without excessive slack. Components are mounted in an aesthetically pleasing way.	Efforts to keep wiring tidy and safe are apparent, but there may still be some indication of sloppiness in wiring, termination, bundling, etc.	Most of the electrical system shows little attention to details. Vehicle may appear incomplete or rushed.
	10	6	2
	Interior and Exterior Finishes		
	The vehicle looks complete and finished, with obvious attention to detail. All required markings are as designated.	Vehicle appears mostly finished, although some incomplete details are obvious. Some markings may be absent	Vehicle shows little attention to details, appears sloppy or unfinished. Vehicle is missing some, or all, required markings
	5	3	1

Design Award			
	Use of Design Technology		
	Team clearly conveys their use of multiple design technologies (CAD, Modeling, Simulation, Clay, etc) by multiple students on the team, and exhibits artifacts from those technologies	Team conveys use of at least one design technology, or is vague in conveying their usage, or all use of design technology is by one team member. The team may speak about design technologies but fail to present any artifacts	Team conveys no understanding of or use of design technologies
	10	5	0
	Vehicle Form		
	Vehicle chassis and body present a neat, tidy, finished appearance. Attention to the finish of the vehicle are obviously apparent. Vehicle aesthetic is very pleasing and/or unique	Vehicle is somewhat modified from stock, and indicates some attention to the vehicle finish. Vehicle aesthetic is moderately pleasing or unique	Vehicle appears to be stock with little or no modification
	10	5	0
	Design Details		
	Vehicle exhibits obvious attention to "design extras" - small design details that set the vehicle apart from the field or add to the overall aesthetic.	Vehicle exhibits some limited "design extras"	No "design extras" are apparent
	5	3	0

Presentation Award			
	Clear Explanation of Innovations, Engineering, Craftsmanship, Design, Communication, and Ambassadorship, and Communication		
	Student addressed all focus areas with examples	Student addressed 5 areas with examples	Students addressed 3 area with examples
	7	5	3
	Logical Organization of Presentation		
	Progressed logically and clearly	Jumped around with sketchy details	Haphazard and confusing
	4	2	0
	Effective Use of Graphic Aids		
	Ample variety of visual aides integrated into video presentation	Little variety in visual aides utilized	No visual aides apparent
	4	1	0
	Articulation (Speaking Clearly)		
	Used technical language and terms in a professional manner	Used slang and non professional language	
	4	1	
	Team Participation during Presentation		
	All students participated in some way	Most of the team participated	Only 1 or 2 participated
	3	2	1
	Enthusiasm and Pride		
	Wore team shirts, smiled and were excited	Showed some enthusiasm	Were distant and unengaged
	3	1	0

Ambassadorship Award			
	Effectiveness of Involvement & Inspiration of outreach		
	Organized, pertinent and "hands on" project delivered to HS/MS/EL	Did classroom visits and lectures with team to HS/MS	Minimum outreach to incoming students
	10	8	6
	Innovativeness of Ambassadorship Method /Process		
	"OMG- that is an awesome idea!"	"That's a pretty cool way of doing it"	"OK- but I've seen that before"
	10	8	6
	Were at least 100 younger students reached?		
	Yes	No	
	5	**0**	

Public Relations Award			
	Public relations plan developed and acted upon		
	Significant initiative - 3+presentations made, 3+ press releases distributed	Moderate initiative - 1 presentation made, 1 press release distributed	Little planning or afterthought
	9	5	2
	Social media campaign - Facebook, Twitter, instagram, etc.		
	Multiple social media outlets utilized, multiple posts and followers	Some social media accounts created, few posts and followers	Little social media attempted
	8	5	2
	Quality press kit materials created and released		
	High quality, student-created Press release, brochure, other collateral presented, description of where it was released	Press release, brochure, etc. provided, not released or not student-produced	No press kit
	8	4	0

CAD & Manufacturing Award (Optional)			
	CAD Design		
	Team demonstrates that multiple students worked on the design and each made changes or improvements. The product is innovative and useful. High quality of CAD design presented.	The product is somewhat innovative and useful. Design shows improvement.	Design appears incomplete or rushed. Team does not show iterations.
	10	6	2
	Additive Manufacturing		
	The product is well made and functions as intended. Team demonstrates multiple iterations toward final product. 3 or more prints presented demonstrating change.	The product is slightly out of spec but functions as desired. 2 or more prints presented demonstrating change.	Product did not print clean, or as designed and/or does not function.
	10	6	2
	Technical Report		
	The one-page tech report succinctly includes: - Statement of Problem that product solves - Approach – How problem was tackled - Results – Problems and solutions - Summary – What should we remember?	The one-page tech report includes some of the four elements described at left and shows moderate effort.	The report appears sloppy, rushed, or unfinished.
	5	3	1

