FSAEA26 Cost Scenario

The cost and manufacturing event fundamentally attempts to teach and nurture an appreciation for the manufacturing and production phases of a product's life cycle, with the cost report being a window into the basic process planning needed in the professional world. This level of planning, however, seldom exceeds the effective resolution which would be expected at an initial tendering RFI (Request For Information) process. The cost scenario for FSAEA26 is aimed at demonstrating the next level of detail and further bridge the gap towards industry level manufacturing planning. As such, we ask that each team provide a critical manufacturing report as found in most moderate to major businesses to ensure designs are fit for production. This is the "Design For Manufacturing", or "DFM" report.

The DFM report is a tool used to review an entire transformation chain of a product from raw material sourcing to delivery on the assembly line, or into an end-user facing product for a full product DFM. It contains detailed analysis on design elements and risks, material selection and sourcing considerations, tooling, jig, and fixture designs, and product quality assurance forward planning. A list of content typically found in a DFM report is provided in the annex to this document, with specific items which will not be required for FSAEA26 but normally included in a DFM report indicated.

Teams are asked to review their vehicle as planned to be presented at the formula SAE competition and locate a minor assembly which is:

a. Readily visible when viewed from outside the vehicle as it will be seen at the cost and manufacturing event.
b. Contains between 4 and 8 parts.
c. Contains at least 2 different materials of noticeably different manufacturing processes (for example, machined metals, 3D printed polymers, injection molded polymers, extruded rubbers, etc.)
d. May contain some purchased level parts, but must have at least 3 parts which are transformed from raw material to finished part.
e. Not be of significant manufacturing complexity level.
f. Should not contain team designed PCBs or complex electrical components due to complexity, however, purchased electronics are be acceptable within the assembly

The DFM needs to be completed to the level that the minor assembly is ready for fitment to the vehicle. The report will need to be able to be visually presented at the competition, either through a physical printed report, or presented on a physical screen. Teams will be expected to talk the cost judge/s through their report, and explain any methodology or considerations made when generating the report. Within the context of the cost and manufacturing event on the day, we expect most teams will present this in a 10-20 minute window, depending on choice of assembly, content covered, and preparation level.

Teams should consider that scoring will be based exclusively on content presented in the scenario, the judges will be instructed to disregard any considerations outside of this when scoring the scenario. Legibility of the report presented, whether physical OR digital, will be a function of the cost and manufacturing event scenario scoring.

Annex 1 – Contents of a typical DFM report

1. ***A summary page containing details of the content in the DFM, specifically***
    a. DFM report document number;
    b. DFM report revision control number;
    c. DFM report level status;
        (not required for FSAEA26 cost scenario)
    d. DFM approval and sign off signatures
        (not required for FSAEA26 cost scenario)
    e. Part/Assembly documentation identification numbers;
    f. Part/Assembly descriptions;
    g. Part/Assembly documentation version control numbers;
        (typically the revision number)
    h. Part/Assembly CAD/PDM suitable identification numbers;
        (not required for FSAEA26 cost scenario)
    i. Part/Assembly CAD/PDM suitable version control
        (typically the revision number, not required for FSAEA26 cost scenario)
    j. Specific proposed part material;
    k. Specific part/assembly function;
    l. Part function safe usage environmental requirements
        (thermal/ moisture tolerance/ ingress protection/ UV durability/ chemical tolerance/ shock tolerance);
    m. Specific Quality Assurance Level, as listed below;
    n. General manufacturing lifetime production volume estimations
        (function of the business case your team will present in the business event, how many parts will you need to support vehicles are you planning on building?);
    o. A list of tooling, jigs, or fixtures identified;
    p. A list of capital equipment required and identified;
    q. A list of any safety considerations or controls required.

2. ***Material selection***
    a. Material Type;
    b. Proposed Material Supplier;
        (only the company name is required for FSAEA26 cost scenario, however in a full DFM report the contact details for the specific sourcing location would also be provided)
    c. Proposed Material Supplier Part Number;
    d. Regional availability, MOQ (Minimum Order Quantity), and lead time analysis;
        (For the FSAEA26 cost scenario, this will NOT be required, however note this is required in full DFM report and is typically broken down into regions defined at a continental continental level, however Asia and Europe do break down further due to specific geopolitical influences. Especially in plastics and metals, different regions can have different properties due to differences in the chemical composition of the base compounds and purity levels of the base compounds)
    e. Key material technical properties;
        (For the FSAEA26 cost scenario, only the properties relevant to the parts function need to be listed, however note a full technical datasheet is typically provided in an addendum of the DFM report, with critical parameters called out in the DFM report itself)
    f. Cover page of the Material Safety Data Sheet;
        (For the FSAEA26 cost scenario, only the cover page needs to be provided as to not waste material, ` however note a full MSDS is typically provided in an addendum of the DFM report)
    g. Cover page of a Certificate of Conformity;
        (For the FSAEA26 cost scenario, this will NOT be required, however note this is required in full DFM report and this document should be available from the supplier selected).
    h. For metals, a cover page of a Certificate of Origin.
        (For the FSAEA26 cost scenario, this will NOT be required, however note this is required in full DFM report and this document should be available from the supplier selected to ensure material supply is not violating international trade laws).

