Fabricate Parts for Sub-assemblies

Workbook (AUM8063A)
AUM8063A

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Workbook
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Introduction

Sub-assemblies

Fabricate Parts for Sub-assemblies is based on a practical project consisting of the manufacture of parts to produce sub-assemblies which, in turn, are brought together to produce a completed vehicle body ready for painting and licensing.

The vehicle chosen for the practical exercise is a box trailer, either a fixed draw bar trailer or a tipping trailer, depending on the cutting list chosen. Students should follow the steps illustrated in the diagrams, noting any instructions or notes given.

From parts to sub-assemblies

Vehicle bodies are manufactured from a completed series of sub-assemblies. A completed vehicle body appears as a single total unit, but broken down it is actually a series of sub-assemblies which, in turn, are made up of several parts. Together the parts make sub-assemblies and, put together, the sub-assemblies complete the total body.

An example would be a one-tonne tray body consisting of a series of sub-assemblies brought together. The sub-frame is one unit, consisting of several parts such as the main runners, cross bearers and coaming rails. The drop sides are another sub-assembly, made up of the side pressings plus other parts such as end caps, hinges and locks.

The cab rack is also a sub-assembly, made up of parts such as cross rails, uprights and a kick plate.

Vehicle body components

The following are the parts which would go together to make up sub-assemblies to produce a simple tray body:

1. main runners
2. cross bearers
3. dummy cross bearers
4. coaming rails
5. front and rear coaming
6. cab rack uprights
7. cab rack outer supports
8. cab rack kick rail panel
9. cab rack cross rails
10. rope rails
11. rope rail stays
12. floor
13. splash boards
14. splash guard stays
15. light bracket.

Some optional extras include:

a) drop sides
b) loading gates
c) twist locks
d) pin holes
e) pin racks
f) ‘V’ box
g) tarp box
h) tool box.

Using the numbers of the various parts, listed on the previous page, draw an arrow to the corresponding component on the following drawing of a typical tray body.

Semitrailers are similar to all other vehicles in that they consist of many parts made into sub-assemblies, which in turn come together to make up the finished vehicle body. The sub-assemblies of a semitrailer van would typically look like the following exploded view.
Fabricate parts for sub-assemblies

Practical component

General construction guidelines

- Always wear personal-protective gear.
- Cut the longer components first.
- Use off-cut material where possible.
- Paint between mating parts.
- Use anti-spatter on zinc-coated material.
- Do not weld across longitudinal beams or members.
- Tack weld all components.
- Check measurements and squareness before fully welding.
- Only fully weld when the sub-assembly is complete and correct.
- Use only the minimal amount of weld necessary; do not over weld.
- Grind welds as you go.
- Avoid sanding away zinc and protective coatings.
- Work to a tolerance of ±1 mm.
The above trailer is a completed assembly. The main sub-assemblies are the base frame, the draw bar, the body pressing, front and rear gates, mudguards and locking assembly. The sub-assemblies are made of parts, the drawings to manufacture these parts and relevant information are contained in the following pages.
Order of manufacture and assembly of sub-assemblies

- Construct the base frame.
- Construct the draw bar.
- Drill holes and add conduit for electrical wiring.
- Assemble the base frame and draw bar.
- Assemble axle and suspension system.
- Attach axle assembly.
- Fold the body and assemble.
- Fold and attach the end plates.
- Fold and construct tail and front gates.
- Hinge the gates.
- Fold and construct the wheel guards.
- Attach the wheel guards.
- Construct the rope rail assembly.
- Attach the rope rails.
- Manufacture the locking mechanism for a tipping trailer.
- Attach the locking mechanism.
- Add extras such as safety chains and wiring plug holders.
- Drill holes for number plate, VIN plate, mud flaps, gate drain holes.
- Weld the vehicle identification number onto the draw bar.
- Do a final general clean-up.
- Assemble the wiring loom.
- Install wiring.