Square ONE Nation Alliance Award (Optional)			
	Communication & Project Plan Developed and Acted On		
	Significant initiative - 3+ Zoom or other video meetings held, iterative design processes and relationship growth demonstrated, nearly "sister cities" in interest for continued alliance.	Moderate initiative - 2 video conferences, limited demonstration of process, and relationship building	Minimal planning and interaction or appears to be one team's work.
	8	5	2
	Technical Accomplishment		
	Demonstrated an innovative and functioning model solution to a mobility challenge facing either or both of the communities. Technically impressive. Demonstrate understanding of connectivity.	Created a model solution to a mobility challenge. Moderately creative and functional, moderate understanding of connectivity.	Conceptual but not functional or complete.
	9	5	2
	Collaboration & Presentation		
	High quality, student-created slides and collateral presented demonstrating shared school spirit and community pride, student growth and understanding. Venn diagram of two teams.	Teams scratched the surface of building relationships and understanding. Moderate effort and interaction presented.	No presentation slides, collateral or diagram provided.
	8	5	0

Remote Control & Sensing Award (Optional)			
	Technical Achievement		
	Device or system performed 100% as designed, when initiated, and without multiple trials, glitches, or delays. Functionality is exactly as intended.	Point deductions for: - Violates design parameters - Restarting device - Multiple trials - User intervention - Erroneous functionality - Excessive delays - Individual device functionality without communication	Device or system will not turn on, or shows zero functionality
	9		0
	Innovation, Purpose & Value		
	The device or system has a clear purpose, is innovative & original, and provides significant value to the end user.	Point deductions for: - Purpose is unclear - Value of device or system is questionable or minimal - Device or system is new to the team, but not original or innovative - Device is primarily purchased components and demonstrates minimal work by the team	Device or system is a "gimmick" or "decoration" and provides no practical value, or is entirely composed of "off the shelf" purchased components, or was used in identical form in a previous competition, or was copied from another project.
	9		0
	Communication Reach		
	Device or system reliably demonstrates two way communication over the internet, providing global reach	Point deductions for: - Communication is unreliable - Communication is limited in range (e.g. local via bluetooth only) - One way communication	Communication doesn't exist
	7	5	0

Performance Award Rubrics

2020-2021 SQUARE ONE AUTONOMOUS IVD SCORE SHEET					
ALPHA CHALLENGE - Autonomous Motion					
DESCRIPTION	The vehicle will be started by a team member and after a delay of a few seconds or a signal received remotely, the vehicle will drive forward in a straight line for 3 meters (+/- 0.5 m), make a right turn, then drive forward for an additional 3 meters (+/- 0.5 m).				
MILESTONE DATE:	Video submission is due by 5 pm January 15th, 2021. Any submissions received/posted after this date will result in reduced points. Videos shall be uploaded to the individual team's folder in the shared Google Drive				
SCHOOL NAME				**TOTAL POINTS:**	
JUDGE NAME & AFFILIATION					
JUDGE COMMENTS:					
RUBRIC					
ZERO POINTS	*REDUCTIONS (1 POINT FOR EACH OF THE FOLLOWING)*			*5 POINTS*	
Using vehicle from previous competition	Vehicle does not turn			Video submission shows the vehicle starting the challenge after being prompted by a team member and travelling the specified distance, turning right, then travelling the specified distance, then stopping on its own. The only human input is to begin the sequence.	
Vehicle does not move	Vehicle actions outside of 3 meter (+/- 0.5 m) spec				
	Vehicle design violates the rules*				
	Vehicle travel is not straight forward				
	Each time a team member intervenes				
	Vehicle does not stop on its own				
	Vehicle does not indicate end of run				
	Vehicle turns very early or very late				

2020-2021 SQUARE ONE AUTONOMOUS IVD SCORE SHEET					
BRAVO CHALLENGE - Obstacle / Crash Avoidance					
DESCRIPTION	The vehicle will begin moving forward until an object is introduced to its path. The object can be a team member walking into the path and stopping, or a large solid inanimate object placed by a team member. The object will remain for 10 seconds before being removed. The vehicle should continue its path for another 1+ meters. Vehicle will complete three trials, with all three scores being averaged				
MILESTONE DATE:	Video submission is due by 5 pm February 12th, 2021. Any submissions received/posted after this date will result in reduced points. Videos shall be uploaded to the individual team's folder in the shared Google Drive				
SCHOOL NAME				**TOTAL POINTS:**	
JUDGE NAME & AFFILIATION					
JUDGE COMMENTS:					

