Guide to the UK National Competition: MTC

For enquiries regarding the Manufacturing Team Challenge (MTC), entrants to competition, rules and/or any information required please contact:

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Documentation and Sources of Information

The MTC requires a team of three people competing as complementary specialists, combining skills such as project management, electronics, programming, machining and computer aided design. Time, cost and quality are all factors in the competition; in addition to individual talents, participants must contribute to the team as a whole, showing self-awareness, interpersonal skills, and thinking outside the boundaries of their own area of expertise.

WorldSkills UK LIVE

MTC 20xx Briefing Video. The link will be emailed to all competition entrants directly. However, subscribing to **United Kingdom MTC** video channel on YouTube you can access this and other support videos.

More Information

For competition information, further resources including how to register, competition rules and steps for competing, visit:

https://worldskillsuk.org/champions/national-skills-competitions/tools-and-resources

WorldSkills UK LIVE MTC Google Classroom

To join the Classroom go to classroom.google.com, click on Join and enter using code **7v4g6q2**

Contents:

- WorldSkills UK LIVE Guide to the MTC competition.
- WorldSkills UK LIVE MTC Portfolio B support video link: https://www.youtube.com/watch?v=5gzjH6F96UM
- Template spreadsheet for all raw materials.
- Example competition booking sheets.
- Flowcode 8 instructional video links, for those seeking support with programming.
- Google resources video link to help use the google classroom.

The Key Competition Elements

There are 4 key components to the MTC and the marking scheme is broken down into these four areas:

1) The Main Project:

The main project is defined by the **brief** and usually consists of a **design and build** challenge with a series of tests to check conformity against the brief specification.

This is worth around 40% of the marks but does vary.

2) Portfolio A and B:

Portfolio A will be specified in the brief and asks for a **video** of elements of the project and some **paperwork** regarding the project; such as a manual or troubleshooting guide, and other related material.

Portfolio B consists of **drawings** created using CAD and E-CAD.

This is worth around 20% of the marks but can vary.

3) Costings:

This is the cost of **raw materials**, the theoretical cost of manpower for the competition and the cost of theoretical hire of certain machinery.

This is worth either 10% or 5% of the marks, depending on the project.

4) Surprise Projects:

These are unseen projects to be undertaken by competitors that test 3 areas: **Electronics** assembly and manufacture, **Fabrication** with MIG welding, (though TIG is an available option), and **Turning**.

This is worth 30% of the marks.

Tips: Often a team will concentrate solely on the main project at the loss of the other elements. It must be remembered that this is only 40% of the total marks available. A good portfolio A and B with good costings can score 30%, 20% being assured before the competition starts.

The surprise projects are often overlooked, and some teams have ignored them completely instantly losing 30% of the marks.

Though a good main project is important, overlooking the other elements will completely cut you out of the medals as other teams will not overlook these areas.

The Main Project

The main project clearly varies year on year and will have different elements asked for to gain the marks. However, there are usual themes within it:

- there will be the need for an **LCD panel** showing information such as battery charge status, speed, direction of travel and some sort of standby message. The ability to build and program this is essential, though the program can be copied from handwritten notes rather than developed at the competition, allowing for outside assistance.
- there are always **time trials**; a **course** of some type will exist that the project must be able to tackle and time will be assessed against the other teams.
- some areas of the brief will be marked on a comparative scale known as **CIS marking**. The fastest, lightest or best performing team sets the benchmark. The slowest, heaviest or worst performing team set the zero score. All other teams fall into score categories of 10% slots within this and are given the mark applicable. For example:
    - a team sets the top score at 10 seconds. Another the bottom at 30 seconds;
    - the divisions will then be 2 seconds each. A team with a time of 21.5 seconds would just fall into the 5th division and therefore score half of the marks available.

Safety marks will be awarded.

- exposed and visible conductors will drop some of the marks for this area.
- sharp edges or burrs will lose some of the mark in this area.
- caution labels regarding electrical hazard, trap hazard, crushing hazard and any other applicable should be fixed appropriately and specified in Portfolio A. Any missing will lose a proportion of the mark here.
- finally, all moving parts need to be guarded so they cannot be touched by a 12mm diameter rod, of 75mm or more in length; this simulates a finger. Wheels and sometimes other items are exempt from this, but the brief will specify what.
- work **quality and visual appearance** will be judged: is it a finished product or a prototype, how well has it been made and is it an industry quality piece or could it be sold to the general public are the areas looked at.

Most other areas are simply yes/no criteria: Does it have and does it work?

For all areas the brief will outline how the project is to be tested and this is important for checking how the prototype designs function.

Not all of the criteria have to be met; that is a team's choice, as you may find something takes too long or costs too much to do. In this case you may wish to sacrifice the marks for this and hope to gain them on the costings section. This is a personal choice and one that should not be taken lightly as it is a gamble that may or may not pay off.

There may be of course an element that your project simply cannot do without a major redesign and you may choose to not do so.

Gambling like this can pay off and has for teams, but many more have lost the marks and not regained them elsewhere.

Portfolio A

This can get you 10% of the marks before the competition starts.

The portfolio is simple yes/no criteria mostly but can have judgement elements too.

The first part is the **video**; this will ask for very specific items to be included. This may be the project being packed away or being setup.

It is important to caption the video to tell judges what is happening, else it may be difficult to tell and lose marks.

Be very literal in the interpretation of what is asked for and do not miss anything out.

The second part is the **portfolio** to be handed in.

This may ask for elements such as a **troubleshooting guide**, **team profile**, description of **how all controls are used** and what they do.

In this area including captioned and arrowed **drawings** or **photos** always makes the portfolio look better and makes it easier to understand.

A **contents page** is essential as is a **nice presentation** of the portfolio: presented in a folder or project wallet, not just stapled or loose sheets.

Again, you must be literal in the interpretation:

when asked for a description of all controls, teams often miss out one or two.

The main controls being a **joystick** and some **push buttons,** teams would normally list this, usually with pictures to illustrate; then they would ignore the emergency stop and key switch.

As these control power and are a user-controlled feature, they are also controls. This means the mark is lost as not ALL of the controls are listed.

You may be asked for **advertising material** as part of the portfolio, and this again needs to be followed literally. A team may be asked for 10 pictures to be included and captioned, the brochure to be A5 folded from A4 and centrally stapled:

- 9 pictures loses that mark, 11 certainly gains it.
- a chapel fold may look nice and be A5, but it is not what was asked for so again loses the mark.

In all, if you are unsure then use the email address on the cover sheet to carefully check.

Portfolio B

This one often catches out even the most seasoned of competitors as it is created before hand, but recreated in competition. Under pressure it is easy to miss out a measurement or a symbol.

There are usually **3 sets** of these needed for a competition, although some teams use 4 sets.

Set 1) This is handed in to Judges on the Familiarisation day. Judges use this to conduct a toolbox check to ensure materials are brought at least 50mm too long of a length, or 50mm in two directions if a sheet or plate is brought.

It is also used later on in the competition to check parts for conformity to drawing when they are made. Check if this criteria is in the brief, as it is not always.

This set should be on **coloured paper** and clearly marked **Draft**.

Set 2) This set should also be on **coloured paper** and clearly marked **Draft**. It can be used by teams to copy when they make the CAD drawings and schematics or can be used to make the components and assemble the product. Some teams bring 2 sets so they can do both at the same time.

Set 3) This set will be created using Autodesk Inventor and Eagle during the competition. This set will be handed in to Judges on a supplied memory stick and this set will be marked.

Note that handing these in as a PDF is preferable for two reasons:

1. They can not be altered so no Judge can be accused of that by a team;
2. They can be opened without specialist software.

The Portfolio B will normally be asked for by 12:00 hours on the second day of competition, so bear this in mind when creating a schedule.

All drawings must be to ISO standards but there are also extra requirements set by precedence in International competition. ISO 5455 for example gives that the scales used can only be 1:1 1:2 1:5 and multiples thereof. Using another scale will cost marks.

There are two categories of faults for drawings: high impact and low impact. A high impact fault will drop all marks, the number of low impact faults will determine the mark otherwise.

