APPENDIX I

Procedure for filling the questionnaire: Numerical values of all attributes cannot be calculated easily. For example the value for attribute DFM of a product depends on the items in the appendix. The value for DFM (attribute) is obtained by assigning the values to all dependent factors and summing and normalizing. For this, positive contributing criteria are given values from 0 to 5 in ascending order. In particular consider simplicity, the value 5 will be assigned for more simplicity and for least simplicity the value 0 will be assigned. All least contributing criteria are given values from 5 to 0 in descending order. For example closer tolerance the value 0 is given and for wider tolerance the value 5 will be assigned.

A: Design for Manufacturing

<table>
<thead>
<tr>
<th>Attribute</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>Simplicity</td>
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<td>Standard components</td>
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<td>Process ability of material</td>
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<td>Common parts and materials</td>
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<td>Parts ease for fabrication</td>
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<tr>
<td>Liberal/tight Tolerance</td>
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<td>Utilizing special process</td>
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<tr>
<td>Manufacturing sequence</td>
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<tr>
<td>Minimize number of parts</td>
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<td>Shape of the parts</td>
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<td>Easy for inspection</td>
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<td>Robustness of design</td>
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<tr>
<td>Use common parts</td>
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<td>Parts to be multifunctional</td>
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</tbody>
</table>
• Avoid tight tolerance
• Avoid secondary operation
• Use common datum
• Minimum weight
• Use general purpose tooling
• Many operation in one setting
• Compact design
• Foldable and stackable design
• Use of available stock

B: Design for Assembly
• Number of part count
• Modularize multiple parts
• Assemble space
• parts identify oriented for insertion
• Prefer self-locating parts
• Standardize to reduce part variety
• Maximize part symmetry
• Design in geometric or weight polar
  properties if nonsymmetrical
• Eliminate tingly parts
• Color-code for parts having similarity
• Prevent nesting of parts
• Mating features for easy insertion
• Provide alignment features
• Insert new parts into an assembly from above
• Eliminate re-orientation of parts
• Eliminate fasteners
• Provide flats for uniform fastening
• Space between fasteners& features
• Prefer easily handled parts
• Weight of the components
• Foolproof (poke-yoke)
• Prefer self-locating parts
• Avoid flexible and fragile parts.

C. Design for environment
• Material recovery and reuse
• Design for disassembly
• Product waste minimization
• Waste recovery and reuse
• Packaging recovery
• Use of hazardous or undesirable material
• Hazard to production workers
• Noise level (80 decibels accepted limit)
• Disposal of waste
• Recyclable material
• Restricted material

D. Design for safety (DFS)
• Robustness
• Error feed back signal
• Multiple trigger for safe
• Nonflammable materials
• Condition monitoring system
• Avoid sharp corner in parts
• Avoid projection in parts
• Rotational parts to be covered
• Alarm to toggle from the danger
• Sign post in dangerous operations
• Handling slippery parts
• Provision for handling the par
• Optimal feedback
• Failure feedback
• Safety lacks

E. Design for reliability (DFR)
• Fail safe approach (weak spots monitoring)
• Replace the components in life period
• Increase the reliability of the components
• Design with higher factor of safety
• Test under maximum load condition
• Test for real condition
• Improve design for failed components
• Define the definite working condition

F. Design for maintenance (DFMn)
• Easily visible and accessible
• Easy removal of Cover, housing, panels
• Avoid pres fits, bonding, riveting,
• Modular design is great boon.
• On-line testing possibilities
• Indicator for maintenance
• Standard spares
• Compatibility with maintenance tools

G. Design for aesthetic features (DFAF)
• Smoothness
• Shininess/reflectivity
• Texture
• Curviness
• Color
• Simplicity
• usability
• symmetry
• modernism
• structural integrity
• Appearance
• Handy
• Pride

H. Design for economy (DFEc)
• Design and development cost
• Material cost
• Production cost (for all operations)
• Assembly cost
• Cost of the fasteners
• Other over head expenses

I. Design for ergonomics (DFEr)
• Space for assembly
• Orientation
• Position of operator during assembly
• Fatigue of the operator
• Position of the control panel
• Surrounding of the operator
• Operator work volume
• Operator safety
• Automation when possible