FACULTY OF ART DESIGN AND ARCHITECTURE
DEPARTMENT OF INDUSTRIAL DESIGN

ENGINEERING DRAWING MANUAL
SUPPLEMENT TO ENGINEERING MEDIA 3
SUBJECT CODE: DEN311
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This manual supplements and interprets the SABS code of practise for engineering drawing 0111 part 1, but does not replace it. This manual is Part 2 to the Engineering Drawing Manual for Engineering Media 2.

INTRODUCTION

Engineering drawing is a visual language that enables designers of all disciplines to specify the exact shape, size, materials and finishes a product should conform to. Like any language, it only works because the people using it have a common understanding of the rules and the vocabulary of the language. The rules of engineering drawing are based on a well-reasoned system of representing shapes and their dimensions as fully as possible with the greatest degree of accuracy, the smallest possibility of error, and using the least amount of information.

This manual has been created in order for students to have a better understanding of the process of producing comprehensive Engineering Drawing for the products they have designed.

Engineering Drawing is either right or wrong – there are no grey areas.

When going about creating an Engineering drawing the author must be aware that this is a binding legal document. If a problem occurs at any stage during the production of the components that you have generated Engineering Drawings for, the responsibility will lay with you the author. While at university studying this will of course pose no real problems – only your marks will be affected, when completing drawings for industry this could have a serious impact on your livelihood, the company you are working for and the manufacturers of the components for whom you have designed the product. Small problems can hold up production for several months and costs incurred may become your responsibility.

This is the reason why we take Engineering Drawing so seriously. By the time you complete your second year you will be expected to produce production ready single or dual component Engineering Drawings. At the end of your Third Year it is expected that you will be able to produce multicomponent and complex assembly production ready Engineering Drawings. A product that cannot be manufactured from an Engineering Drawing you have produced will mean you fail this course.

The process we have devised for going about generating the best possible Engineering Drawings is the following:

First Year:
You will be expected to learn and fully understand the SABS standards for Engineering Drawing.
You will be taught the basic principles of Engineering Drawing – line work, projection symbols, layout, datums and the basics of geometrising a product you have designed – all of this in the chosen CAD package available to you on the departments computer lab. It is suggested that you acquire a computer for your home use at this stage that will run these software packages.

Second Year:
This year will build on your knowledge gained in first year and will teach you the principles of Engineering Sketching – this will be applied to all Product Design projects until the end of Third Year and into the B-Tech Year should you be accepted.
You will be required to produce Engineering Sketches, General Assembly Drawings and Exploded View Drawings in the prescribed manner of the Engineering Media and Product Design projects for the first half of the year. The second half of the year will be devoted to producing all of the above plus Detail Part/Component Drawings of your Product Design projects.

Third Year:
The third year will build on your knowledge gained in the first two years. In third year you will go into more depth of technicalities such as: advanced three dimensional surface and solid modelling; Tolerancing; referencing and specification of standard components; surface finish tables; and advanced engineering design principles. You will also be expected to produce drawings for the external manufacture of your designs, physically testing your ability to communicate your design intentions through the standard engineering conventions.

As an Industrial Designer leaving this university your fundamental understanding of all aspects of the design process will make you an incredibly valuable member to any organisation or in your own business. Engineering media is one of the most important elements of the design process, taking your idea into a real manufactured product. In addition, being able to quickly understand and solve technical and engineering pitfalls will greatly enhance your ability to get products manufactured and into market.

ASSESSMENT CRITERIA FOR ENGINEERING DRAWING

Your drawings will be assessed against the three primary criteria listed here. If you keep these criteria in mind when you create engineering drawings, you will be in a good position to evaluate the correctness of your drawings and to make corrections as you draw. This is the best way to learn, and to earn good grades.

· **Thoroughness**: All the information in your drawings should give a complete picture of the size, shape, complexity and manufacturing requirements of the parts drawn. Thoroughness is a matter of providing only the information that is required. Too much information is as bad as too little information. When just the right amount of information is present, then the drawing is complete.

To be thorough you will need to edit and review your engineering drawings a number of times, weed out the incorrect information and add in missing information.

· **Clarity:** Clarity is a matter of including all relevant information using the fewest views and the fewest dimensions with the least amount of clutter. Any information that is confusing, ambiguous, or redundant (a repeat of information given elsewhere) must be eliminated.