3. ***Part design review***
    a. Part definition
        i. Color
        ii. Finish, coatings, and/or conditioning
        iii. Material
        iv. Surface classification
    b. Review of part design complexity, and design-based risks to functions or product qualities.
    c. Specification of process flow chart to transform material into finished part
    d. Cycle time estimation
    e. Tooling requirements per process step
    f. Jigs and Fixture requirements per step

4. ***Assembly design review***
    a. Review of part interactions;
    b. Fastening and/or joining review;
        i. Fastener choice (where applicable) (For the FSAEA26 cost scenario, this will NOT be required)
            a. FOS criticality analysis
            b. Grade-vs-Cost decisions analysis
            c. Environmental Protection analysis
            d. Torque or Force analysis
        ii. Joining review (where applicable) (For the FSAEA26 cost scenario, this will NOT be required)
            a. Process instructions
            b. Inspection requirements
            c. Control Limits and Parameters
        iii. Accessibility for tooling
    c. Specification of process flow chart to transform base parts into finished assembly;
    d. Cycle time estimation;
    e. Tooling requirements per process step;
    f. Jigs and Fixture requirements per step;
    g. Review of changes in orientation during assembly, showing orientation required for each assembly step;
    h. Ease of part handling and positioning;
    i. Serviceability and maintenance consideration and review.

5. ***Tooling and fixturing design***
    a. A list of each piece of capital equipment required to transform the raw materials to finished parts then install them together.
        For the FSAEA26 cost scenario, this will be limited to the overall type and power level of the equipment needed, however in industry you will expect the unique plant equipment asset number, or list of suitable numbers, which are expected to be used.
    b. A breakdown of what each piece of tooling which is required to do physical transformations of raw material to parts, or parts into assemblies.
    c. A breakdown of any fixtures required to hold raw materials, semi-finished parts, or parts in place whilst additional transformative processes occur, typically associated with machining or welding operations and physically secured to a machine or factory structure.

d. A breakdown of any jigs required to hold materials or tools in specific positions during either material transformation processes, or during assembly for precise positioning control.
e. A preliminary safety and risk assessment for the use of any required tools, fixtures, or jigs.
f. Note that additional analysis is typically included to analyses the tooling design and review risks of part defects occurring due to the tool design, however For the FSAEA26 cost scenario, this will NOT be required due to the limited resources most teams would be able to use to complete the analysis.

6. ***Documentation level review***

a. Critical dimension and tolerance sensitivity review (i.e. if the part is over or under tolerance)
    i. Stack-up analysis from part tolerances to assembly tolerances
    ii. Review of expected tolerance stack up for each transformative step
b. Review of documentation level process specifications
c. Review of completeness of part traceability information, physical and digital
d. Design Failure Mode Effects Analysis (DFMEA) on part and assembly level, highlighting any risks expected associated with the design which can degrade product performance and/or product safety and/or process safety, which would need to be controlled in production.
e. Process Failure Mode Effects Analysis (PFMEA) on part and assembly level, highlighting any risks expected associated with the process which can degrade product performance and/or product safety and/or process safety, which would need to be controlled in production.

7. ***Quality Assurance (QA) preliminary planning***

a. Specific Quality Assurance Level, which is the rating of the sum of processes for a part OR sum of processes for the assembly in relation to risk to the product as a result of a failure to meet the specified quality of the product. This is generally directly correlated to the AQL general or special inspection levels.
b. Proposed inspection strategy, sampling rates, and testing methods
c. Review of equipment requirements for quality control and inspection
d. Template for first article inspection, and specification of size required for first article inspections
e. Planning for statistic process control of entire production process from raw materials to the finished assembly

8. ***Cost and Expenditure analysis***

(For the FSAEA26 cost scenario, this section will NOT be required, however note this is typically required in full DFM reports)

a. BoM part costing
b. Tooling and Capital expenditure costing
c. Production throughput and efficiency
d. Expected and Acceptable Yield and Reject Rates

9. ***Supply chain analysis***

(For the FSAEA26 cost scenario, this section will NOT be required, however note this is typically required in full DFM reports)

a. Supplier status (typically ranked as “New”, “Onboarding”, “SQE inspected”, “Approved”, “Trusted”, with each level affecting the requirements for SQE (Supplier Quality Engineer) and PPAP (Production Part Approval Process) requirements)
b. Supplier capability analysis
c. Supplier upskill plan (if required)
d. Supplier Quality Assurance System Review
e. Supplier Quality Control Audit
f. Supplier Compliance Audit

10. ***Sustainability and Environment analysis***

(For the FSAEA26 cost scenario, this section will NOT be required, however note this is typically required in MODERN full DFM reports)

a. Material recyclability
    i. Recyclability level of material from in-process or pre-consumer wastage
    ii. Recyclability level of material from Post-Consumer recycled content
    iii. Acceptable limits for recycled content of both recyclability levels
b. Material production and transportation footprint
c. Production energy and consumption requirements
d. Plan for end-of-life disposal and material recovery
e. Design review for material wastage reduction
f. Compliance requirements for markings and/or documentation and/or life cycle support.