

**Documentation Checklist: FSAE and Baja SAE Tube Structures
Preparing and Submitting Documents to VR3 for Review and RFQ**

Sept 1 2017

The purpose of this checklist is to identify and correct the most common problems with preparing documents suitable for producing profiled tube components.

This is based on 'SOLIDWORKS' CAD but is equivalent to any 3D 'solid body' modeling/documentation requirements.

1. Are the following 3 files available to review the tube structure configuration and submit a proposal?
 - 3D CAD model of the tube structure
 - Pdf version of the assembly drawing (with balloon numbers and material list)
 - Excel spreadsheet of the material list
 - *Sample documents are available from our website
 - *VR3 will review and submit a proposal/quotation IF the above documents are suitable

2. 3D Solid Model CAD Files
 - Have you reviewed our '[3D Modelling Guideline](#)' document for tube structures?
 - 3D CAD file must be created as 'solid body' features; not surfaces, splines or non-geometric features.
 - Are the sketches 'fully defined'? This will avoid many problems.
*Avoid under defined import data or 'fixed point' definitions on sketches and design constraints.
 - Are you trying to define too much in one 3D sketch?
*Divide layout sketches into multiple 3D and 2D sketches for a more stable CAD model.
 - Add one tube member at a time. Avoid using one structural member to create multiple tube members. This will cause problems downstream when trims or updates and revisions are applied.
*It is pay now or pay later regarding the time required, especially when design changes are applied downstream
 - See comments regarding bend features below to ensure suitability (item 3).
 - See comments regarding square tube components below (item 9).
 - Ensure all tubes have clearly defined centerlines (i.e.: check 'temporary axis' in SOLIDWORKS).
 - Are all tubes modelled to nominal tube sizes? (outside diameter and wall thickness in standard 'inch' sizes)
 - Use the 'combine' command to join straight tube segments into a single body / cut list item.
 - Does the number of cut list items equal the number of tube components?
 - We prefer the 'weldment/assembly' version of the 3D CAD model for review purposes.
*It is easier and quicker to review the trims, bend features and manufacturing details.
*Individual part files are preferred after the configuration is 'approved for manufacture'
*Individual part files cannot be checked by VR3. We can only manufacture 'as is'
 - Native SOLIDWORKS files are preferred. Parasolid (*.x_t) or step (*.stp) formats are alternatives.

3. Bend Features (the most challenging aspect of tube structures):
 - Have you reviewed our bend guideline document?
 - Are the bend features modelled in defined planes? (i.e.: consecutive centerlines of straight sections intersect)
 - Do the bend centerline radii (clr) match our bend dies?
 - Is the tube wall thickness suitable for the selected bend radius of each tube?
 - Is there a minimum 4" of straight section between consecutive bends?
 - Is there a minimum of 4" from the deepest cut in the end notch to the tangent of the first bend?
 - Can mating tubes nest onto the straight section instead of nesting onto the bend feature?(will result in better fit)
 - Has the 'combine' feature bend applied at the end of the design tree after all trims?
 - Check for symmetry of formed tubes if required by design.

Note: *Keep the bend features as simple as possible, especially considering this is a one off project.
 *If our constraints are met, complex bend feature can be beneficial to the design configuration.
 *Although we do a good a job of producing bends in multiple planes, simpler is better.
 *Packaging and shipping can get more expensive because of awkward and bulky volumes.

4. Trim Features:

- Have tubes been trimmed one at a time in a similar sequence as the tubes are added?
*It is best to trim tubes immediately as the tubes are added as structural members.
*i.e.: add a structural member, trim this tube, add next structural member, trim, and repeat for the entire model
- Are all the tube ends trimmed? (i.e.: no missing trims)
*It is much easier to avoid missing trims when the above process of adding trims as you go is used.
- Are there any 'hollow node' style trims? These must be avoided! (see item 9)
- Are there extra trims / scallops? (Occur when Trim/Extend is not selected correctly, turn off as required)
*Our 3D modelling guidelines suggest adding trims in the same sequence as adding structural members. This will avoid missing trims, hollow nodes and allow for easier modifications if there are changes
*Refer to the VR3 sample SOLIDWORKS model for a demonstration of ideal trimming scenarios ([VR3.ca](#))
*Do not apply weld gaps on trim features. GTAW / TIG welding thin wall tube structures do not require gaps.
*Metal to metal contact around the perimeter is recommended.
*This will produce the easiest to assemble and most stable welded tube structure.