· **Difficulty factor:** Your drawings must address the level of difficulty that suits the learning requirements of the project. Drawings that avoid addressing the problems set out in the brief cannot be assessed against the learning objectives, and will be penalised even if they are in other respects 'correct'.

1. ENGINEERING SKETCHES

In the Department Industrial Design as a student you will not only produce printed Engineering Drawings from CAD, but also hand drawn Engineering Sketches that are fundamental to the understanding of what you intend to do with the engineering of your product before you go into the CAD engineering stage of your design process next.

Engineering Sketches are vital in assessing how the designer intends to solve some crucial design and technical issues without wasting time in front of the computer or modelling in the workshop trying to solve these retrospectively.

Obviously Engineering Sketching requires that you be able to complete quality concept drawings, for this reason this is only a second year level expectation.

Engineering Sketches are intended to be reasonably accurate representations of the mechanical/technical/engineering workings of a design whose aesthetic form and visual details ***have already*** been resolved. The Engineering Sketch will need to demonstrate a sympathy and understanding for the materials and manufacturing process in which the product is to be made.

1.2 Purpose

Developing Engineering Sketches should solve any major problems that the designer might not have foreseen during the designing of their product. This is vital, since problems are solved before committing time to a prototype or CAD.

It is a good idea to start your design process with an Engineering Sketch of an existing product that you may be basing your design on, or using the internal components of, or updating for a client. The reason for completing a sketch of an existing product is not for industrial espionage, but rather to learn from others' mistakes and understand some of the clever thinking that may have gone into making their product work. If you are updating the design for a client, this re-evaluation can be an excellent starting point for designers to engross themselves in the product to be designed and help you to not reinvent the wheel.

1.3 Views

The chosen views will attempt to describe in the most economical fashion possible all that the designer and manufacturer could discuss in terms of assembly/manufacturing/internal components of the product.

Each product is likely to have its own way of revealing itself through the Engineering Sketches – an important consideration to bear in mind is that the outside visual details should be resolved before this stage is reached. Although some Engineering Sketches may require the designer to produce outside views to describe how internal design and engineering has affected the visual aspects of a product, the most important area of consideration is the assembly and manufacturability of the product.

1.3 Line work and shading

The line work required for Engineering Sketches should be similar to that of Technical Illustration i.e. shadow line on all edge areas with lighter line on facing surfaces. The drawings should be large, A2 is recommended, as this will be easier to discuss. It is suggested that the drawings be black and white permanent line drawings as this makes reading simpler – occasionally some line shading could help for clarity, or grey marker, but initially the drawings should only be undertaken as line work.