Only tack weld your work for each part or sub-assembly until it has been checked by your supervisor. Stay within the guidelines ie ± 1 mm and square.
### Fixed draw bar trailer cutting list

Cutting list for the base frame

<table>
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<tr>
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<td>1</td>
<td>50 × 50 × 5 Angle</td>
<td>1 460</td>
<td>1</td>
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<tr>
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<td>40 × 40 × 5 Angle</td>
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<td>3</td>
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<td>4</td>
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<tr>
<td>8</td>
<td>40 × 40 × 3 Angle</td>
<td>1 220</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>50 × 50 × 5 Angle (draw bar)</td>
<td>1 610</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>40 × 40 × 3 Angle (draw bar)</td>
<td>1 510</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>5 mm (wear plates) MS Plate</td>
<td>150 × 75</td>
<td>2</td>
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</table>

Cutting lists are not always supplied. These are derived from the drawing of the item to be manufactured. It is always wise to make up a cutting list of the part to be made and before beginning construction. If certain size material is not available you will be aware of this early on and appropriate alterations can be made. For example if 50 × 50 × 5 angle is not available for the front bearer and 50 × 50 RHS is substituted, both the mainrunners and side rails will need to be reduced by 45 mm in length.
Standard trailer base frame

Note:
1. Check spring sizes before fitting parts N 5, 4 and 6.
2. All materials ex 40 x 40 x 3 angle unless otherwise stated.
**Note:**
Cut one end of part No 1 as shown in 'Detail A' before setting up draw frame.

It is important to remember **not** to weld across the draw bar; only weld along the draw bar and any other longitudinal members. Welding across longitudinal members creates a weak point due to a lack of flexibility when the vehicle is in motion.
Tipping trailer cutting list

2 100 × 1 200 mm

Cutting list for the base frame

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<td>40 × 40 × 5</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>5 mm (wear plates)</td>
<td>150 × 75</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>5 mm (hinge plates)</td>
<td>to pattern (see drawing)</td>
<td>4</td>
</tr>
</tbody>
</table>

The cutting list above is for a tipping trailer and varies from the fixed draw bar version in that the base frame has provision for carrying hinge plates for the draw bar. The draw bar is a separate sub-assembly.
Tipping trailer base frame

Note:
1. Check spring sizes before fitting parts No7 and 8.
2. All materials EX 40 x 40 x 5 angle unless otherwise stated.

12 Hole for wiring
50 x 50 x 3.2 RHS

Position with drawbar
5 mm MSR

50 x 50 x 3.2 RHS

156 Position with drawbar
5 mm MSR

5 mm MSR Plan

EX 5 mm MS Plate

1220

Front

1220

Detail A

Section XX

120

100

100

100

745

1395

2100

1460

3515

2585

1050

1115

Axle

Section on C

Detail B

Section YY

50 x 50 x 3.2 RHS

15 Hole for wiring

EX 5 mm MSR

Note:
1. Check spring sizes before fitting parts No7 and 8.
2. All materials EX 40 x 40 x 5 angle unless otherwise stated.
Tipper draw bar – measurements

- 20 mm Ø NB black pipe
- 65 x 35 x 3·2 RHS reinforcing plate
- 65 x 35 x 3·2 RHS locking bar hinge plate
- 12 mm Ø hole for wire harness
- 100 x 55 x 5 plate

Dimensions:
- 770 mm
- 1080 mm
- 1200 mm
- 230 mm
- 180 mm
- 1040 mm
- 100 mm
Tipper draw bar – angles

To find the angle of change for the drawbar:

![Diagram of a triangle with sides 1200, 1200, and 770, and an angle of 19 degrees.]

The front of the drawbar forms a triangle of these two known approximate measurements.

To find the length of side B, use the formula:

\[ A^2 + B^2 = C^2 \]

Transpose B

\[ C^2 - A^2 = B^2 \]

\[
1200 \times 1200 - 385 \times 385 = \sqrt{1291.775}
\]

Answer = 1137 approx.

To calculate the amount of material to notch out of the drawbar for the correct bend the following formula can be used:

\[ \tan \frac{\angle}{9.5} \times \text{material width} = \frac{\angle}{5.8} \text{ mm} \]

Cut 5.8 mm each side of the notching centre line.

11.6 mm in total

One side of the drawbar

Notch out 11.6 mm and bring together
The tipping trailer draw bar has to be notched out, which sometimes weakens the component at that point. The strengthening strap reinforces the point of notching and doubles up as a wear strap against the body guides.
To join the tow-hitch plate to the draw bar – only weld along the draw bar not across it. Only weld along the 160 mm side and across the front.
The draw bar pivot plates require a hole drilled through them to allow a pivot pin to be inserted through the plates and the draw bar, a 16 mm high-tensile bolt or similar will suffice.

