EVER
Electric Vehicle Rally

EVER V

COST EVENT RULES

Under the auspices of:

The Arab Republic Of Egypt
The Cabinet

Owned by:

أكاديمية البحث العلمي والتكنولوجيا
ACADEMY OF SCIENTIFIC RESEARCH AND TECHNOLOGY

Organized by:

AIN SHAMS UNIVERSITY

PHub

Contents

Important notice: additional information about the cost and manufacturing event including cost tables and other information can be obtained from the EVER website.

ARTICLE 1: SCOPE of COST EVENT RULES

- The cost event is associated with three main tracks of EVER V which are Dynamic track, Concept Track, and Autonomous Track. The rules mentioned in this document are applicable for all tracks with the rules for the Autonomous Track is in ARTICLE 11:.
- Participant teams at autonomous track may use the rules mentioned in this document as guidelines and following it may be an addition to the required reports.

ARTICLE 2: EVENT OBJECTIVE

- The main objective of this event is acquainting the participants to the methodologies used in costing and processes and production planning used in producing the designed vehicle(s) on Industrial scale. The specific objectives of the cost and manufacturing event are:
  - Enhance participants knowledge about the industrial implication of producing electric vehicles.
  - Equip participants with the understanding of the importance of cost, budget, and trade-off decisions in engineering designs.
  - Provide hands-on experience in creating a bill of material (BOM) and impart knowledge on key manufacturing and design principles.
  - Prepare the manufacturing documents needed for production planning, operations management, quality control … etc.
- The required deliverable in this event is comprised of two (2) parts.

1) Cost Report:
   - The preparation and submission of a report (the “cost report”), which is to be sent to the cost judges prior to the competition.
2) Manufacturing documentation:

- All teams are expected to deliver through the manufacturing documents the following (but not limited to):
    - Make or buy decision justification.
    - Working drawing for all manufactured parts.
    - Processes planning for the manufacturing of each item that will not be purchased.
    - All tooling needed in each manufacturing process.
    - All estimated times for each manufacturing process.

- All teams are expected to present the cost and manufacturing reports in front of the judges and the judges will discuss the reports with the teams.
- The aim of the discussion will not be limited to how the team developed the cost estimate of the vehicle but also to stand on the thoroughness of the report, understanding of the teams' members to the cost and manufacturing presented and how the team follow a clear and sound methodology in determining the cost elements and the manufacturing processes.
- A cost versus performance score will be given to teams with the best performance and the lowest cost, and other teams will be scored accordingly.

ARTICLE 3: DEFINITIONS

The following definitions will apply throughout the cost event rules.

- Bill of material – a hierarchical list of all parts of the vehicle. A BOM lists every item that is on the vehicle but also shows the relationships between these items, for example showing the parts that make up an assembly. A costed bill of material (cBOM) is a standard BOM that includes cost information including cost of purchased parts, raw materials and processes that go into manufacturing the vehicle.
- Module - each table has numerous entries which describe a classification of entry.

  - There are several types of hose clamps, and all have various costs. The category of hose clamp may be worm drive, constant tension, etc.

- Cost – the cost for each item from the materials table is simply the quantity multiplied by the unit cost.
- Cost report – all materials, submitted for judging related to cost calculations.
- Manufacturing Report – all materials submitted to judges related to manufacturing procedures of the vehicle.
- Cost tables – all tables that list costs for objects and processes.
- Design for manufacture and assembly (DFMA) – the process where parts are designed for ease of manufacture and assembly, resulting in lower cost.
- Fasteners table – a cost table that consists of not only traditional fasteners such as bolts, nuts and rivets but also adhesives, hose clamps and retaining rings.
- Fixed cost – costs associated with production that are independent of volume produced.
- Initial cost – the cost of the vehicle submitted for initial judging in the cost report.
- Lean manufacture – a methodology for producing goods that emphasizes the elimination of waste and improvement in process flow with the goal of optimizing the cost and quality of goods.
- Materials table – lists the costs for raw materials used to manufacture parts built by the teams and also of finished parts purchased by the teams.
- Purchased parts – also called bought parts; these items are listed in the cost tables in a near as-installed condition. For example, wheels, and batteries are purchased parts. In some cases, purchased parts may still require additional processing before they can be assembled to the car. Wheels, for example, do not include the machined features for mounting to the hub. Purchased parts do not include fasteners.