1.4 Process

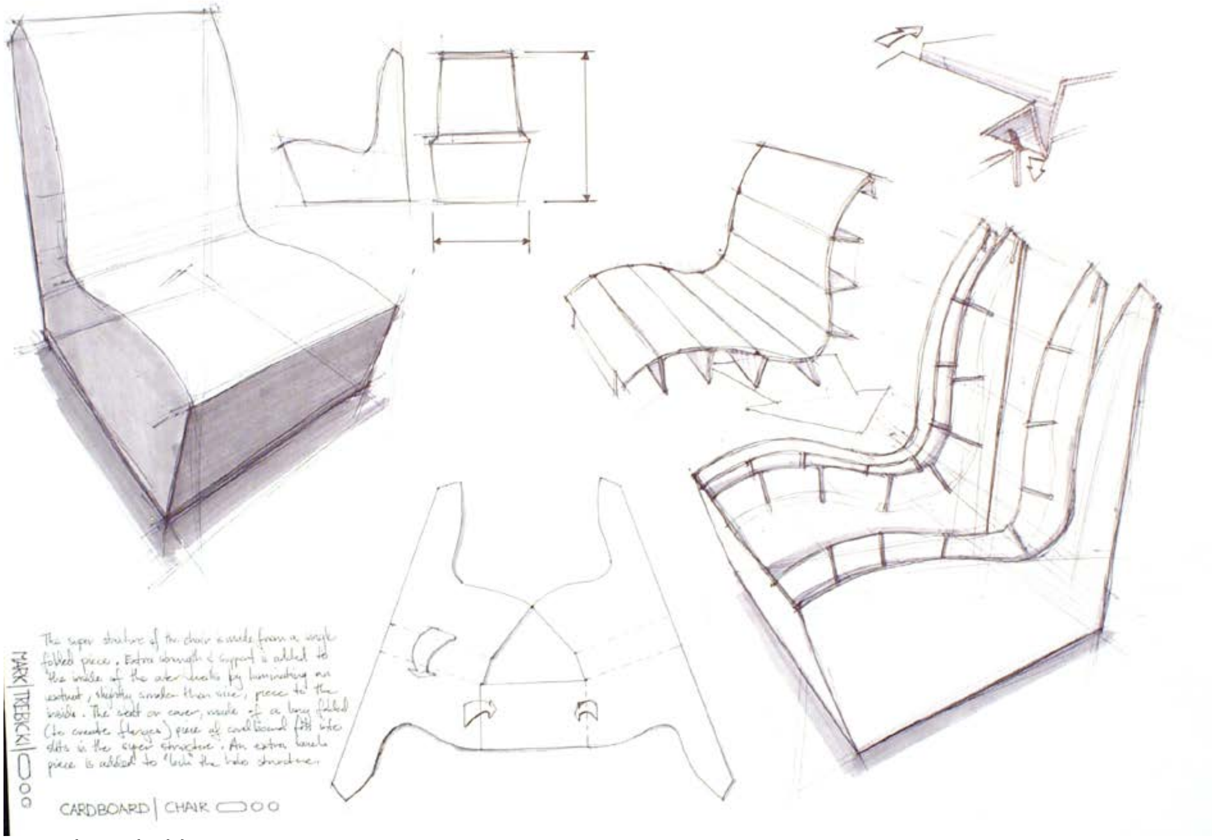
To go about producing such a drawing it is suggested that the designer completes an under-lay. This is a set of rough sketches in which the designer roughs out the views and begins to insert details; thereafter one traces this work onto a final page in which it will be cleanly and accurately completed. Engineering Sketches do not require a title block; the designers name and logo will however be required to appear in an appropriate area on the page. Some textual explanations may appear on the page – but try keeping this to a minimum, as far as possible the drawings should try to be self explanatory. In certain circumstances a Parts List might help to clarify the components used in the product: how many components there are; what standard components are included; details about these standard components; and suggested manufacturing processes to be used etc.