These are:

HIGH IMPACT FAULTS	LOW IMPACT FAULTS
Missing details for machining	Missing or wrong scale
Missing material	Missing dimension raw material
Missing general tolerance	Missing quantity
Missing specific tolerance	Missing piece number
Missing dimensional	Missing projection drawings
Missing views	Missing specific roughness
Wrong drawing	Missing piece name
	Missing line thickness

To score the full marks all of the above information needs to be on the drawings.

High Impact Faults

Missing details for machining: If a machine process takes place it should be stated what it is using either the correct symbol or by stating. Welding symbols on assemblies being welded.

Missing material: What is the raw material stock size used? E.g. when using a piece of box section 25x25x1.5mm at a length of 300mm, the stock size is 25x25x1.5mm at a length of 350mm if you have the minimum extra. But also what grade of steel is the box section made from? E.g. E220.

Missing general tolerance: What is the general tolerance of the part or parts? You may simply put +/- 1mm, you may have another size, you may have a sliding generic scale that shows different tolerances for different lengths on your drawing template. Or some other method to show anything not specifically toleranced is covered.

Missing specific tolerance: It is normal to have at least one specific tolerance on a drawing and I advise you to ensure you do. Often parts have a tight tolerance somewhere and it is good to denote this with the measurement. What style of tolerance is open to you.

Missing dimensional: A missing dimension will simply lose that mark. Center lines should be in place on anything circular at least, this is considered part of correct dimensioning.

Missing views: For a cylindrical object normally 2 views is the minimum, though some details may be missing if you do this. For a cuboid based object 3 is normal, again more may be applicable and with some only 2 may be needed. But ensure they are there. A 3D rendered view should also be put on in all cases, the scale of the rendered view does not have to match the drawing or conform to ISO 5455. Carefully consider the use of sectional views for some detail also.

Wrong drawing: Simply the drawing that is not what the title says or the 2D does not match the 3D view.

Low Impact Faults

Missing or wrong scale: No scale in the title block or a scale that does not conform to ISO5455 or the scale stated is different to that of the drawing.

Missing dimension raw material: This is the same as missing material above, but only applies to the dimension, not everything.

Missing quantity: The quantity to be manufactured for the project is missing from the title block.

Missing piece number: Each drawing should have a drawing number to be referred to in the assemblies and the costings spreadsheet. Equally each piece must have an item or piece number to be referred to in the assembly, as a drawing may contain more than one piece. These numbers should be unique and consistent.

Missing Projection drawings: If using first angle the symbol is expected to be in the title block to show this, similarly if using third this symbol is also expected.

Missing specific roughness: The correct symbols for surface finish, surface removal finish and machine removal processes are not enough. For materials that are not touched but left as they are supplied, the correct symbol should be used for this also.

Missing piece name: Following on to the assembly, each part should have a name or description. This is required in the title block also.

Missing line thickness: Not traditionally shown on CAD drawings but still considered best practice internationally, so the line weight used for the drawing should be in the title block.

3D Drawings

These are normally the assembly drawings.

You may use one overall assembly or a set of sub assemblies with a final full assembly drawing.

Each assembly must have a Bill of Materials or Parts List that is consistently numbered and described to match the 2D detail drawings.

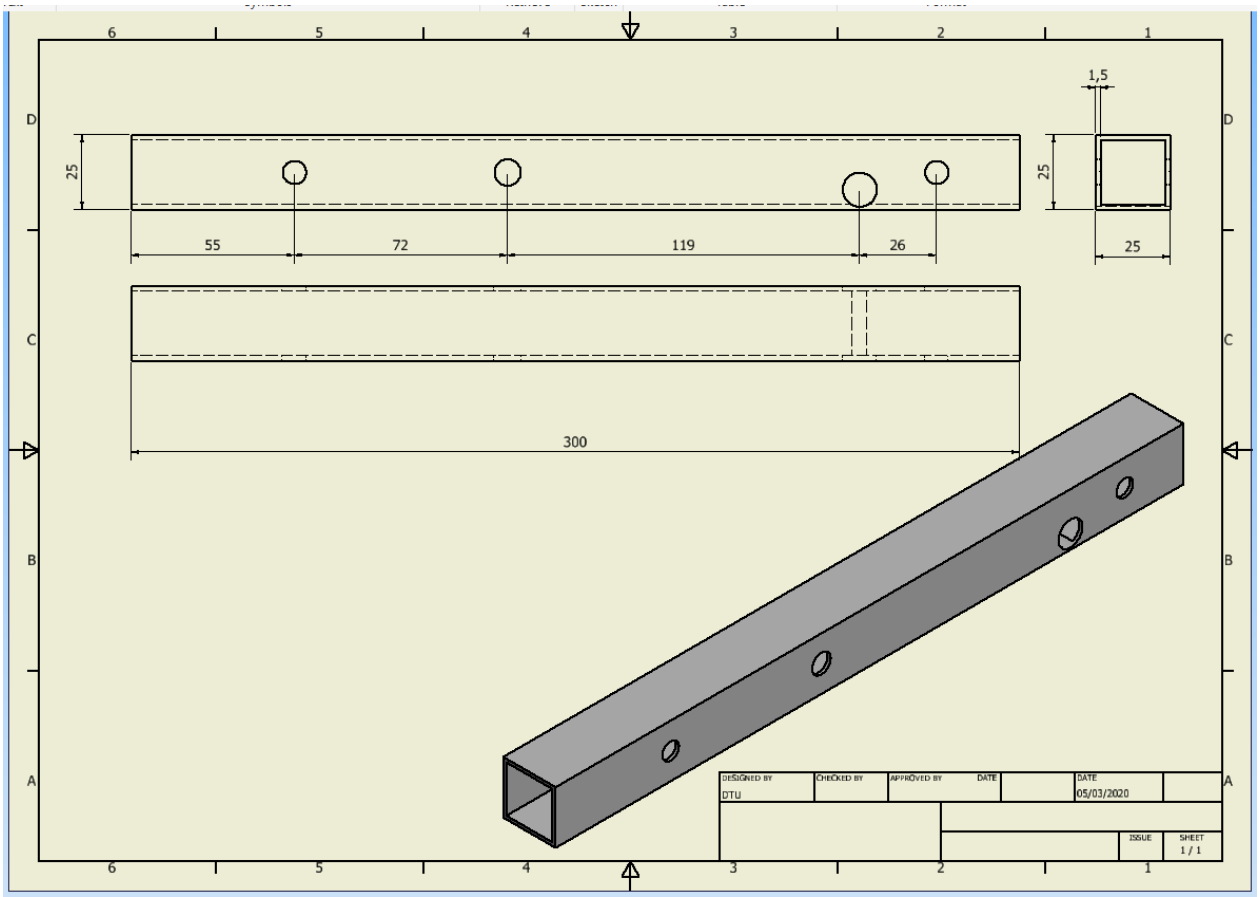
It should show how everything is put together and welding symbols should be added where applicable.

As the 2D drawings are only required for parts that are manufactured or modified, block representations can be used for bought parts such as wheels and motors and the libraries may be used for bolts, nuts, washers etc.

Every part should be ballooned and identified, meaning your assembly may require multiple views or an exploded diagram.

These drawings should be consistently numbered in sequence with the 2D drawings.