- Quantity – the amount of the item
- Raw materials – materials used for manufacturing parts, such as aluminum, steel and rubber hose.
- Tools – tools refer to hand or power tools used to assemble the vehicle. The costs of these tools are not included in the cost report. The effect of the tools used for assembly are captured in the process tables for labor as different costs are given based on the tools used for assembly.
- Tooling - is the production tooling associated with processes that are specific to the part geometry. The costs of tooling must be included in the cost report. For example, the dies to stamp out a chassis bracket are tooling. The press used to stamp the bracket is not, and is considered production equipment which is not part of the cost event.
- Unit – is the measurement system used to define the quantity of a parameter.
- Unit cost – is the cost for something assuming a numerical value of one (1) of the unit used to measure the item. The cost is the quantity of an item multiplied by the unit cost.

ARTICLE 4: COST REPORT

The cost report must:

- Include The total cost of the vehicle.
- Use the standardized cost tables as it helps in unite the materials and process labels.
- List and cost each part on the prototype vehicle. This includes any equipment fitted on the vehicle at any time during the competition.
- Be based on the estimated costs of materials, fabrication, purchased parts, and assembly of the car. The costs shall be calculated as defined in these rules.

- Be based on the actual manufacturing technique used on the prototype, e.g. Cast parts on the prototype must be cost as cast, and fabricated parts as fabricated, etc.
- A cost breakdown for each part determining its direct manufacturing cost (materials, labor and expenses) and its share of overheads and the ratio between direct cost and shar of overheads.
- Include tooling (e.g. Welding jigs, molds, patterns and dies) for processes requiring it.
- Exclude R&D and capital expenditures (e.g. Plant, machinery, hand tools and power tools).
- be designed to:
    - Be verifiable at the event. Differentiating between different types of materials (for example different alloys of steel) is not possible so no differentiation is made in the table cost.
    - Higher costs of some goods must reflect actually higher value of those goods. However, the costs must still allow for team innovation and vehicle content, with some reduction in cost score.
- The cost report consists of a full vehicle BOM with cost data derived from the cost tables and supporting documentation. The cost report must be submitted in two (2) forms:
    - Electronic version – the upload of the electronic cost report has to be done in these steps:
    - Upload of the vehicle BOM as microsoft excel ® file (.xls or .xlsx)
    - Upload of the supporting material (dbr_files) as one separate pdf file (.pdf)
    - The electronic version of the two files must be identified as follows:
        - schoolname_competitioncode_cr_BOM.xls using the complete team's name and the competition code.
        - Example: university of ever_ever_cr_BOM.xls
        - Example: 087_university of internet_ever_cr_supplement.pdf
    - The electronic version of the cost report must be submitted via EVER website.
- The cover of the cost report must include the following:
    - University name

- Competition name

- The cost report must consist of the following:
  - Cover page.
  - Table of contents.
  - Cost summary page listing each section's cost, and the total vehicle cost.
  - Eight commodity report sections with the parts placed in the sections as specified in appendix S-3.
  - Tabs for each section.

ARTICLE 5: Manufacturing Report:

- Bill of Materials (BOM)
  - The BOM is a parts list for every vehicle part. It also shows the relationships between the items.
  - The following terminology will be used when referring to the BOM.
    - The overall vehicle is broken down into eight (8) systems which are defined in appendix S-3.
    - Systems are made up of assemblies.
    - Assemblies are made up of parts.
    - Parts consist of materials, and fasteners.
  - An example BOM structure is shown below:
    - Motor & Drivetrain..... System
    - Motor..... Assembly
    - Differential..... Assembly
      - Housing..... Part
      - Aluminum..... Material
      - Needle Bearing..... Material
      - Internals..... Part
    - End Cap..... Part
  - All assemblies, parts and fasteners in the BOM must use a standard numbering convention explained in appendix S-2.