1.5 Types of Drawings

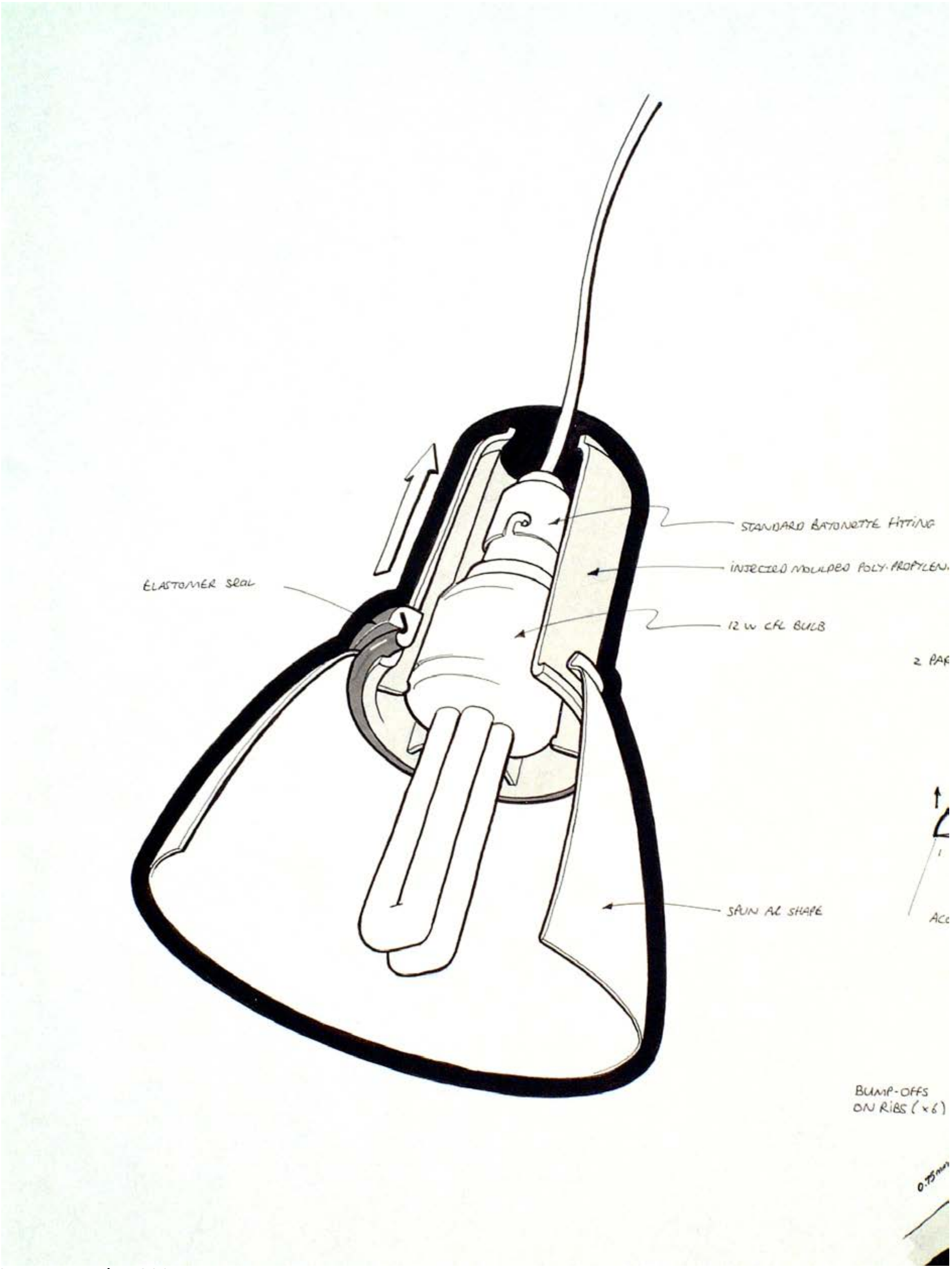
The options available for Engineering Sketches are: views that show the interface areas directly i.e. the parts are turned outwards like a peeled and split orange, another option is to complete ghosted views where the reader can see through the outer casing into the component.
It is often very difficult to show all the information in just one single view, therefore it is recommended that specific details be taken out to clarify exactly what the designer intends. Bear in mind that the thinking and resolution of problems you show here could save a lot of time and solve most issues before committing to the next stage of your project.

