DESIGNING A PRODUCT IN THE STYLE OF

David Constantine – Motivation – Multisport Wheelchair

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Innovative Engineer and Designer

REVISION BOOKLET

WORLD ASSOCIATION OF TECHNOLOGY TEACHERS

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The chair opposite has been inspired by the imaginative work of Motivation.

The seat folds flat whilst the back rest can be removed and also folds.

The canvas seat is extremely durable and can be manufactured in almost any colour.

Aluminium tube is used as it is lightweight and relatively strong. This means that the chair can be carried with ease.

The folding mechanism is very straightforward. The diagrams opposite, show how the front and back legs fold.

The single pivot at the centre of the front and back legs, allow them to be opened and closed easily.

The folding linkage limits the opening distance of the legs and adds necessary strength to the overall structure.
These drawings show the front section / set of folding legs, dia. A.

AND

The back section / folding legs and back rest, dia ‘B’, can be disassembled and the legs folded in the same way as the front legs.

Rivets are used to hold the linkage together. They also allow the joint to move, which means that the chair can be folded and unfolded. Nuts and bolts are not used as they will eventually loosen and the joint would fall apart.
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<thead>
<tr>
<th>ORIGINAL DRAWING</th>
<th>SAMPLE SKETCH</th>
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<td><img src="image1" alt="Complete Front View" /></td>
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<td><img src="image4" alt="Folded Version" /></td>
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**PARALLEL JOINT.** The joint shown opposite is for joining two tubes in parallel. The joint is in two halves and a single bolt is tightened using an allen key, fixing to two tubes together.

**FOUR WAY JOINT.** This joint allows four tubes to be fixed together. It is a friction fit, but if the tubes were threaded (had a screw thread) at the end, they would be extremely secure and could be regarded as permanent.

**SIX WAY JOINT.** This allows up to six tubes to be jointed. A friction fit, but if the tube was threaded at each end (screw thread), this would be a very secure joint.
TWO WAY PARALLEL JOINT. This allows two pieces of tube to be joined in parallel.

SPLIT TUBE JOINTS
This four way joint can be adjusted / tightened with a allen key. As the allen key is turned, the split in the tube narrows, tightening on the tubes. The allen screw could be replaced with a screw that can be turned by hand, such as a wingnut or a ‘knurled’ pattern.

ADJUSTABLE JOINT.
Loosening the main screws / bolts, allow the tubes to be adjusted to the right position and then tightened.
TIGHTEN WITH ALLEN KEY

PARALLEL JOINT.

THREE WAY JOINT.

FOUR WAY JOINT.
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<thead>
<tr>
<th>ORIGINAL DRAWING</th>
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<tr>
<td><strong>PARALLEL JOINT.</strong></td>
<td><img src="image" alt="3D Sketch of Parallel Joint" /></td>
<td><img src="image" alt="2D Sketch of Parallel Joint" /></td>
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<td><img src="image" alt="Tighten with Allen Key" /></td>
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<tr>
<td><strong>THREE WAY JOINT.</strong></td>
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<tr>
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Study the wheelchair design below, drawn in the top row. In the blank rows below, sketch your version, in pencil or with a fine black pen.
Study the wheelchair design below, drawn in the top row. In the blank rows below, sketch your version, in pencil or with a fine black pen.
You are to design a folding chair for use at a music festival, in the style of Motivation’s Multisport Wheelchair.

You will:
Write a specification for the folding chair.
Draw a variety of initial ideas, for a folding chair.
Select your best idea and develop it further.
Include detailed notes / annotation that explain your developed design.

Write a specification. Identify four specification points / design requirements for the folding chair.

1. ____________________________________________

2. ____________________________________________

3. ____________________________________________

4. ____________________________________________

SAMPLE SPECIFICATION POINTS

1. The chair will be in the same style as the Multisports Wheelchair.

2. Lightweight tubular aluminium / steel (round section) will be used in the manufacture of the chair.

3. The chair will fold, so that it can be carried and stored easily. It will lock in position when opened, so that it is safe.

4. The chair will be ergonomically designed, so that it is comfortable when seated and comfortable to pick up, move and fold away.

5. The joints will allow for movement (folding) and be strong, in order to take the weight of an adult.
Draw a variety of ideas for your folding chair. Include notes / annotation and labels to help explain your designs.