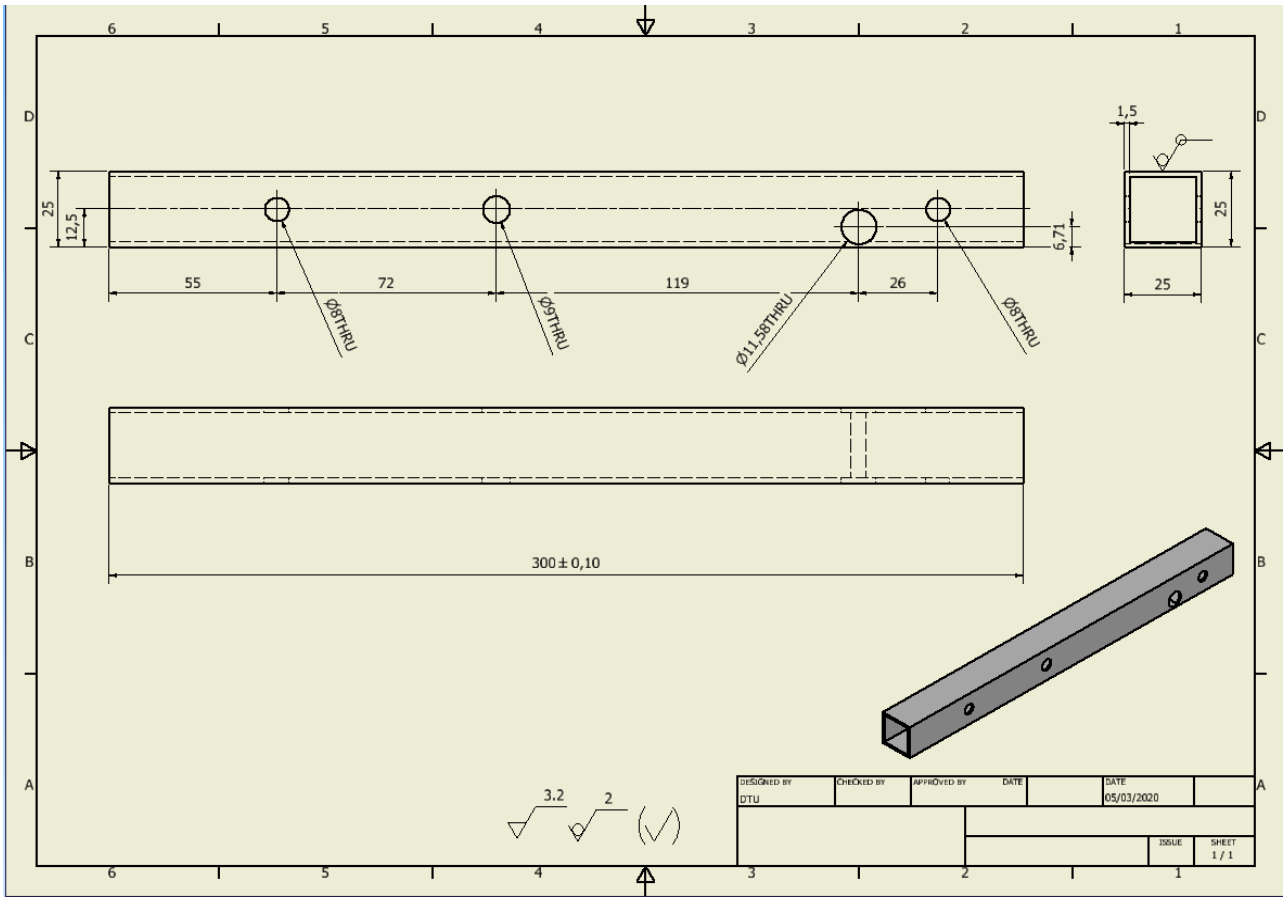
Drawing Examples - 1



Ignoring the title block as it is not filled yet, this drawing has several problems.

1. There is no height nor center lines for the drilled holes; the holes may or may not go completely through the part, nothing tells me.
2. It has the correct views but does not have a pleasant layout. The 2D parts are squashed together and the 3D part is too large.
3. There are no specific tolerances on this either.
4. All of the hole diameters are missing.

Drawing Examples - 2



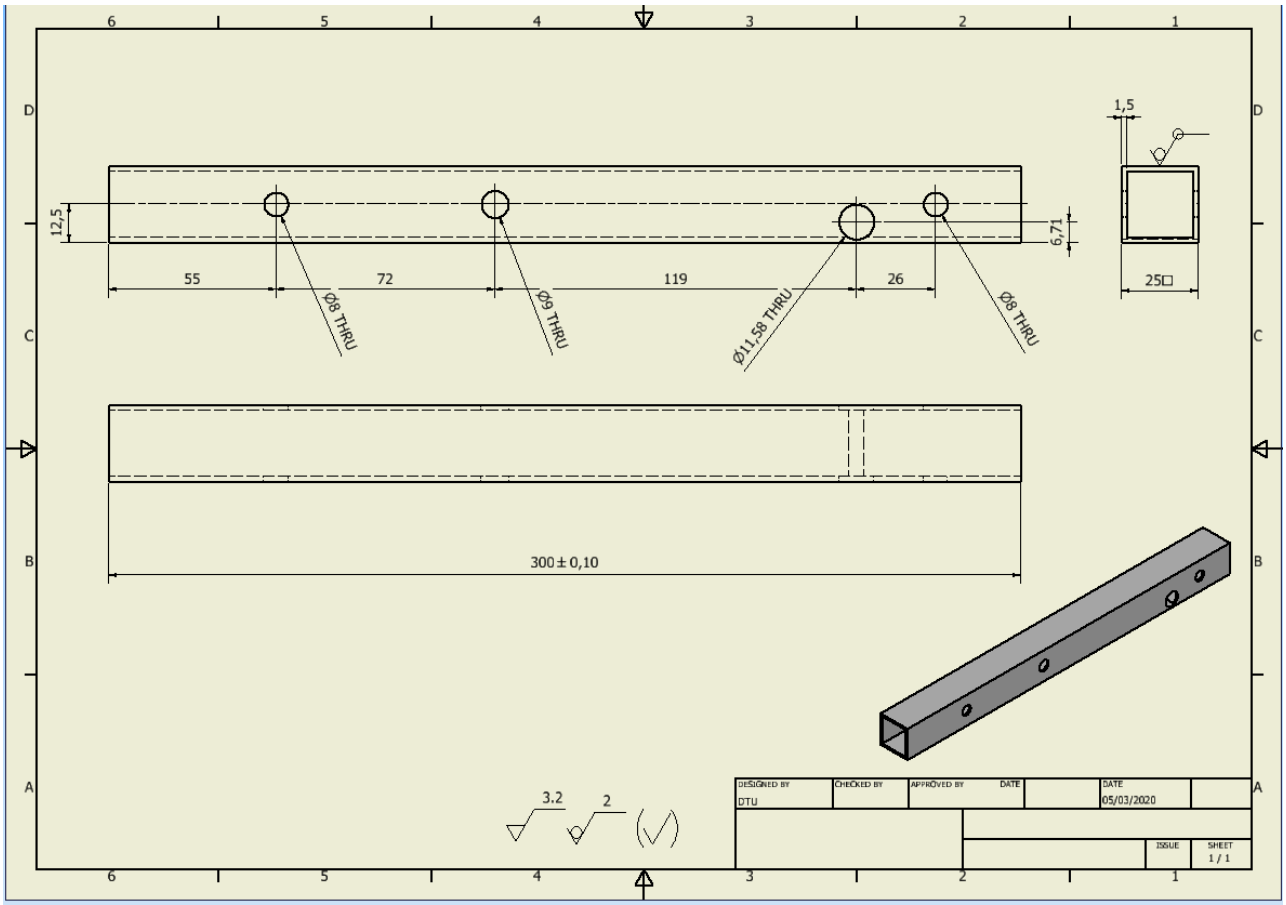
This second version is more acceptable:

1. Everything is now dimensioned; I now know the holes go through the component and center lines are in place. With the center lines in place it is arguable that the 12.5 mm measurement on the left is not needed.
2. Changing the size of the 3D model has allowed for the 2D drawing to be better spread out.
3. There is now a specific tolerance.
4. The holes now have sizes, and we know they go through the part.
5. Also added are the symbols for surface finish and machine surface removal finish.
6. The 25mm size given on the left-hand side is not needed as it is already on another projection.

Though still a little squashed it complies with ISO 5455 having a scale of 1:1. A smaller scale could be used for this drawing and a second part added to the drawing if wished.

Ignoring the title block this is likely to get the marks where they are yes/no marks, but for a judgement of quality the extra measurements would count as an error against the appropriate dimension marks.