RUBRIC		
ZERO POINTS	*REDUCTIONS (1 POINT FOR EACH OF THE FOLLOWING)*	*5 POINTS*
Using vehicle from previous competition	Vehicle design violates the rules*	Video submission shows the vehicle starting the challenge after being prompted by a team member and traveling straight until an object is detected. The vehicle should stop upon sensing the object. The vehicle remains motionless for the duration of the object being in place. The vehicle continues after the object is removed.
Vehicle does not stop when object is in path	Vehicle stops and stutters forward while object is in the path	
Vehicle does not move at all.	Vehicle does not continue moving after object is removed	
	Vehicle hits the object while coming to a stop	
	Vehicle does not travel straight line	

2020-2021 SQUARE ONE AUTONOMOUS IVD SCORE SHEET			
CHARLIE CHALLENGE - Lane Assist			
DESCRIPTION	The vehicle will use sensors to detect a highly reflective line on the ground that will represent a road lane. The vehicles will drive along a path and stay inside of the lanes. The distance travelled will be between 6 - 10 meters. The lane will be 2-3 meters wide (between stripes). The course will be established the morning of the final event, but video submissions can be on a course the team creates. Vehicles must provide audible or visual "encroachment indicators" whenever lines are being approached and steering adjustments are made.		
MILESTONE DATE:	Video submission is due by 5 pm March 12th, 2021. Any submissions received/posted after this date will result in reduced points. Videos shall be uploaded to the individual team's folder in the shared Google Drive		
SCHOOL NAME		**TOTAL POINTS:**	
JUDGE NAME & AFFILIATION			
JUDGE COMMENTS:			

RUBRIC		
ZERO POINTS	*REDUCTIONS (1 POINT FOR EACH OF THE FOLLOWING)*	*5 POINTS*
Using vehicle from previous competition	Vehicle design violates the rules*	The vehicle starts and drives through a course while using sensors to stay inside of the reflective lines. The vehicle needs to complete the entire course without leaving the lane, and provide encroachment indicators every time steering adjustments are made for full points.
Vehicle does not move at all.	Each lane departure	
Vehicle does not use sensors	Each human intervention	
	Each time a steering adjustment is made without audible or visual encroachment indicators	

2020-2021 SQUARE ONE AUTONOMOUS IVD SCORE SHEET			
DELTA CHALLENGE - Parking Shark			
DESCRIPTION	The Vehicle will perform a parallel parking action within the following parameters: The space will be 3 meters long and 1 meter deep. The vehicle must travel along a straight path for a minimum of 3 meters to locate an open space between 2 objects then use sensors to maneuver into the open spot, like a passenger vehicle. The vehicle must be fully inside the space and indicate when parking is complete.		
MILESTONE DATE:	Event Day		
SCHOOL NAME		**TOTAL POINTS:**	
JUDGE NAME & AFFILIATION			
JUDGE COMMENTS:			

RUBRIC		
ZERO POINTS	*REDUCTIONS (1 POINT FOR EACH OF THE FOLLOWING)*	*5 POINTS*
Using vehicle from previous competition	Vehicle doesn't indicate when parked	The vehicle starts at a minimum of 3 meters behind the open space and travels until it finds the open space by using sensors. The vehicle then begins maneuvering into the spot to be completely within the 3 meter x 1 meter parking space between 2 objects. Vehicles must back into parallel spots (like passenger cars) and must provide visual or audible indication that parking is complete.
Vehicle does not move	Vehicle design violates the rules*	
Vehicle does not locate open spot	Each contact with another object	
	Each human intervention	
	Doesn't operate like passenger vehicle (e.g. driving laterally). Multi point penalty TBD by judges	
	Vehicle parks via "dead reckoning" w/o sensors. Multi point penalty TBD by judges	

2020-2021 SQUARE ONE AUTONOMOUS IVD SCORE SHEET

ECHO CHALLENGE - Parking Garage

DESCRIPTION	The vehicle will drive into a dark area (simulating a tunnel or garage), stop, and turn on its light(s). The lights can be headlights or another form of light. The specific light and placement may be determined by the team, but it must be bright enough for the judges to view from the exterior of the dark area. When a door on the opposite end of the "parking garage" opens, the vehicle will continue travel, exiting the garage and turning its lights back off, stopping with the rear of the vehicle approximately 1 meter outside of the garage.
MILESTONE DATE:	Event Day

SCHOOL NAME				**TOTAL POINTS:**	
JUDGE NAME & AFFILIATION					
JUDGE COMMENTS:					