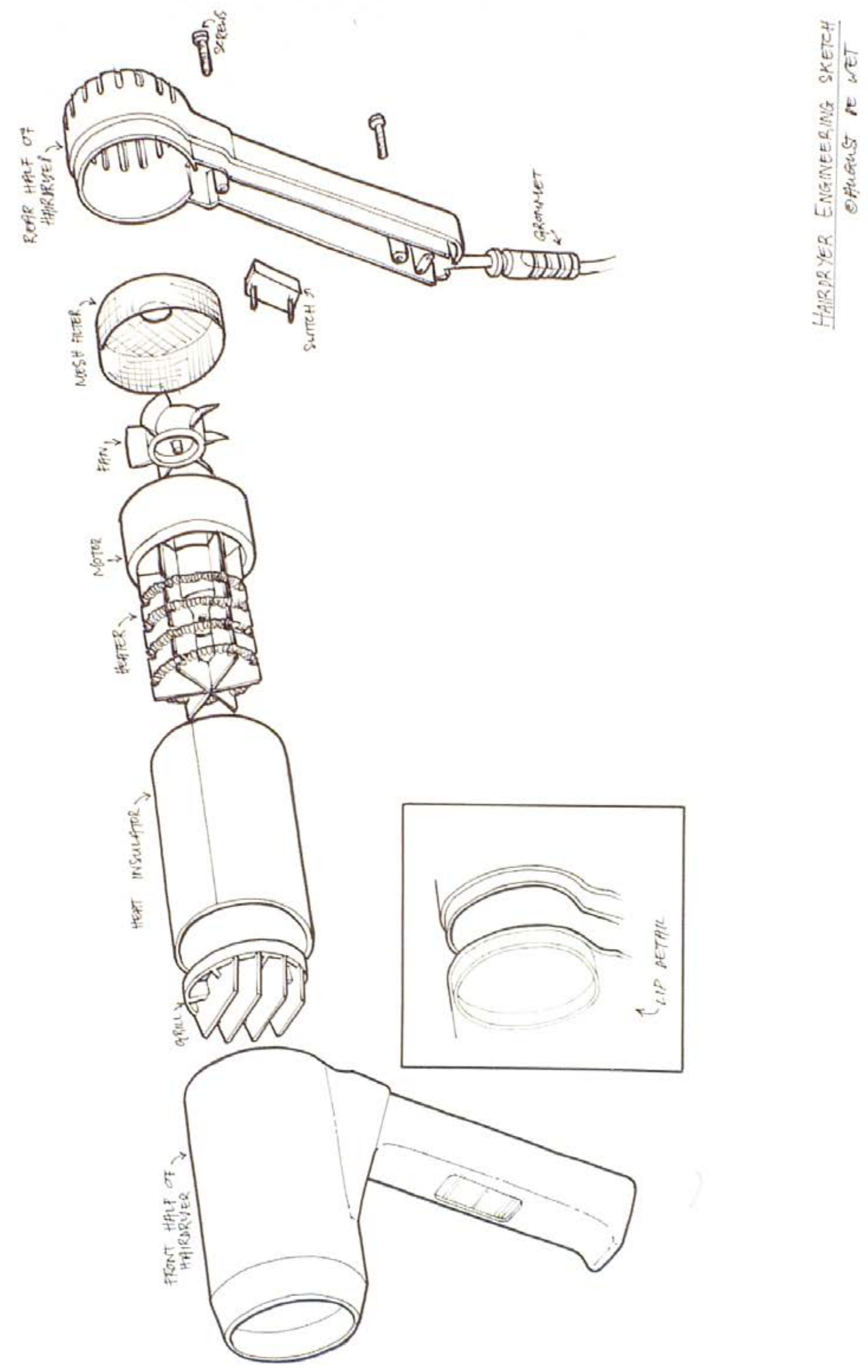
Typical details might include boss couplings, screw housings, split line intersections, mechanical or moving part indicators etc. These details could be in the form of side views or