Drawing Examples - 3



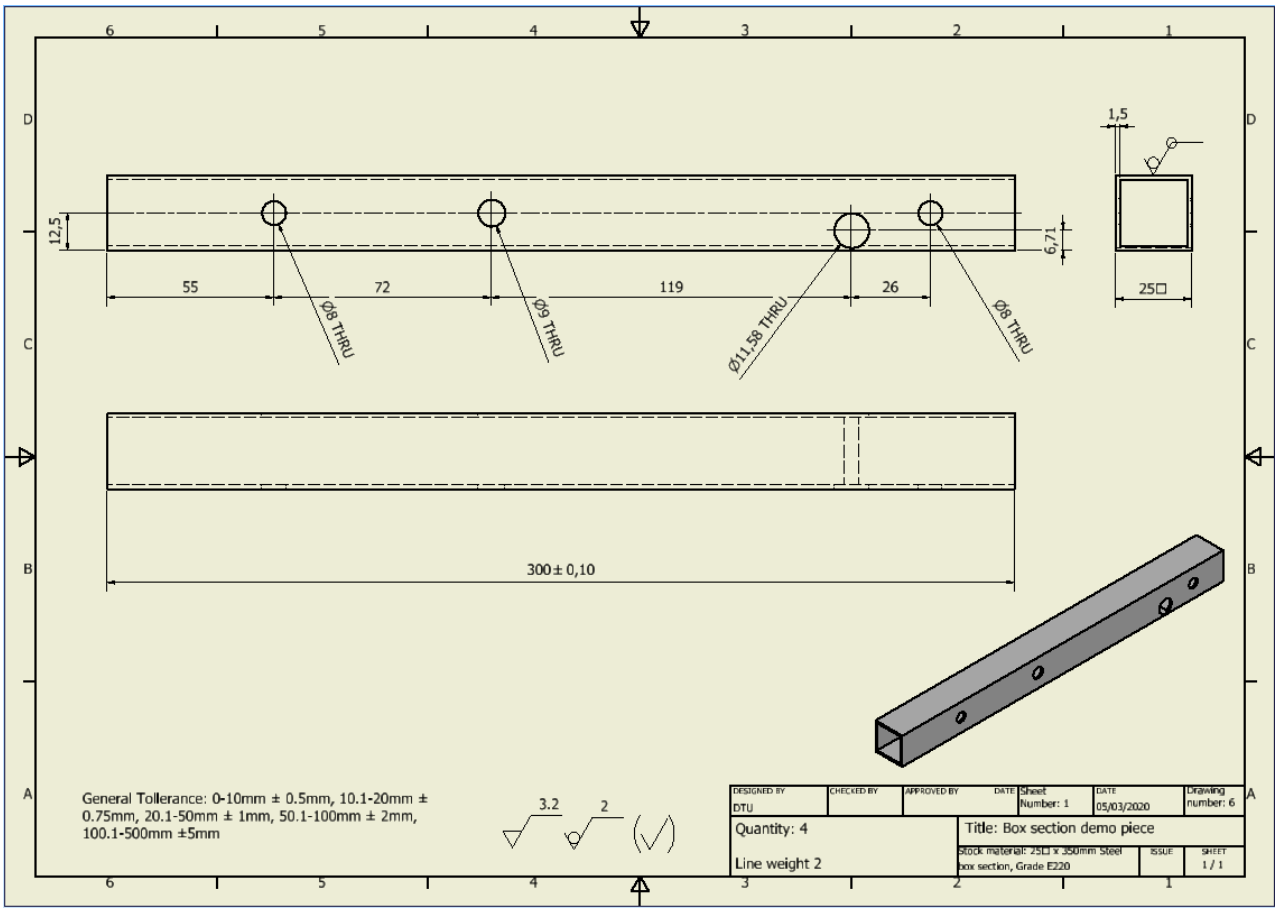
This third version is better again.

- it has all of the elements of the second corrected
- it now has removed the extra measurement from view 1
- the end profile has been changed to say box on one measurement and taken the second away.

These two things make the drawing look less cramped in the space.

A space has also been added between the hole diameters and THRU; this now looks clearer and easier to read.

Drawing Examples - 4

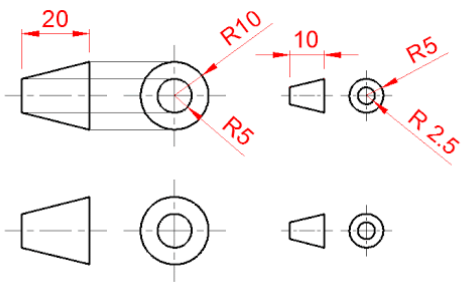


The fourth version now contains everything on the checklist, or does it? The title block is complete, an example of a generalised general tolerance that could be applied to all parts is given and machining and surface finish symbols are in place.

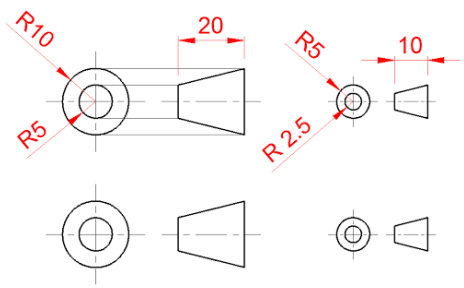
One thing that is missing from this is the projection symbol (see below), therefore the drawing would lose the marks for correct projection, as there is nothing to say what the correct projection is.

However you may note that the title block template has items not needed in it and a not very pleasant layout to what is there. Whilst this is not wrong and would get the marks for yes/no, it may suffer aesthetically on a judgement mark.

A bespoke designed block with only what is needed in it is often a better solution.



FIRST ANGLE SYMBOL



THIRD ANGLE SYMBOL

Electrical/Electronic Drawings

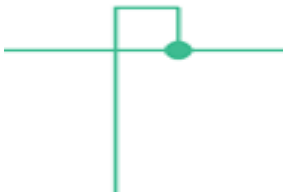
The first criteria is looks at the layout of the drawing and looks for the drawing border, drawing title and drawing number which should be in sequence with all of the mechanical drawings and presented using a similar, but not necessarily the same, title block.

The second criteria looks to see if the drawing is done to best practice.

Considered as International best practice and currently used for WorldSkills competitions are:

- ***Wires connecting are indicated by a heavy black dot; wires crossing, but not connecting, have no dot, do not use a little half-circular, (very common practice but considered old fashioned and outdated now).***

This is correct!

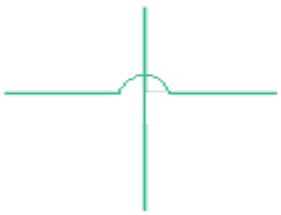


Wrong

This should not connect like this, but as above.

Correct

This should be a crossing and no dot indicates that there is no connection.



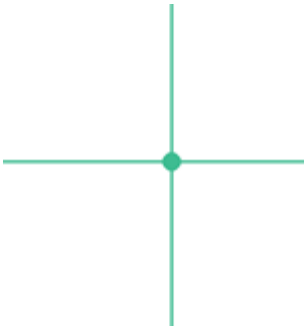
Wrong

This was considered the normal method for indicating a crossing for many years but is now not considered good practice and should not be used. (Eagle will not do this.)

- Four wires must not connect at a point; i.e., wires must not cross and connect;

Correct

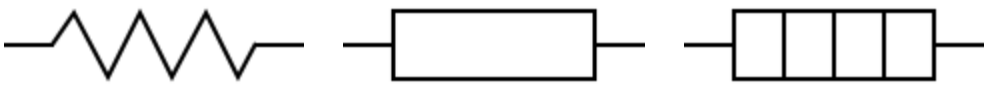
This is the correct method of connecting 2 wires to a third, note the connection at two different points and are signified by a dot.