RUBRIC

ZERO POINTS	*REDUCTIONS (1 POINT FOR EACH OF THE FOLLOWING)*	*5 POINTS*
Using vehicle from previous competition	Vehicle design violates the rules*	The vehicle starts and drives into a darkened area that simulates a garage. Once inside the vehicle stops moving and turns on 1 or more lights indicating that it recognizes darkness. When the door on the opposite side of the garage opens, the vehicle continues its travel, exiting the garage, turning off its lights, and parking outside of the garage
Vehicle does not move at all.	Each human intervention	
Vehicle does not use sensors	Vehicle does not drive straight	
The vehicle does not light up	Vehicle contacts another object	
Light is on prior to entering the dark area	The vehicle does not stop completely inside the garage	
	Does not restart / exit garage	
	Does not turn off lights on exit	

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FOXTROT CHALLENGE - Station Navigation					
DESCRIPTION	The vehicle will use GPS to navigate and drive to a specific location (set of coordinates) given by the judges. The coordinates will be given on the day of the final event. The location will have a 2 meter diameter circle around it. Teams will have 3 trials to have their vehicle travel into the circle and stop and the highest scoring of the trials will be the final points earned score.				
MILESTONE DATE:	Event Day				
SCHOOL NAME				**TOTAL POINTS:**	
JUDGE NAME & AFFILIATION					
JUDGE COMMENTS:					

RUBRIC		
ZERO POINTS	*REDUCTIONS (1 POINT FOR EACH OF THE FOLLOWING)*	*5 POINTS*
Using vehicle from previous competition	Vehicle design violates the rules*	The vehicle starts driving and travels 20+ meters to stop inside of a circle surrounding the coordinates given, and provide audible or visual indication that travel is complete. Final score is the best of three trials
Vehicle does not move at all.	Each human intervention	
Vehicle does not use sensors	Each meter (or partial meter) that the furthest point of the parked vehicle is away from the marked circle. 1.2 m away = 2 point deduction	
Vehicle does not use GPS	Vehicle doesn't indicate completion	
Vehicle doesn't complete task within 3 minutes		

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GOLF CHALLENGE - Fleet Transport					
DESCRIPTION	The vehicle will detect and follow another vehicle throughout an undefined course. Each vehicle involved will allow the other teams to place a marker of some kind on the rear of their car. This will simulate fleets following each other on the roadways in a "platooning" configuration.				
MILESTONE DATE:	Event Day				
SCHOOL NAME				**TOTAL POINTS:**	
JUDGE NAME & AFFILIATION					
JUDGE COMMENTS:					

RUBRIC		
ZERO POINTS	*REDUCTIONS (1 POINT FOR EACH OF THE FOLLOWING)*	*5 POINTS*
Using vehicle from previous competition	Vehicle design violates the rules*	The vehicle uses a sensor to detect and follow the path of the vehicle in front of it. The vehicle must follow for a minimum of 10 meters. The vehicle should manage the same turns and curves that the lead vehicle does.
Vehicle does not move at all.	Each human intervention	
Vehicle does not use sensors	Contacts another object	
Does not follow lead vehicle	Reductions for failure to follow will be determined by judges and may be multiple points	

2020-2021 SQUARE ONE AUTONOMOUS IVD SCORE SHEET					
Mobility Exhibition					
DESCRIPTION	Teams will demonstrate innovative mobility functionality, not seen in the other AIVD Missions. Teams are free to use whatever sensor technology they feel is appropriate. Teams must integrate the AIVD vehicle as part of the demonstration, but may also develop and demonstrate auxiliary equipment to simulate other devices (traffic signals, DRC units, emergency vehicles, etc) or other objects (buildings, pedestrians, etc) in their environment that interact with the AIVD vehicle. These demonstrations should model scenarios & challenges that occur in the current mobility industry. This exhibition is intended for teams that have successfully completed all the other AIVD Missions ("Alpha" through "Golf"). The scoring for this exhibition will only be used in a "tie-breaker" scenario.				
MILESTONE DATE:	Event Day				
SCHOOL NAME				**TOTAL POINTS:**	
JUDGE NAME & AFFILIATION					
JUDGE COMMENTS:					

RUBRIC		
ZERO POINTS	*REDUCTIONS*	*5 POINTS*
No Demonstration	Demonstrations are not unique or innovative	Teams that successfully completed all other missions, now demonstrate unique mobility related functionality, using their AIVD vehicle. Demonstrations are clearly linked to "real world" mobility scenarios, and challenges are addressed in a thoughtful, innovative way.
	Scenario is not "real world" relevant.	
	Did not utilize AIVD Vehicle	
	Functionality was not completely successful	

End of IVD Parameter Document