- Working Drawings:
  - All working drawings of manufactured parts must be delivered with all dimensional and geometrical tolerances needed.
  - The working drawings must be classified and numbered in accordance with the relation of the part with the subassembly, assembly or system in constitutes.
  - The parts quality affecting dimensions and tolerances must be clearly defined.
  - Any special instructions in manufacturing the part required by the designer must be clearly mentioned.
- Processes Planning
  - All process sheets for each part must submitted indicating all processes that will be used to manufacture each part.
  - The processes should be ordered in technologically correct sequence.
  - For each process the estimated time of the process, the needed tooling and any other special requirement should be mentioned.
  - The process controlling parameters should be mentioned if possible, such as feeds, speeds … etc.
  - A separate section should be made for all used tooling indicating parts manufactured using it, the processes used to produce the tooling and its bill of material.

ARTICLE 6: COST TABLES

- These tables have been compiled to represent the cost of parts and processes that a university team pay for manufacturing their vehicle. You only fill the prices for the material or process you used, you don't have to send back cost tables, on the other hand BOM and dbr_files required to be submitted.
- The following cost tables are used:
  - Materials
  - Processes
  - Fasteners
  - Tooling

- Cost models & costing methodology:
    - The detailed explanation of the cost models and costing methodology is included in appendix S-1 and should be referenced for understanding the use of the cost tables.
    - The costs tables are intended to include all materials, processes and fasteners needed by the teams to accurately reflect the content, manufacture, and assembly of their vehicle. However, it will be necessary to add items to the tables to suit individual team requirements. To do so, simply add it.

ARTICLE 7: COST DOCUMENTS SUBMISSION

- The cost report must be submitted in the designated format for each event.
- A printed copy of the report must be available at the competition and must be on A4 size paper, using a 10-point font size or larger.
- It is imperative that the cost judges have the cost reports in enough time for proper evaluation. Teams that submit reports late will be penalized according to the rules.
- Any error that results in a team over/under reporting a cost in their cost report will be penalized.
- The BOM must follow the format given above. There must be no other BOM levels (columns) added or any removed. Deviations from the structure published will be penalized.
- There will be a formal discussion with the judges at the competition.
- At this discussion, the cost judges will:
    - Review whether the specification of the vehicle in the cost report accurately reflects the vehicle brought to the competition.
    - Review the manufacturing feasibility of the vehicle.
    - Assess penalties for missing or incorrect information in the cost report compared to the vehicle presented at inspection.

ARTICLE 8: APPENDIX S – 1 Glossary of terms

- Raw materials
    - Raw materials refer to the material stocks used to produce parts from scratch, such as billet steel for machining or aluminum ingot for casting. Bar, sheet and tube stock are purchased using raw material costs. The raw material purchased must include machining allowance.
    - Gross weight will refer to the weight of the raw material, including all machining stock.
    - Net weight will refer to the weight of the finish machined part.
    - Material costs are based on part gross weight. For example, a steel hub is machined from solid bar. The interior is removed by boring. The cost of the bar must include this interior material. Raw materials are normally cost by volume. A cost by weight is also given using an official density listed in the tables.
- Assembly labor
    - Mass – the mass of the part influences the time it takes the operator to assemble the part to the assembly or vehicle. Light parts can be installed with one hand. Heavier parts require two hands and the heaviest parts need a lift assist apparatus. These factors are accounted for by selecting the appropriate entry from the process labor tables. The actual part mass must be equal to or less than the value selected. For example, a 300g part would have an assembly labor category of 1 kg.
    - Interfaces – the more interfaces a part has with the surrounding parts the longer it takes to assemble. Parts designed for minimal constraint are the easiest and cheapest to assemble.
    - Fit type – the ease with which a part can be assembled is described by the fit. There are three categories of fits:
    - Loose – the part assembles with no force. Examples include a quick release steering wheel onto the steering shaft and a bracket bolted to a monocoque. (not required to be costed)
    - Line online – the part is designed to have a close fit to the surrounding parts and some buildup of force is required to get the part started. Examples include a rod end inserted between two tabs in double shear and a splined axle shaft into the differential gear. (Not required to be costed)
    - Interference – significant force is required to insert the part and mechanical assistance may be necessary. Examples include a rubber hose onto a barbed fitting and a ball bearing into a bore.
- Machining

- Costs for machining operations are based on the volume of material removed. The actual machine used, whether mill, lathe or otherwise, is the same unless a specific line item is included for that machine, such as gear hob.