Wrong

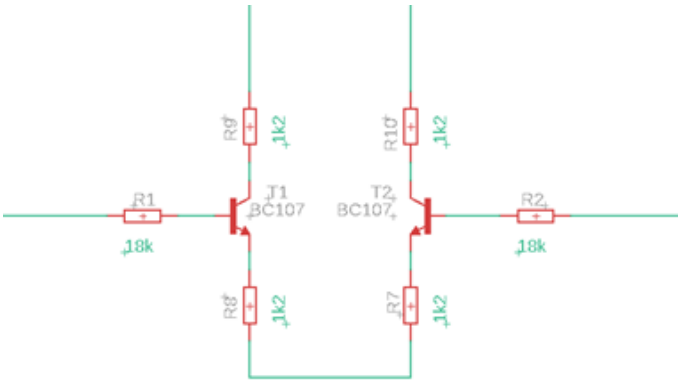
Although the dot is present, this is not acceptable. This can be viewed as a crossing not connection if the dot is scratched or worn away, possibly if glanced at. It could also be viewed as connecting 3 wires to a fourth.

- Always use the same symbol for the same device;



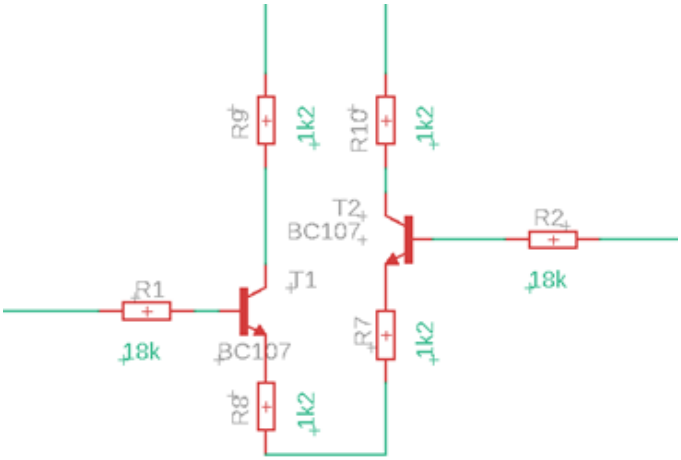
All of these symbols are acceptable; however it is not acceptable to use more than one in the circuit diagram. One symbol library should be consistently used throughout. ANSI, DIN, BSI or any other convention should be consistently adhered to.

- ***Wires and components are aligned horizontally or vertically, unless there's a good reason to do otherwise;***



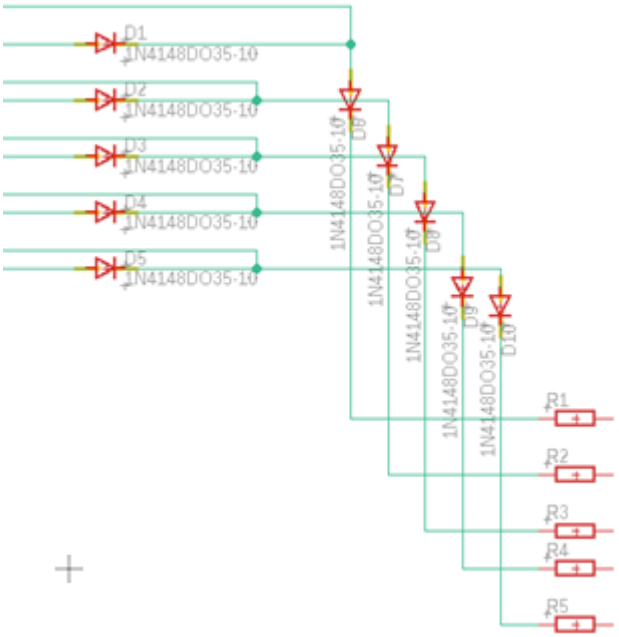
This is correct.

All of the symbols have followed the same convention of labelling and alignment. All components are aligned and laid out in a clear way.



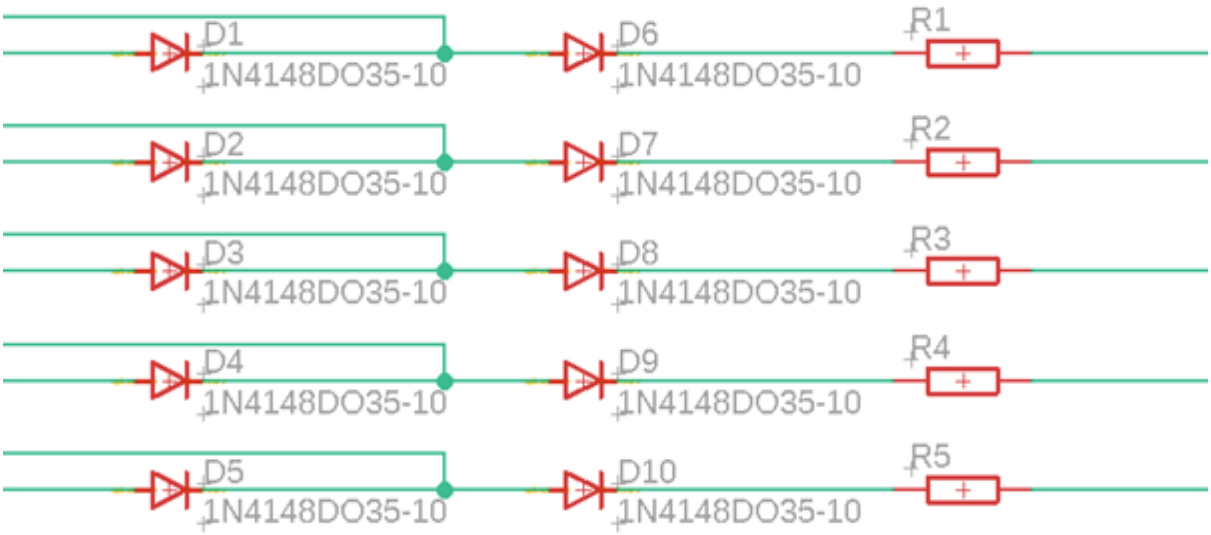
Incorrect

This is the same circuit laid out slightly differently. In this one, the T1 and T2 have not kept the same labelling convention. The components are not aligned and there is no reason for this other than it is to make the diagram smaller.



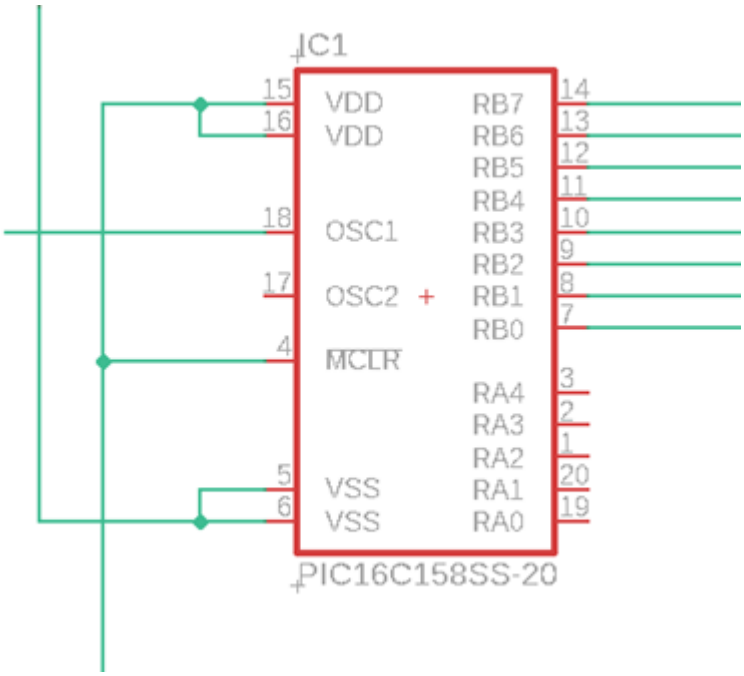
This circuit portion is poorly aligned and very hard to read.

The connections have not followed the same convention for the D1 branch.



This example is the same circuit as the previous one, but much clearer to read and easier to see how things are connected.