To ensure the pin on both sides are perfectly in line, the holes are not drilled beforehand but all at the same time.

**Method**

Set up the draw bar on the base frame exactly where it must go. That is, equidistant in from the side rails on both sides. The centre of the draw bar tow-hitch plate must be in the centre-line of the base frame. Tack weld the hinge plates to each side of the draw bar. Mark the centre of the hinge pins exactly the same measurement from the front of the base frame. Remove as one item and drill through each leg of the draw bar using a post drill. Break the tacks and reassemble.
Draw bar body guide

draw bar body guide – one pair

This guides the draw bar into the correct body position and prevents lateral movement when the vehicle is in motion.
The clearance between the front of the tow-bar hitch and the draw bar must be great enough to clear the tow-bar of the towing vehicle. In most cases 95 mm will be sufficient. This measurement is to the centre of the draw bar which curves in 5 mm.
Axle alignment
To line up the axle, it is very important that everything lines up with the centre-line of the vehicle, usually established by using a string line. If the axle is not in line, the trailer will not track correctly, that is, it will want to travel across the road in the direction in which the axle is facing.

**Method**

- Assemble the springs and hubs to the axle.
- Measure the distance from the front of the base frame to the centre-line of the axle – in this case 1115 mm. This is back past the centre-line of the trailer to place more mass onto the towing vehicle and ensure better towing.
- Measure from the hub to the side rails on both sides – they must be the same. (x)
- Measure from the hub to the centre-line at the front of the draw bar, they must be the same. (y)
- Once correct, tack weld the front-spring hangers in place and check measurements x and y again.
Spring hanger gusset

This gusset reinforces the spring hanger to prevent possible future stressing.

Provision for wiring

A five core wire runs from the front of the vehicle at the draw bar to the rear of the vehicle to operate the lighting required by law. This wire must be supported along its length at a maximum interval of 600 mm (vehicle standard regulations), this interval should be shortened if deemed necessary as it is often not adequate.

In the case of a fixed draw bar trailer and a tipping trailer, the draw bar acts as the wiring support. The wire core enters the draw bar and is supported the full length of the draw bar until the wire exits. Provision for wiring support along the body is given by the use of 15 mm Ø tubing (or similar) at intervals down the near side.

With the fixed draw bar, trailer holes are drilled through the bearer at the rear to allow the wire to pass from the near side to the off side and remain tucked well up into the body.

The tipping body uses the rear cross bearer as a conduit with the wiring entering through a 12 mm Ø hole in the near side and exiting through a 12 mm Ø hole in the offside.
Fixed draw bar

DETAIL A
25 mm ID black pipe for electrical plug

DETAIL B
12 mm Ø hole for wire

DETAIL C
15 mm Ø tube x 25 to carry 5 core electrical wiring
**DETAIL A**
25 mm ID black pipe for electrical plug

**DETAIL C**
15 mm Ø tube x 25 to carry 5 core electrical wiring

**DETAIL D**
12 mm Ø exit hole for wiring

**DETAIL B**
50 x 50 x 3.2 RHS
12 mm Ø hole for wiring
Sheet management

Each trailer requires 2.5 sheets of 1.6 zincanneal. When cut in the manner shown, there is maximum usage of material.
Body pressing details

Note:
Calculate the pressing dimensions and enter them on the drawing below.
Material is 1.6 mm zinc-annealed.
Length is the same as the base frame.
Width is 1200 mm.
Rear and front side panels

**Note:**
To allow for slight variations in the body folds: when making the panels, fold the 20 mm segment first, then mark the larger fold off the job.

**Material** 1.6 mm zincanneal

**Method:**
Mark out material to allow for minimum waste. Cut out each panel. Mark the detail. Cut out the waste. Fold the 20 mm first. Mark 50 mm fold on the job to ensure perfect fit. Fold the 50 mm section.
Front and rear gates

Material
Gate 1.6 mm zincanneal
Ends 40 x 3 angle
Cut material at 400 mm x the internal width of the trailer minus 10 mm.
Front and rear gates – exercise

Tailgate face side

Tailgate opposite side

Fill in the missing dimensions using the progressive measurement method.