sectional view formats where the specified area is clarified.

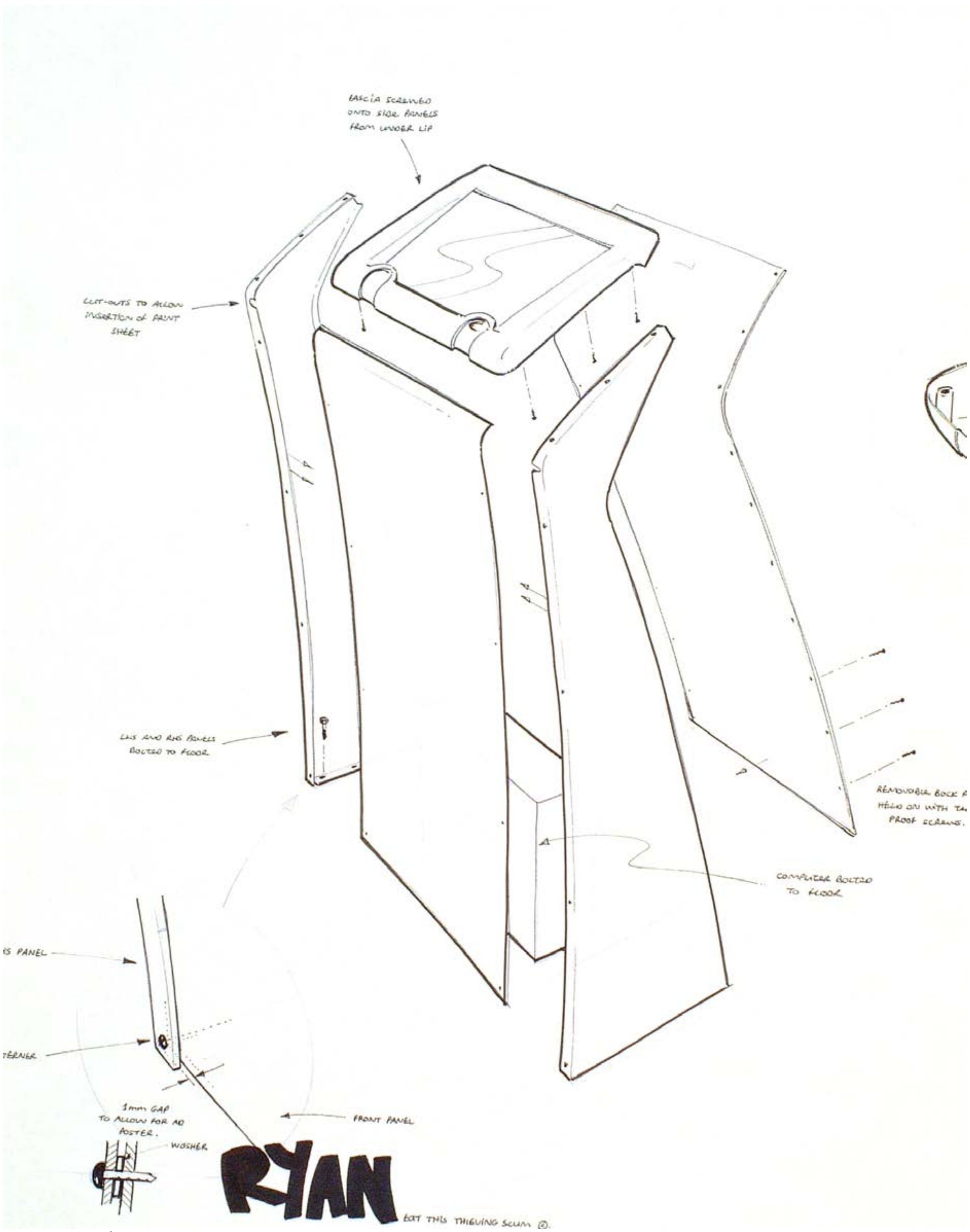
Some examples of Engineering Sketches produced by students from the 2001 2nd, 3rd Year and BTech Industrial Design programme:

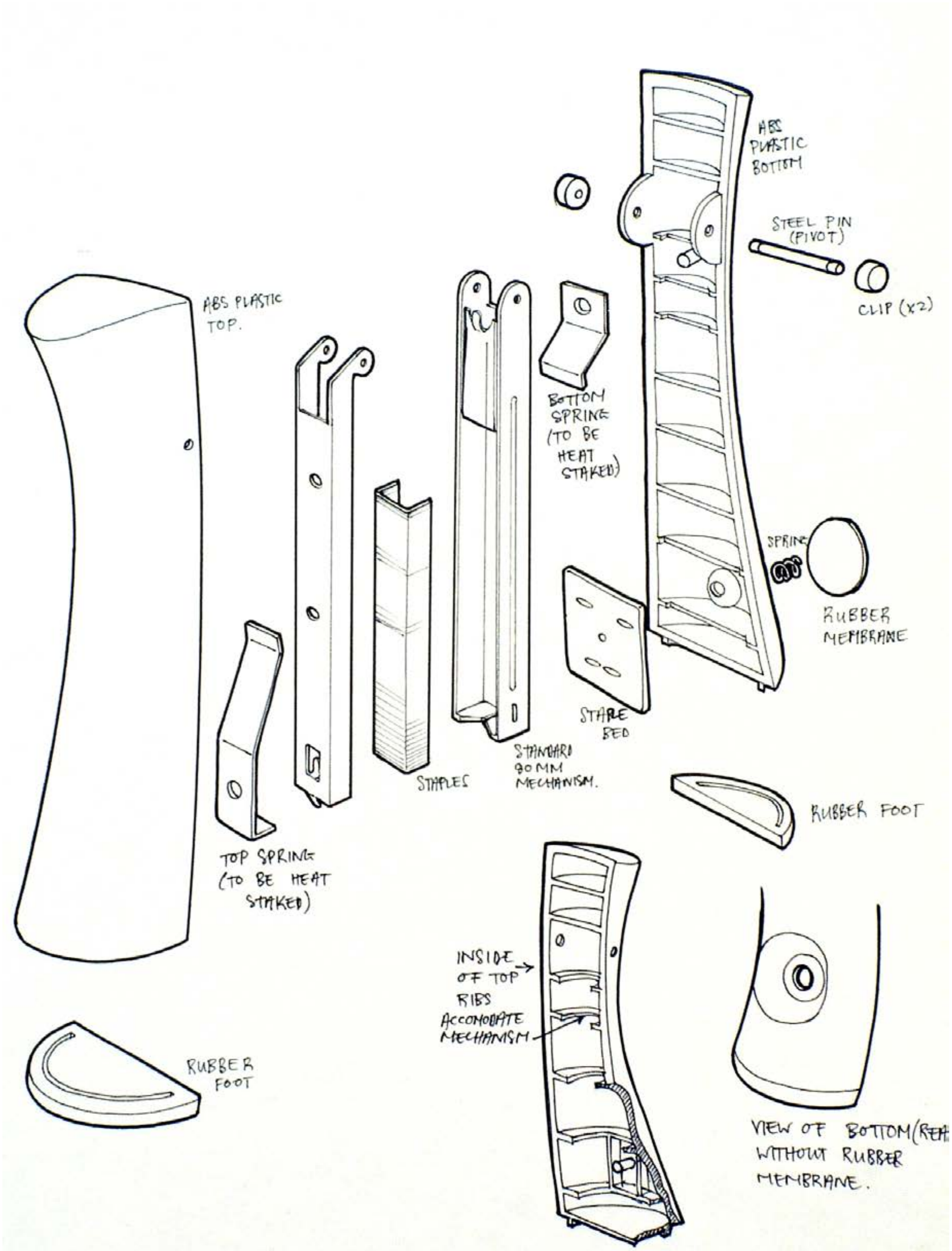


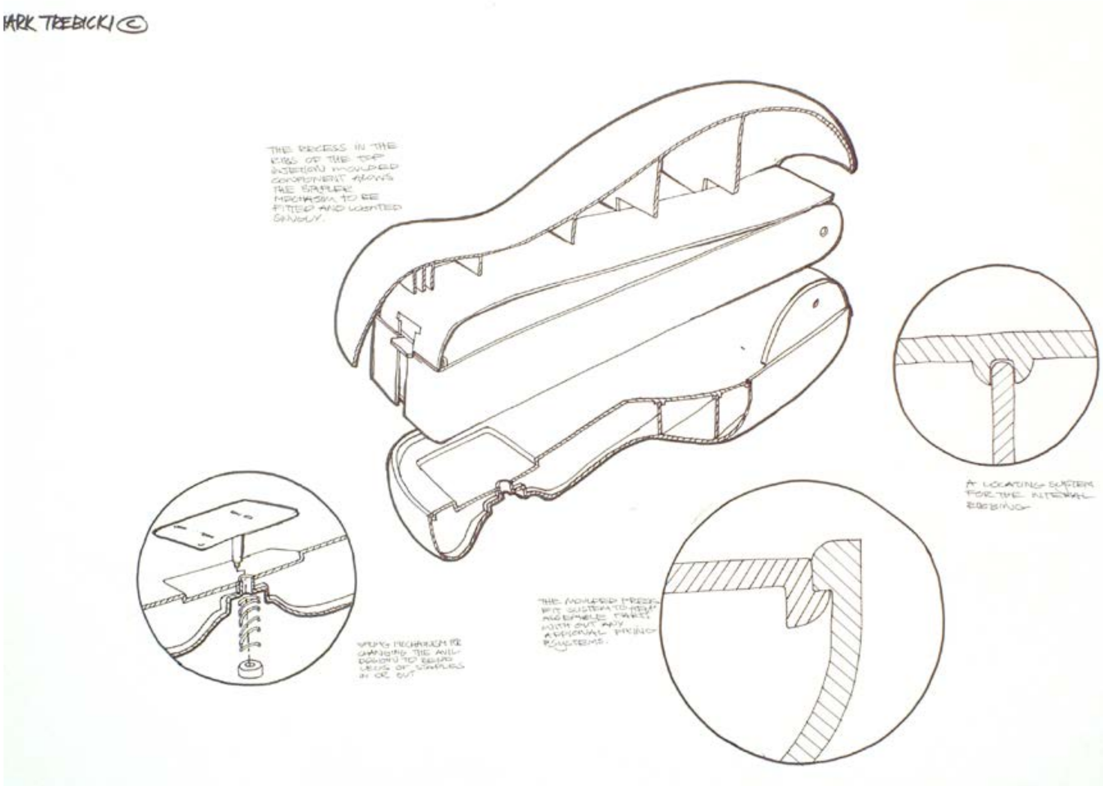
© Mark Trebeki 2001


STANDARD BAYONETTE FITTING
INJECTED MOULDED POLY-PROPYLEN
ELASTOMER SEAL
12 W CFL BULB
SPUN AL SHAPE
BUMP-OFFS
ON RIBS (x6)