- ***Label pin numbers on the outside of a symbol, signal names on the inside***;



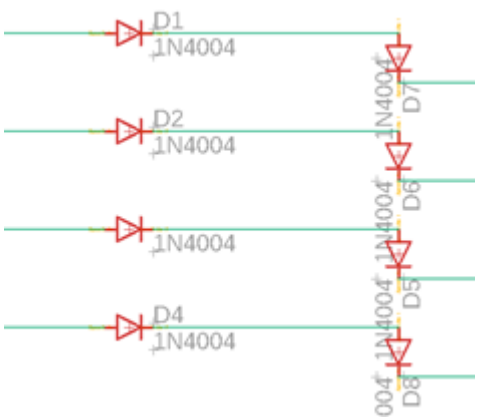
This clearly shows all of the signal names on the inside of the PIC chip; the pin numbers are on the outside.

- ***Wires and components are aligned horizontally or vertically, unless there's a good reason to do otherwise;***

Correct

Incorrect as no component size or part number is given.

Incorrect as no part definition is given.



Incorrect as the alignment of the lettering is confused and hard to read, one circuit definition is missing.

It is acceptable to have the definition and part number in two orientations only, no more, but should be laid out as to be tidy and readable with ease.

Correct.

This example makes the definition and part number easier to read but is in two orientations.

Correct

In this example the definition and part number are easier to read and in only one orientation.

Either of these are considered acceptable.

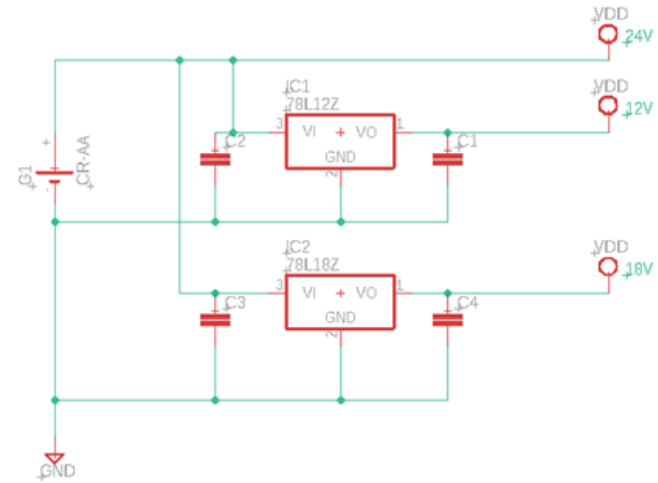
Battery and/or power symbols

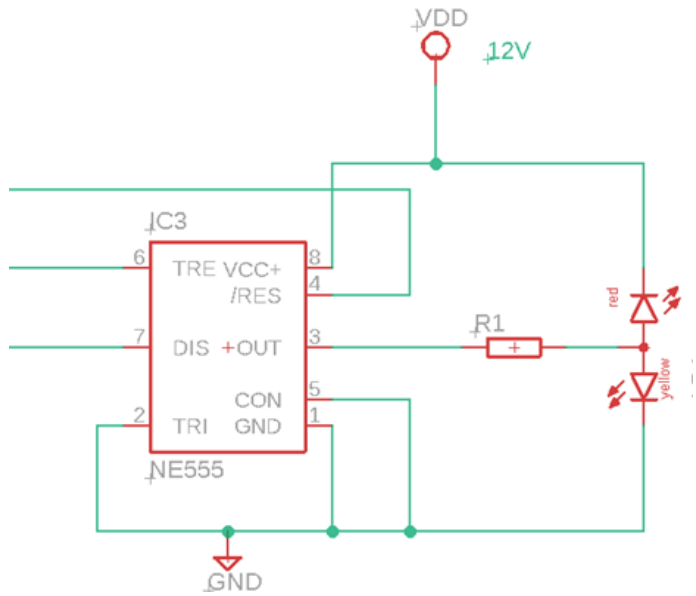
The marking scheme asks for a battery symbol to be present.

However, it is more normal to use power supply connections for VSS positive and VDD ground.

In the instance of the test project there must be a battery present for the supply of the project, therefore, it is normal to put this into the schematic.

However, power may be denoted as a power supply section with one or more voltage regulations to lower the voltage. This may be drawn as a separate circuit and then the connections made to these various points be added as VSS connections with the appropriate voltage and VDD or GND with an earth symbol to denote 0V as per the following example.





This would show that this part of the circuit is connected to the ground point, in common with the first circuit and the 12V supply output from the first circuit is in common with the 12V supply rail of this circuit.

The final criteria requires the circuit diagram to contain a battery, motor and switches as well as the display.

Costings

Each team must create a full spreadsheet of all parts, materials purchased and raw materials.

Raw materials such as lengths of metal, plastics and batteries have a fixed price for costing by weight or by size that is specified in the Technical Description. The spreadsheet has a section for the raw materials that fit this.

Standard materials such as flat bar, sheet, box section, H section, angle and bar are all costed in this section by weight.

Batteries are costed by type and the amount of Wh.

The PCB's used must be costed by CM2. This changes from time to time to account for changes in market prices, so it is essential that the costs for each item are checked in the Technical Description.

The Technical description will always give the correct prices, but at the time of writing is as follows.

€0.50/cm2	PCB
€0.50/Wh	Batteries: PB, NiCd, NiMh
€1/Wh	Batteries: Lithium
€7/Kg	Mild Steel
€10/Kg	Aluminium
€28/Kg	Stainless Steel
€37/Kg	Brass

Assessment

These costs will be used not just for the marks for the spreadsheet, but also for the marks of the costs of raw materials, one of the three costing categories. This will be discussed later.

Should any item be found missing while the spreadsheet is being marked, it will be added at a price found by the marking team for a similar or the same product. This price will then be multiplied by three as a penalty price and added to the cost submitted.

Missing and incomplete items will cause the team to lose the marks for the spreadsheet and increase the project cost as above.

Further to the raw materials, the mechanical components and electronic components must also be listed.

This is an example showing mechanical components (Note: the drawing numbers are missing):

LIST OF ALL MATERIALS AND COMPONENTS - XX TEAM											
Mechanical Components											
Item	Draw n.	Material (English name)	Description (Same words of the comprovation)	Qty	Unit	Currency code	Unit Price GBP	Unit. Price Euro	Total Price		Prices evidence
1		26" Bicycle wheel	Ridewill nike rear wheel 26 x 1.75 Steel hub	2	pc	GBP	10.65	€ 12.4792	€	24.96	https://www.ridewill.it/p/en/ridewill-bike-
2		26" Bicycle tyre	Michelin World tour rigid 700 x 35 tyre	2	pc	GBP	7.75	€ 9.0811	€	18.16	https://www.fawkes-cycles.co.uk/2407792/products/michelin-world-tour-rigid-700-x-35-tyre.aspx?currency=GBP&gclid=CjwKCAiAqOriBRAfEiwAEb9oXWY7vqFEa1Rk683C859-2WNGdakOfy3Za4_GFH-zodBzmZ-AxM75GRoCSKwQAvD_BwE
3		Giant tyre innertube	Giant Inner Tube 700 x 28-32C 27 x 1-1/8 1-1/4 Single Unboxed SV - Black , 700x28-32C	2	pc	GBP	1.50	€ 1.7576	€	3.52	https://www.amazon.co.uk/Giant-Inner-28-32C-Single-
4		Jappaned chain	rs pro steel japanned chain	0.5	pc	GPB	1.30	€ 1.5233	€	0.76	https://uk.rs-online.com/web/p/chain/0750547/
5		Nylon wheel	PL Series Plastic Wheels	2	pc	GPB	2.92	€ 3.4215	€	6.84	https://www.rosscastors.co.uk/wheels/nylon-wheels.html
6		Foam sheet	50*50 cm/1mm Espuma EVA Folhas De Espuma Papel Esponja Papel Feito À Mão DIY Materiais de Artesanato Flor Multicor prop Festa de Natal	2.3	pc	GPB	0.80	€ 0.9374	€	2.16	https://pt.aliexpress.com/item/32916586463.html?spm=a2g0o.productlist.0.0.5564475asRm7sW&algo_pvid=d96c1e6d-a358-4b79-a173- [illegible]

In this example you can see that each item is numbered to keep them sequential in the first column.