Note:
To ensure a correct fit to suit your trailer body, mark the last two folds off your job with a 4 mm packer each end to ensure an even gap.
Hinges – one pair

50 x 75 x 5 flat bar

12 mm rod
1 x 110 long
1 x 120 long

20 mm Ø round bar
drill 12.5 mm hole

25 x 25 square bar
drill 12.5 mm hole

Plug weld
Tailgate-locking pin

7 mm Ø hole

20 mm Ø rod x 75

Note:
Tack weld the tailgate into position.

Attach the rear hinges and tack into position.

Drill the tailgate-locking pin holes through the tailgate and the rear panel at the same time.
Holes for rear lights

The holes drilled for the rear lights will only suit one type of combination light. If a different set is used – so the holes will differ. The centre hole is for the electrical wires, the two outer holes are for fixing the base of the combination lights.
When positioning the hinges it is important that the pins are inline, both horizontally and vertically, otherwise binding will occur and the gate will not swing easily.

Both hinges need to face in the same direction so that tailgate can be removed. In this case they are facing to the rear side of the vehicle. One hinge pin is longer than the other to allow for ease of assembly when putting the gate back on. The longer pin will locate and hold the weight of the gate while the shorter pin can be more easily located into position.

Drain holes need to be drilled in the bottom of the gate. These are positioned 40 mm in from each end and 10 mm in diameter.
The front gate is fixed in position with four 6 mm gutter bolts, this provides for removal if required.

Drain holes are drilled in the bottom of the gate. These are positioned 40 mm in from each end and are 10 mm in diameter.
Tail-light protector

The tail-light protector is to prevent damage to the red lenses of the tail-light in the case of accidental damage – such as reversing into a pole.

They are stitch welded from the underside of the protector so the welds are not visible. Only use the minimal weld such as five stitch welds 10 mm long.
Mudguards

Mudguards are a legal requirement on all vehicles. They are designed to prevent water and mud spraying onto following vehicles. They must be as wide as the tyres and low enough at the rear to keep the spray at a low trajectory. To help this, mud flaps are added to the rear of the mudguard.

Mudguards

Mudguards are a legal requirement on all vehicles. They are designed to prevent water and mud spraying onto following vehicles. They must be as wide as the tyres and low enough at the rear to keep the spray at a low trajectory. To help this, mud flaps are added to the rear of the mudguard.

Fill in the missing dimensions:
Mudguard positioning

centre-line of the axle

(850 approx)
Rope rails

The purpose of a rope rail is to provide an easy means of attaching ropes, straps or chains with which to secure the payload. The size of the rope rail is dependent on the predicted payload to be carried. The two parts used in order to make a sub-assembly are the rail itself and the uprights.
Locking bar hinge plate

The following parts come together to make up the locking bar mechanism for a tipping trailer. This sub-assembly is not used for a fixed, draw bar trailer.

The locking bar hinge plate welds to the inner corners of the draw bar and the spreader bar.
Locking bar mechanism

1. Locking bar 20 mm Ø x 1370 mm
2. Angle catch 30 x 5 x 10 angle
3. Retainer lug 50 x 5 x 100 plate
4. Reinforcing plate 40 x 3 x 100 flat bar
5. Hinge 20 mm Ø NB pipe x 75
6. Hinge plate (see drawing)
7. Over centre catch 20 x 20 x 3
This retainer bar carries a figure 8 (not shown) which is permanently on the retainer bar. This needs to be slipped onto the retainer before welding because it cannot be added after. The figure 8 is looped over the locking bar to keep the body locked down when not tipping. The retainer bar is at a different angle to the locking bar, so during travel, if the figure 8 slips down to the retainer it will become tighter, not looser.
Job completion

The following items are the extras which need to be carried out:

- all spatter removed
- safety chain welded on
- nyloc nuts on the spring shackles
- nyloc nuts on the ‘U’ bolts
- nyloc nuts and washers on the draw bar hinge
- holes for the VIN plate
- holes for the tail-lights
- holes for the tailgate pin chains
- drain holes drilled in the bottom of the gates
- a safety catch added on from the body to the draw bar for tippers
- a VIN number welded onto the draw bar
- VIN stamped onto the gates.