5. Weldment / Assembly Drawing:

- Has our sample drawing been reviewed?
- Is each tube **CLEARLY** identified with a balloon number?
*If you cannot find a tube on your drawing, neither can we. Please ensure the drawing provided is clear.
 - i. Ensure the arrows point to a unique feature of the tube.
 - ii. Ensure the arrows DO NOT point to the end points of members at multi-tube nodes/clusters.
- Is the material list / cut list added to the assembly drawing?
- Is the scale and proportion legible when plotted on 8.5" x 11" or 11" x 17" paper?
- Do the material descriptions (tube OD and wall thickness) match the actual 3D model?
- Assign a drawing number, description, date and revision level to the document.
- Save/print this drawing as a pdf document.

6. Material List:

- Has our sample excel spreadsheet been reviewed?
- Does the number of cut list items (solid bodies) match the number of tubes?
- Is additional or spare tubing material required? Add as an extra line on the material list.
- Use the automated 'cell formulas' of the sample spreadsheet. Learn to use these and do not manually override formulas or data.
- Identify / indicate any tubes or components that are 'supplied by others'.
- Ensure the total number of tubes matches the solid model and requirements.
- Increase the quantities of spares, test pieces or extras that may be required.
- Clearly specify the material grade required. This is typically 4130N. (see items 11 and 12)
- Add suspension tubes, bracket tubes, or extra material required to this excel document / material list.
*The best value is one order / one shipment.

7. Drawings and Documents

- Are the CAD files, drawings and documents assigned a unique number and revision level or date?
- Is the school name and project description, date/revision clear and unique?
- Are left / right tube parts assigned separate part numbers? These are usually unique parts and are not interchangeable.
*100% identical parts can have multiple quantities. This applies to square ended tube features or other simple 2D features.

8. Order Processing Information:

- Is a purchase order number / approval required to be issued by the university/school/institution?
- Has funding been approved by the school?
*If a PO is not issued credit card information will need to be provided prior to your tube set being shipped.
- Technical contact: Name, email address, phone number
- Order / payment contact: Name, email address, phone number
- Shipping Contact: Name, email address, phone number, street address, bldg. name / number, zip code

- EIN / Fed ID number for the school/institution is required for first time customers
 - *required to complete shipping paperwork for US customs
 - *all fees and paperwork are included in our pricing for student projects

9. Square Tube Modelling Details:

- Ensure square tubes are modelled with 'concentric' corner radii.
 - *This represents the actual tube better and results in a better tool path.
- Ensure cutouts or end features are offset from the corner radii by .010" or more.
- See our 3D modelling guidelines for more information on square tubes ([VR3.ca](#)).

10. Hollow Node Trims:

- Avoid 'hollow node' style trims.
 - *While the 3D model will appear okay, the manufactured version would be less than ideal.
 - *This is because the tool path and cut edge are perpendicular to the tube surface. The result would be:
 - i. More difficult to position and locate the tubes
 - ii. There would be gaps and no substrate/underlying material to weld to
 - iii. Welds would be 'groove' type welds which are not recommended for thin wall tubing, especially 4130N
 - iv. Fillet welds are preferred; easier and stronger
- Hollow node trims will be avoided if trims are applied in sequence as the structural members are added one at a time.
- See our 3D modelling guidelines for more information and ask for sample/demonstration documents if required.

11. Tubing Material Specifications and Sizes:

- Clearly indicate the material specification on the material list (spreadsheet).
 - *4130N is the most commonly used material and available in the widest range of OD's and wall thicknesses.
 - *C1020 is a second choice but available in fewer diameters and only .065" and .095" wall thickness.
 - * These tubing materials are available in nominal inch sizes only, not metric sizes.

12. Tubing Material Supply Note:

- VR3 supplies the tubing material.
- Sending material (4130N tubing) is typically not a good choice.
- We have gone this route before. It is very inconvenient and costs us extra time and money.
- Paperwork to cross the border is a nuisance.
- Shipping and handling may cost more than the material.
- We will end up with additional customs (border crossing) paperwork bill(s).
- Manufacturing and scheduling delays will be significant.
- We prefer/need full or long lengths of material. We do not pre-cut tubing before notching.
- Free material is often left over material, likely shorts and possibly damaged.
- It takes us more time to sort out and confirm material.
- We maintain trace ability of all our purchased materials and cannot mix lots of material from various sources.
- We carry most sizes of 4130N tubing up to 2.000" OD ready to manufacture.
- If a mistake is made with bending tubes, it is our time, material, and expense not yours if we supply the material.
- Whether 2" or 200 feet is required, we usually have enough material in stock in all common FSAE / Baja sizes.
- Our pricing is based on supplying material, cutting and bending services as a complete kit with very good value for one-off student projects.