Drawing Number: This refers to the drawing or drawings that this component will be used in. This may be the assembly drawings or a single component drawing.

Material: This refers to the name of the component, this must be the name used in English only.

Description: This must be the description used for the component in the catalogue from which the price is derived.

Quantity: This is the number of these items that will be used in the project.

Unit: This is the unit that it is purchased in. This is:

PC, purchased by piece	M, purchased by metre	Kg, purchased by weight

Currency code: In this case it is GBP as it is the UK competition, but should be the country in which you reside or purchased the materials.

Unit Price: This is the cost of the individual unit as given in the evidence.

Unit Price Euro: As per the Technical Description all costs must be converted to Euros using the exchange rates on the first Monday in April of the competition year.

Total Price: This is the cost in Euros multiplied by the number used.

Prices Evidence: This must be a link to an online source that details the cost of the item, matches the description and can be used by the Judges to verify costs.

For this the link does not have to be to the exact place purchased – it can be another supplier but must be the same item, or, if the same item cannot be sourced, a similar item with a higher cost.

The link may not show the same cost as listed, as prices and exchange rates do alter, but will be close and this is factored by the marking team.

No discount prices can be used, it must be the full item cost without any applicable purchase taxes.

Costing categories

Raw materials: this is costed as given in the spreadsheet, penalties may be applied for incorrect information as above. The raw materials category is marked with a slight variation of the CIS scheme after compliance is calculated.

Working hours: Teams must book on and off the build. The hours are recorded and calculated with a cost given in the technical description.

The shortest time that can be booked is 15 minutes and all working is in 15 minute slots. If one team member is working, all are considered to be working. This works on a variance of the CIS marking also.

Additional equipment: In this section teams will be asked to book and record the time in 15 minute slots as for working hours, but costs are applied for each piece of equipment used.

Costing CIS system: After compliance to specification is applied, (see brief for details), the final costs are set. The cheapest cost will set the benchmark. The 10% slots of this cost are applied to find the score section for each team. However, once 200% of the benchmark is realised, all teams from this point will score zero, rather than just the lowest score setter. This also means conversely that if costs are similar for all, all can score highly.

Surprise Projects

Manual Turning

The manual turning will be undertaken on a Bar of aluminium or steel.

All diameter tolerances will be to 0.05mm or greater.

This could be +/- 0.025, + 0.05, - 0.05, + 0.02 and - 0.03 and any other combinations.

All lengths will be 0.2mm tolerance.

The machine used during competition will usually be an XYZ lathe.

The tooling for all the above will be supplied at competition including toolholders, collets etc. This will also be released in the IL list.

Assessment:

Normally this is undertaken by micrometer. Any measurements not given will be checked by another expert.

The marks are normally split between simple measurements ensuring that the tolerances are met and conformity to drawing marks which remove points for other unmarked features missed or mistakes.

MIG Welding

(Note: for the National competition this is normally combined with fabrication as one project.)

The MIG Welding will be undertaken using steel flat bar, box section and sheet, or any combination. Though other supply forms are used, it is always steel.

All tolerances will be to 1mm or greater.

The machines used during competition are normally supplied by Lincoln Electric.

The tooling and consumables for the above will be supplied at competition.

Assessment:

Normally this is undertaken by a team of 3 Judges that are not compatriot to the team. Measurements are taken and recorded against the target value.

The marks are normally split between simple measurements ensuring that the tolerances are met and conformity to drawing marks which remove points for features missed or mistakes.

Fabrication

The fabrication will be undertaken using steel sheet up to 1.6mm

All tolerances will be to 1mm or greater.

The machines used during competition will normally include a guillotine and box and pan folding machine capable of up to 1.6mm.

The tooling and consumables for the above will be supplied at competition and if nuts, bolts and washers are required these are also supplied by the country setting the task.

Assessment:

Normally this is undertaken by a team of 3 Judges that are not compatriot to the team. Measurements are taken and recorded against the target value.

The marks are normally split between simple measurements ensuring that the tolerances are met and conformity to drawing marks which remove points for features missed or mistakes.

Electronics

This is normally a kit of parts with board and instructions. Velleman type kits are mostly used.

The team is not expected to design a suitable layout and build the circuit, as this is simply an assembly task.

This is done in the teams' build bay, so no machinery needs to be booked.

Assessment:

Marks will be given for certain functions working as they should, soldering joints being bright, shiny and correct, no evidence of dry joints, dull overheated joints, solder splashes being removed, tracks not being damaged and things of that nature.

Notes on the Competition

Normally supplied Equipment for use are:

Lincoln Electric MIG and TIG welding equipment - bring your own PPE.

A Cut-off saw or Bandsaw; not both.

A XYZ lathe - please bring your own lathe tools, some may be supplied.

A Pico soldering station with a selection of tips.

A build bay.

A computer with AutoCAD, Inventor and Eagle installed. Though for Eagle you will need your own account. Go to Autodesk's website to create one.

Specific free software asked for by teams for programming purposes such as Arduino IDE. Purchasable software must be brought and licenced for use by the team and can be installed during familiarisation.

All Materials for the Surprise Projects and tooling where required.

Practice materials for Familiarisation day. You may bring additional materials.

Project Requirements

Any other tools and materials for the project you must bring but note these are all weighed and the highest weight scores 0, the lowest weight scores max marks. Everyone else is graded between.

The brief may contain a list of banned items, but please also refer to the current banned items list given in the technical description; infringements will have the offending item removed with no replacement offered or a time penalty imposed.

Anything that can be made, or anything that can be substituted and made at the competition must be done. Otherwise a penalty of 3 times the estimated build time is added to your costs. A good example is a linear actuator can be made using a motor and lead screw. The linear actuator therefore carries a penalty.

Time is incredibly important, and it is easy to run out of it. A good practiced schedule is important.

Working as a team is paramount; a team arguing or not communicating will always have large problems.

Preparation is everything! Well laid out materials and tools in the build bay will always speed progress. Jigs and fixtures save a huge amount of build time by removing marking out.

Know the brief well and make sure you miss nothing!

However long you think you have to do all of this to the best of your ability; you do not have long enough!

Competitor Journey (Commitment)

To receive this document you will have signed up to the national qualifiers for Live.

The stages ahead are as follows:

1. Passive stage- The passive stage is designed as an introduction to manufacturing concepts as well as three core skills. This is to be completed by the 31st of May. This can be done in one day, plus some time for thought and design of manufacturing processes. This gives the opportunity for feedback and perhaps some insight into changes and ideas you may want to employ in the later stages.
2. Registration closes.
3. Within 1-2 weeks all teams will be sent a video link to a Youtube video giving a briefing for the assigned task.
4. Each team will be given the chance for a virtual meeting to ask questions and go through any areas they are uncertain about. This will occur by the end of May.
5. The end of June to the beginning of July: all teams will be required to participate in the national qualifier stage. This will be a virtually led round and marked remotely. (See below for details of the requirements.)
6. Around August, WorldSkills UK will announce those being invited forward to the national finals event to compete. 1 or 2 teams may be asked to hold in reserve in case teams drop out.
7. National finals event with Gold, Silver and Bronze awarded.

8. In a selection year the top competitors from the nationals' finals will be being invited to join the international squad and will be asked to accept or decline a space.
9. Those joining Squad will have 1 year approx. to train with the Training Manager (TM) before selection of a final team takes place.
10. The final team will train for 1 further year approx. including international pressure tests and then having met certain minimum requirements they will represent the UK in the International competitions.

The Qualifier

In order to keep your design secret from other potential competitors you will be required to undergo virtual assessment against the brief. For this there will be no requirement for surprise elements but everything else will be assessed.

The Main Project

A working prototype will be assessed against the brief criteria. Not all tests may be exact, for example, it is not possible to transport a course around the UK, so elements of this may be assessed to find a grade.