- When costing the raw materials that go into making machined parts the machine stock must be included in the purchased material mass, even though this material is machined away to produce the final part. This represents the cost of the purchased material. For example, an upright bore is machined into a piece of billet aluminum. The interior material that is milled away must be included in the billet mass and hence cost. The same feature machined into a casting need only include 1mm of machine stock of the machined away material.

- Tooling & fixturing

  - Tooling is necessary when certain processes are used. These can be identified in the tables because the tooling required will be indicated. Sometimes several types of tooling are available for the same process. Each has a description and an associated process with which it can be used. If a process has more than one tooling type associated with it the team must use the tooling that is closest to the actual tooling used in their prototype vehicle construction. Most tooling costs are independent of part shape, the assumption being that tooling for smaller parts will be built with multiple cavities to create an optimal cost effectiveness.

  - The tooling cost should be included with the appropriate part on the BOM. Tooling is not a separate section.

- Composites

  - Laminate – used to build the laminate one (1) ply at a time. A ply is a single layer of the laminate consisting of a single sheet of material, regardless of material or thickness. A ply may consist of woven carbon, unidirectional glass, adhesive film or honeycomb core, for example.

  - Curing operations – used to take a laminate and convert it to a finished composite structure. All curing operations include vacuum bagging, peel ply, breather cloth and other consumable materials and labor. Costs also include part removal from the mold.

  - Room temperature cure – used for room temperature curing resin systems.

  - Oven cure – used for higher temperature cure cycles for composites. Limited to one (1) atmosphere of external pressure.

  - Autoclave cure – used for high temperature and pressure composites curing.

  - Curing operations require tooling. Tooling must reflect the type of tooling actually used (composite, aluminum, steel, etc).

- If hybrid weaves are used the cost can reflect the ratio of the materials in the ply. For example, a 50% carbon fiber, 50% glass woven ply may use the average cost of the carbon and glass materials. If the actual fiber ratio is not used then the cost of the ply must be the cost of the highest cost material present.

- When costing composite materials, the total mass of the part in the cost report must match the actual mass of the part as presented on the vehicle for cost judging. The composite material, whether carbon fiber or other must be the cost of both the fiber and resin together. This is true for both prepreg and dry fiber systems and is further stated in the materials table. The mass of each ply can be adjusted to make the finish part mass match the cost report.

ARTICLE 9: APPENDIX S – 2 STANDARD PART NUMBERING

- All assemblies and parts in the BOM must have a part number using the following convention: competition code – date code – car number – base number – suffix.

- Competition code – a code for the competition entered. (EVER 2024).

- Date code – last two digits of the year of the event.

- Base number – five (5) digit code assigned at the student's discretion.

- *For assemblies*: this starts with a, followed by "system designation" – a two (2) letter code for the system under which the assembly is associated, these can be found in appendix S-3. And finally, 2-digit code represent the assembly number in the specific system.

- *For parts:* the first two numbers are for the assembly under which the part is related, the last three digits for part number in the assembly.

- Suffix – two-character code showing part change history. These are provided for student use only **(optional)** so if desired all can be "aa".

  - First character refers to the part design revision level.

  - Second character refers to the part process revision level.

- For example, a part entered into the chassis section for car number 27 competing at an event with code "ever" that the students have decided is part one in assembly 3 would be:

  - Ever – 18 – 27 – afr03 –03001– aa

- The same part, after significant design changes would become:

- Ever – 18 – 27 – afr03 –03001– ba

- The steering wheel quick release assembly that the students have decided is the ninety eights assembly for the **steering** group would be: ever – 18 –27 –ast98 – aa

- Note that the next assembly number for **brake** system –as an example– won't be ninety ninth but start counting from one. So, each system has an independent number of counting. So, it should be

  - Ever – 18 – 27 –abr01 – aa

ARTICLE 10: APPENDIX S – 3 ORGANISED LIST

- The cost report must follow the organized list of systems and assemblies/parts outlined below. Any questions as to the correct location of the specific items must be submitted to the rules committee.