**CHAIR ONE**

This chair is manufactured from aluminium tube. The folding joints have a rivet at their centre, allowing movement.

The chair folds so that is quite narrow.

**CHAIR TWO**

Double joint used at each corner, tightened with allen key, holding the chair frame together.
Draw a variety of ideas for your folding chair. Include notes / annotation and labels to help explain your designs.
Draw a variety of ideas for your folding chair. Include notes / annotation and labels to help explain your designs.

**CHAIR THREE**

This folding chair is based on a deck chair. Aluminium rectangular section tube is the selected material, as it is lightweight and corrosion resistant.

The advantage of this design is that it is really simple.

**CHAIR FOUR**

This chair folds into a cuboid shape. It can be placed in the back of a car for transport, as it is a regular shape.

It has two comfortable cushions and the seating positioned has been determined to meet ergonomic demands.
Select your best idea and develop it to a final design. Include notes / annotation and labels to help explain the design and how it meets the original design need (a folding chair for music festivals).

The tubular aluminium is both lightweight and extremely strong.

A two-way joint (above) fixes the back with the back folding mechanism, tightened by an allen key.

Snap head rivets (Round head) (above) are used to fix the rails and the legs together permanently and they allow movement / folding.

The linkage (left) is connected by four rivets which enable the folding of the front and back legs.

The chair can be folded to a small ‘footprint’ / size.

The back rest folds separately.

Both parts of the folding chair are stored in ‘long’ canvas bag.

ERGONOMIC POSTURE

CANVAS BAG FOR FOLDING CHAIR

The caps for the end of each piece of tube are manufactured from synthetic rubber or nylon.
Select your best idea and develop it to a final design. Include notes / annotation and labels to help explain the design and how it meets the original design need (a folding chair for music festivals).
How does your final design meet each of the four specification points you wrote earlier? Use sketches and notes to answer this question.

1. The chair will be in the same style as the Multisports Wheelchair.

   I selected tube for my folding chair, as it is the same style as the Multisports wheelchair. The mixture of canvas and tube also relates to traditional wheelchairs. In addition the chair folds away.

2. Lightweight tubular aluminium / steel (round section) will be used in the manufacture of the chair.

   The round section aluminium tube I have selected for my design, is ideal as it is lightweight and yet strong. The aluminium is easy to cut and shape compared to steel, with the added bonus that it will not ‘rust’. A cheaper version could be manufactured from steel tube.

3. The chair will fold, so that it can be carried and stored easily. It will lock in position when opened, so that it is safe.

   My chair can be folded with ease, as seen in the developed design. It is in two parts and is kept in it own canvas bag. This keeps the two parts together, ready for use next time it is needed. The folding mechanism locks in position, when the chair is open and ready for use.

4. The chair will be ergonomically designed. It will be comfortable when seated and comfortable to pick up, move and fold away.

   The chair has been design with ergonomics in mind. The canvas seat is comfortable and the vertical back rest ensures that the person sat on the chair, is sat in the correct posture. The height of the seat has been calculated using anthropometric data, working out the average seating distance.

5. The joints will allow for movement (folding) and they will be strong, in order to take the weight of an adult.

   The main linkage joints allows the necessary folding and are very strong due to using rivets. The moving joints do not comprise the strength of the chair. The two way push fit joint, has allen key adjustment that locks the joint and tube together. The chair is strong and stable and will have a long life cycle. It can be completely recycled at the end of its lifetime.
How does your final design meet each of the four specification points you wrote earlier? Use sketches and notes to answer this question.

1. The chair will be in the same style as the Multisports Wheelchair.

   [Sketches and notes]

2. Lightweight tubular aluminium / steel (round section) will be used in the manufacture of the chair.

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5. The joints will allow for movement (folding) and they will be strong, in order to take the weight of an adult.

   [Sketches and notes]
OTHER POTENTIAL PRODUCTS YOU MAY NEED TO DESIGN AND INFORMATION YOU NEED TO KNOW.

REMEMBER, THE PRODUCTS YOU DESIGN, MUST BE DESIGNED IN THE STYLE OF THE MULTISPORTS WHEELCHAIR.
A large range of fittings for wheels, shafts and screw threads are available. Most fittings are temporary in that they can be tightened and untightened when required. All the fittings shown here are strong, safe and low cost.

Push on Fittings.