This does not have to be built while being assessed but should be built and fully operational ready for when the Judge arrives. Much like the Death Star, it may be fully operational but not be the finished article at this time! It must be noted, it will be judged in somewhat of a comparison against all other teams' projects entered. This simply means the more it does and the better it is made, the more likely you are to progress.

Portfolio A

This should be complete at this time to be marked.

Portfolio B

This should be complete at this time to be marked.

Costings

A cost for raw materials should be presented along with an estimate of working time and machinery usage. These will be costed and compared to all other teams in the qualifying round.

The National Final

The final score will determine who goes to the national final event, with the top 6 being invited and 2 reserve teams being held.

Hints, Tips, Ideas and Areas to Exploit

I am not going to give everything away that is used by the UK teams and certainly not in writing, but there are lots of common areas all International teams exploit that may be useful to you also.

Firstly I would say the rules are there to prevent unfair practices in competition.

Anything not covered by the rules is not unfair! Using the rules to your advantage shows understanding not unfair practices.

The rules can be found in the Technical Description, but this needs to be read carefully, interpreted very literally and sometimes I need a translator too. But this is all the applicable rules that can be very time consuming to read, but valuable to improve competitiveness.

TIP 1) Preparation, preparation and when you think you are prepared do some preparation.

Is it advantageous to have all raw materials prepared to be an exact size **plus** 50mm or more above the required size. By all this truly means all, but remember, supplied as a length then 50mm in one plane, as a sheet then 50mm in two.

It does take time and money prior to the competition as it generates waste, but you only have to set the machine back stop once for the guillotine and once for the cut-off/bandsaw.

If you're the first team on you will have to set the machines up, if you're the second you may be lucky as a team may be kind enough to have left it for you already set. Best check though! This can save a lot of time in set up, which translates to man hours and machine hire costs. It can also mean you finish early and have a much better product.

TIP 2) Jigs and fixtures.

This adds to toolbox weight so how they are made needs careful consideration. But combine it with the above tip and this means you should never have to mark out anything.

This is a manufacturing competition, so think mass manufacture. Apply Kaizen and Poke Yoke principles and you should never have to mark out anything and checks should be very quick and simple.

TIP 3) Practice build and schedule.

A good well-known schedule is key to success. It must be rigid enough to know exactly how and who for every operation, but flexible enough to allow for mistakes, rework and not being able to get on equipment when you want to.

TIP 4) Design down to the minimum.

What are the least materials and operations you can get away with?

How many common components can be used (this also saves on Jigs)?

Is there something available that can be modified to do the job instead of making it?

Can you use components that cannot be made at the competition using hand tools and the supplied machinery? (Cogs, motors and wheels for example are common ones.)

Design it to last for the competition, not for the next few hundred years.

All of the above affects either cost of materials or time or project weight and can have implications on all of those categories.

TIP 5) Programming time

Programming can be long-winded and laborious, but some methods are faster than others. Pay special consideration to this when choosing how to program the LCD and associated microprocessor. E.g. Arduino IDE is much faster than C++ and you can use any legitimate library from the manufacturer of the LCD or other microprocessor-controlled device, or any that is already built into the software for the programming methods you are using.

TIP 6) Logistics

To get from your bay to the welding booth, bandsaw, pillar drill etc. does not happen instantaneously. Plan in logistics and plan who; some operations may require 2 people for speed and efficiency. E.g. using a pillar drill to make several hundred holes. One person can be fitting jigs and passing materials to the second operating the drill. They can also sort and move back to the build bay the materials finished with.

This does not always have a benefit, it depends on your build, so consider this kind of thing carefully.

TIP 7) More logistics

How are you going to carry materials back and forward from the build bay to machinery?

You may only have one metal bar going to the lathe, so this is easy.

What about going to the Bandsaw with 30 pieces of metal?

TIP 8) One man one job

Unless you work for the council and it is the 1950's this is unlikely to happen at work, so why let it happen in the competition.

Cross training allows the best to take a lead on things, but if they run behind or experience problems another can fill in to keep the project running forward closer to schedule. This also saves on having people sitting around waiting for the third to finish before they can continue their own tasks.

TIP 9) Getting the portfolio A and Drawings portfolio B right

Before you enter the competition, you can gain points with no worry on the day.

Getting the drawing order right so one drawing is simple edits to the next, having a set template for drawings with most of the information pre-filled and lots of practice in doing them saves a lot of time and scores a lot of marks. Inventor is free to download for education (use your college email address to register with AutoDesk), so what else are evenings and weekends for?

TIP 10) Never assume

Teams often assume they have the cheapest raw material cost, then score zero as others are much cheaper. Teams think they are going to finish first in one day, (only ever done once in the history of the UK competition), then struggle to finish by day two end.

Your solution might be the best and the cheapest, until someone else's is better and cheaper, so never stop looking at ways to improve or ways to cut costs.

TIP 11) PPE

Full PPE on at all times when on stand. A judge will not likely stop you unless what you are or are not doing is dangerous, they will just quietly mark down the penalty.

Overalls, or separates are fine, but on at all times, safety goggles, gloves where applicable and safety boots. Without all of those on at all times on the stand you may be stopped working or incur penalties.

TIP 12) Know the brief!

The brief tells you everything, what your product should be able to do, what the judges will be looking for, how it will be marked and what will lose marks.

So far the closest scores between Gold and Silver has been 0.15 marks in 2019. Could the Silver team have pulled that up by hitting just one more tiny part mark and taken Gold instead? This is less than the mark loss for Judges finding a burr on metal.

Not only does the brief tell you what and how criteria will be marked, but it also tells you the marking order and what days they will be marked on. So, when you are testing your final design, use this as a guide and test in that exact order to see if one test is causing a problem to another. The test course and items are also there; would it be a good idea to use things close to this for a test, where possible even recreate them?

TIP 13) Have a good long natter with your friends who have come to support you.

It is always good to waste the time you have chatting about last night's episode of Big Brother or Love Island, that way when you don't finish the product and surprise elements you can have someone else to blame. Obviously, this is not a good idea!

My advice is: pre-warn supporters you will not be speaking to them, if the public speaks politely tell them you are too busy to chat, or, if you must chat, clock off the working time till you have finished. If not the conversational starter of "we wos robbed" might not apply to football for a change. Note: no judge will ever stop you wasting your own time, they will probably have a quiet chuckle to themselves though.

TIP 14) Break it all

Schedule and take breaks, these help you recharge and actually mean you work faster when you do, but you still only have the same limited time. So best plan for a simpler design to build than you thought to get these in.

TIP 15) Bring your mums marigolds.

A clean tidy well laid out build bay is the most invaluable resource in your control.

Each bay will be approximately 4x5M and will contain 1 chair with a computer workstation and computer. 1 electronics bench approx 1.2M long with a chair. 2 workbenches approx 1.2M long, one fitted with a vice. There will also be wall space and floor space.

A clean, simple layout for tools and materials gains much time and ease. Returning all tools to one set area for that tool means everyone can find it, including you! I see teams bumbling about looking for tools all the time.

Similarly a place for all materials, perhaps one for precut and formed and one for after helps. The floor leads to tripping over a lot, but that is entertaining!

Lastly you get penalties for untidy or dirty build bays, this is recorded just before lunch and at days end every day during all competitions. There are so many ways to do all of this, some work for some, others for others, but whatever works for you, get it right and practice using that layout.

TIP 16) Have fun

It is a lot of work, tough competition and maybe only the start to a great journey, enjoying it makes it so much easier!

TIP 17) Win gold

Of all entrants only 1 team can do that, but they are always the happiest leaving. Silver and Bronze medalists are nearly as happy, but everyone else, well, not so much. But Gold is for every team to win or lose, time planning and effort are the biggest determining factors, though of course good design plays a part, but no more than good preparation!

TIP 18) Use your resources well

The more serious side of this is that I am a resource to be utilised during your preparation. My email is the best way to get in touch, though the phone is also viable. Anything at all, just drop me a line with a question, or to sound out an idea you are unsure of, advice on a problem you cannot solve, and I will do my best to get back to you as quickly as I can.

Note: if you are ever sending drawings please do so as a PDF.