At the completion of this project it is obvious that many parts go into making up sub-assemblies and each part is important. For example, a simple tube used to support the wiring, if left out, may cause the vehicle to be rejected at licensing because it would not comply with regulations.

Our project was a simple box trailer, but the same system of fabricating parts for sub-assemblies is applied to larger vehicles, such as semi-tippers and tourist coaches.

As you may have discovered, it is crucial that all parts are made to specifications as they must neatly fit together to produce a sub-assembly and of course the sub-assemblies need to combine accurately to produce a finished vehicle ready to be on the road carrying a payload.
### Material costing sheet

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# Trailer checklist

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<tr>
<td>Assemble frame (complete with boxing and wiring supports).</td>
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<tr>
<td>Square frame.</td>
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<tr>
<td>Fit draw bar.</td>
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<tr>
<td>Welding.</td>
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<tr>
<td>Clean up.</td>
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</tr>
<tr>
<td>Paint.</td>
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</tr>
<tr>
<td>Calculate pressings.</td>
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<td></td>
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<tr>
<td>Cut material for body.</td>
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<tr>
<td>Mark out for body pressing.</td>
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<tr>
<td>Press body.</td>
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<tr>
<td>Fit body to frame.</td>
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<tr>
<td>Weld to underside.</td>
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<tr>
<td>Square sides.</td>
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<tr>
<td>Calculate corner gussets.</td>
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<tr>
<td>Mark out and press gussets.</td>
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<tr>
<td>Fit corner gussets.</td>
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<tr>
<td>Weld corner gussets.</td>
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<tr>
<td>Clean corner gussets.</td>
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<tr>
<td>Fit axle saddle.</td>
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<tr>
<td>Fit springs, axle and square suspension.</td>
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<tr>
<td>Fit bearings and hubs (correct tension and grease).</td>
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<tr>
<td>Fit wheels.</td>
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<tr>
<td>Calculate tailboards (front and rear).</td>
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<tr>
<td>Press tailboards.</td>
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<tr>
<td>Fit ends on tailboards.</td>
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<tr>
<td>Hinge tailboards.</td>
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<tr>
<td>Drill drain holes (x3).</td>
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<tr>
<td>Fit locks to tailboards.</td>
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<tr>
<td>Calculate splash guards.</td>
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<tr>
<td>Press guard.</td>
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</tbody>
</table>
Fit guards with correct rebound.
Match drill guards and mudflap plate.
Cut and fit rope rails.
Drill drain holes to floor.
Fit tow-hitch and safety chains.
Fit electrical plus holder.
Fit lights and wiring.
Connect lights.
Fit light protectors.
Fit VIN number plate.
Clean up trailer paint.

<table>
<thead>
<tr>
<th>After paint</th>
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</thead>
<tbody>
<tr>
<td>Fit mudflaps.</td>
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<tr>
<td>Fit ‘D’ shackles.</td>
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<tr>
<td>Fit compliance plate.</td>
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<tr>
<td>Fit licence holder.</td>
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<tr>
<td>Fit reflectors.</td>
</tr>
<tr>
<td>Check wheel nuts.</td>
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<tr>
<td>Check ‘U’ bolts.</td>
</tr>
<tr>
<td>Check tow-hitch bolts.</td>
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<tr>
<td>Check lights.</td>
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</tbody>
</table>
DESCRIPTION
This guide is a practical unit which uses the manufacture and assembly of a simple vehicle body to demonstrate the relationship between fabricated parts, sub-assemblies and the completed article.

The reader is presented with diagrams and drawings of parts to fabricate which in turn make up the sub-assemblies required for a complete body.

EDITION
First edition

CATEGORY
Automotive Manufacture

COURSES AND QUALIFICATIONS
• Certificate III Automotive Manufacture (Bus truck and trailer)

RELATED PRODUCTS
AUT032  Perform Gas Metal Arc Welding Workbook
AUT033  Prepare and Operate Equipment, Tools and Machinery
          - Hand Tools Workbook
AUT034  Prepare and Operate Equipment, Tools and Machinery
          - Power Tools Workbook
AUT035  Modify or Repair Chassis/Frame and Associated Components Workbook

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