Push on fittings are very popular as they are simply pushed onto the steel / plastic shaft. They are made from hardened spring steel which makes them tough and flexible. They can only be pushed in one direction only (forwards). To remove them they must be forced backwards, this will damage them so that they cannot be used again. As they are very cheap and disposable, they can be replaced. They are suitable for light wheeled vehicles such as light trolleys.

Split Pins

Split pins are very common as they are easy to use and effective. Often they are found on self-assembly trolleys, light wheel barrows, lawn mowers and similar items. They are usually made from ‘soft’ steel or aluminium and they come in a range of sizes.

The shaft/axle is normally drilled so that the split pin can drop through or can be ‘tapped’ through with a hammer. The legs of the split pin are then bent to form an angle, holding the split pin and wheel in place.

A washer can be used to reduce friction between the split pin and the wheel.

Split pins are strong but after time they can wear and break.
Lock nuts are very useful and are used by engineers and mechanics. The diagram opposite shows a wheel pushed onto a threaded shaft. Washers are placed on either side of the wheel and a lock nut is finally threaded in position. This is a highly effective method of securing a wheel on shafts/axles.

A close look at the lock nut shows that it has a nylon sleeve. As the nut is tightened, the thread on the shaft/axle cuts into the nylon, holding it firmly in position.

As the wheel rotates a normal nut will loosen because of friction and vibration of the wheel. However, the nylon holds the nut firmly in position.

An alternative is to use two normal nuts. The second locks the first in position.

Another effective fitting is a combination of a split pin and lock nut. The split pin drops through a hole in the threaded shaft and rests in a ridge on the surface of the nut. The nut cannot be loose because the split pin stops it rotating.
Outdoor furniture can be manufactured from recycled plastic. The table top is manufactured from recycled High Density Polyethylene (HDPE) - HDPE is endlessly recyclable. HDPE can be given the appearance of wood by the use of colour pigments during the injection moulding process. However, HDPE retains the advantages of plastic and can be used to make a high quality products that stay attractive and easy to maintain for many years.

The legs and fittings of this piece of furniture can be manufactured from recycled steel or aluminium.
When set up the cord holds the table legs firmly in position. For folding the table is turned upside down and the legs easily fold into the table top. As this happens the cord becomes slack. Care must be taken to wrap the cord rather than allowing it to become lose. If this happens could cause a trip hazzard for an adult and be even more dangerous to a young child.

This type of table is very light and can be carried quite easily. It can be stored in the boot of a car for transport. The surface of the table can be cleaned by simply wiping it with a damp cloth.

The table is cheap to mass produce as the top is injection moulded. The tube legs can be formed very easily using a pipe bender. All the materials - HDPE and aluminium/steel can be recycled and used again.
The trolley is manufactured from round section steel tube, solid section round steel, sheet steel, square section steel tube and square section aluminium tube.

Why do you think a combination of materials have been used to manufacture this trolley?

________________________________________________________________________

________________________________________________________________________

Why does the shelf have 'slots', where material has been removed?

________________________________________________________________________

________________________________________________________________________

For each of the identified parts, name the metal and section, giving reasons for their inclusion.

<table>
<thead>
<tr>
<th>PART</th>
<th>SECTION</th>
<th>REASON</th>
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<td>STRENGTHENING PIECE</td>
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<td>SHELF</td>
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Steel can corrode if its surface is left unprotected. What type of corrosion forms on the surface of unprotected steel?

________________________________________________________________________

Describe the various ways in which steel can be protected from the corrosion you named above.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
A pipe bender is used to form the ‘curved’ trolley handle. A pipe bender is a piece of equipment used to bend tube to a precise radius. The rounded channel can be replaced with one that has a larger or smaller radius. The tube is first positioned in a straight grooved block - this holds it firmly. The lever arm is then rotated, bending the pipe slowly to the shape of the rounded channel. The handle is formed in this way.

With great care, even unusual shapes can be achieved. Sometimes the tube may need to be packed with sand to prevent distortion and weakening of the tube wall.

The steel bolts are manufactured using a centre lathe. The wheels will eventually be held in position using the bolts and lock nuts. The wheel will rotate and yet remain attached to the main frame of the trolley.
The trolley is ready for assembly using a simple range of everyday tools such as screw drivers and spanners, as well as specialised processes including brazing and welding.