- The two-letter abbreviation after each system name is to be used in the part number.

1. Brake system - br
   - Brake fluid
   - Brake master cylinder
   - Fasteners
   - Brake lines
   - Brake discs
   - Brake pads
   - Balance bar
   - Callipers
   - Proportioning valve
2. Motor and drivetrain – mo
   - Motor
   - Motor mounts
   - Shields
   - Sprocket/pulleys
3. Frame & body - fr
   - Body attachments
   - Body material
   - Body processing
   - Floor pan
   - Frame / frame tubes
   - Mounts integral to frame
   - Pedals
   - Tube end preps
   - Tubes cuts/bends
4. Electrical – el
   - Battery

- Brake light
- Bulbs
- Dash panel
- ECM/motor electronics
- Fuses
- Indicator lights
- Kill switch
- Oil pressure gage/light
- Relays
- Solenoids
- Starter button
- Tachometer
- Water temperature gage
- Wire harness/connectors

5. Miscellaneous, finish and assembly – ms
    - Driver's harness
    - Fire wall
    - Headrest / restraints
    - Mirrors
    - Paint – body
    - Paint – frame
    - Seats
    - Shields
6. Steering system – st
    - Steering rack
    - Steering shaft
    - Steering wheel
    - Steering wheel quick release
    - Tie rods
7. Suspension system – su
    - Bell cranks
    - Front a/arms or equivalent
    - Front uprights
    - Pushrods/pull rods
    - Rear a/arms or equivalent
    - Rear uprights
    - Rod ends
    - Shocks front
    - Springs
    - Suspension mechanism
8. Wheels, wheel bearings and tires - wt
    - Front hubs
    - Lug nuts
    - Rear hubs
    - Tires
    - Valve stems
    - Wheel bearings
    - Wheel studs
    - Wheel weights
    - Wheels

ARTICLE 11: APPENDIX S – 4 AUTONOMOUS TRACK COST EVENT

The primary objective of the Autonomous Track Cost Event is to present the real cost analysis and estimation for a fully autonomous system, prepared for deployment on electric vehicles, thus enabling self-driving capabilities. This requires a comprehensive understanding of the implementation, manufacturing, and integration of each component within your system with real cost estimation.

- The Event also targets how will you validate the system and guarantee the system's safety with the optimum cost that could be spent on doing those processes.
- You must elaborate on the steps that will be used to validate the system's performance and safety including each process cost estimate in detail.
- Note: The event targets the most cost-wise-saving solutions in addition to their effectiveness. Main Components:

- The cost analysis is categorized into five main components: Main Components, Mechanical Fixation, Validation, Safety Measures, and Cost of working hours.
  - Sensor and material selection
    - This section must include the BOM for all the sensors and materials used.
    - The BOM must include the technical specs for all sensors used.
  - Mechanical Fixation:
    - Participants must submit a 3D CAD file depicting the sensors' fixation kit, along with the associated manufacturing processes and costs
    - Make a BOM for manufacturing and the materials used in the design.
    - Include all the machining processes (refer to the machining table) used to design the kits
  - Cost of Validation:

- Validation of the autonomous system necessitates the selection of an appropriate validation environment, whether it be a simulator or real-world testing.
- Participants are required to provide a justification for their chosen validation approach. Additionally, they should describe how they mitigated any disadvantages and provide a cost breakdown for their selected validation method.

- Safety Measures:
  - Safety measures encompass the precautions and systems in place to ensure the safety of passengers and other vehicles and pedestrians in the vicinity.
  - Contestants are expected to submit BOM for their safety system and pro, specifying the sensors and components used in its construction and associated costs.
- Cost of working hours:
  - Contestants should Calculate the total cost of their working hours of all the system and specify the cost of a single hour according to its Kind, whether it is in the development of Software, validation, or testing.

Please consult the Excel spreadsheets for pricing information.

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