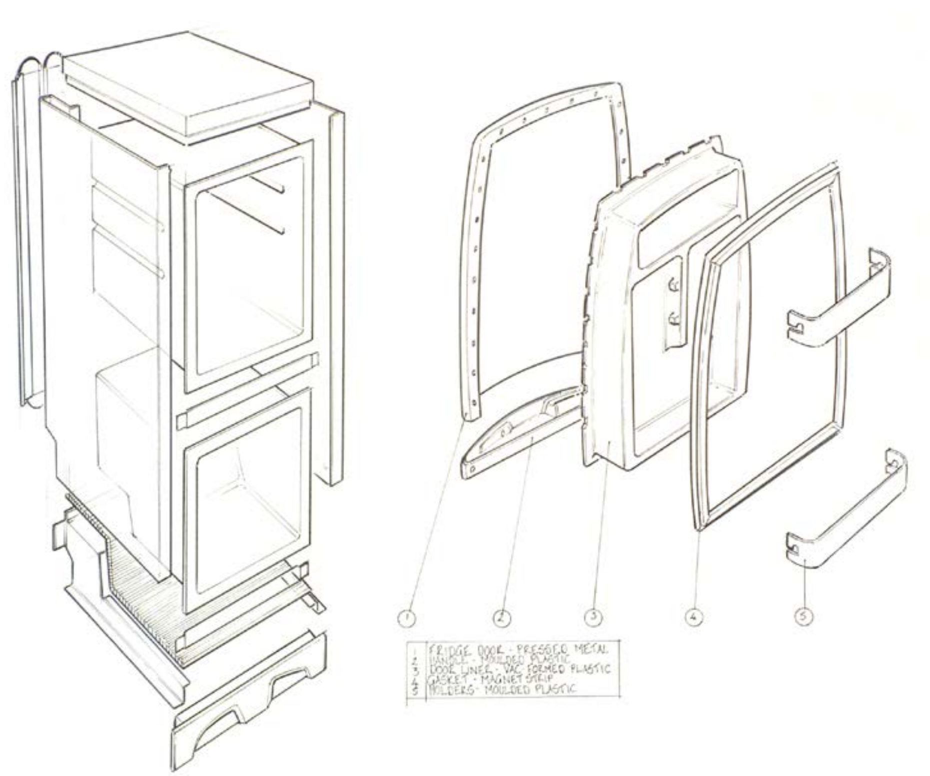

SCREWS
REAR HALF OF HAIRDRYER
GROMMET
MESH FILTER
SWITCH
FAN
MOTOR
HEATER
HEAT INSULATOR
GRILL
LIP DETAIL
FRONT HALF OF HAIRDRYER
HAIRDRYER ENGINEERING SKETCH
©AUGUST DE WET


FASCIA SCREWED ONTO SIDE PANELS FROM UNDER LIP
CUT-OUTS TO ALLOW INSERTION OF PRINT SHEET
LHS AND RHS PANELS BOLTED TO FLOOR
COMPUTER BOLTED TO FLOOR
FRONT PANEL
1mm GAP TO ALLOW FOR AD POSTER.
WASHER
RYAN


ABS PLASTIC BOTTOM
STEEL PIN (PIVOT)
CLIP (X2)
ABS PLASTIC TOP.
BOTTOM SPRING (TO BE HEAT STAKED)
SPRING
RUBBER MEMBRANE
STAPLE BED
STANDARD 90 MM MECHANISM.
STAPLES
RUBBER FOOT
TOP SPRING (TO BE HEAT STAKED)
INSIDE OF TOP
RIBS ACCOMODATE MECHANISM
RUBBER FOOT
VIEW OF BOTTOM (REA
WITHOUT RUBBER MEMBRANE.



© Mark Trebeki 2001



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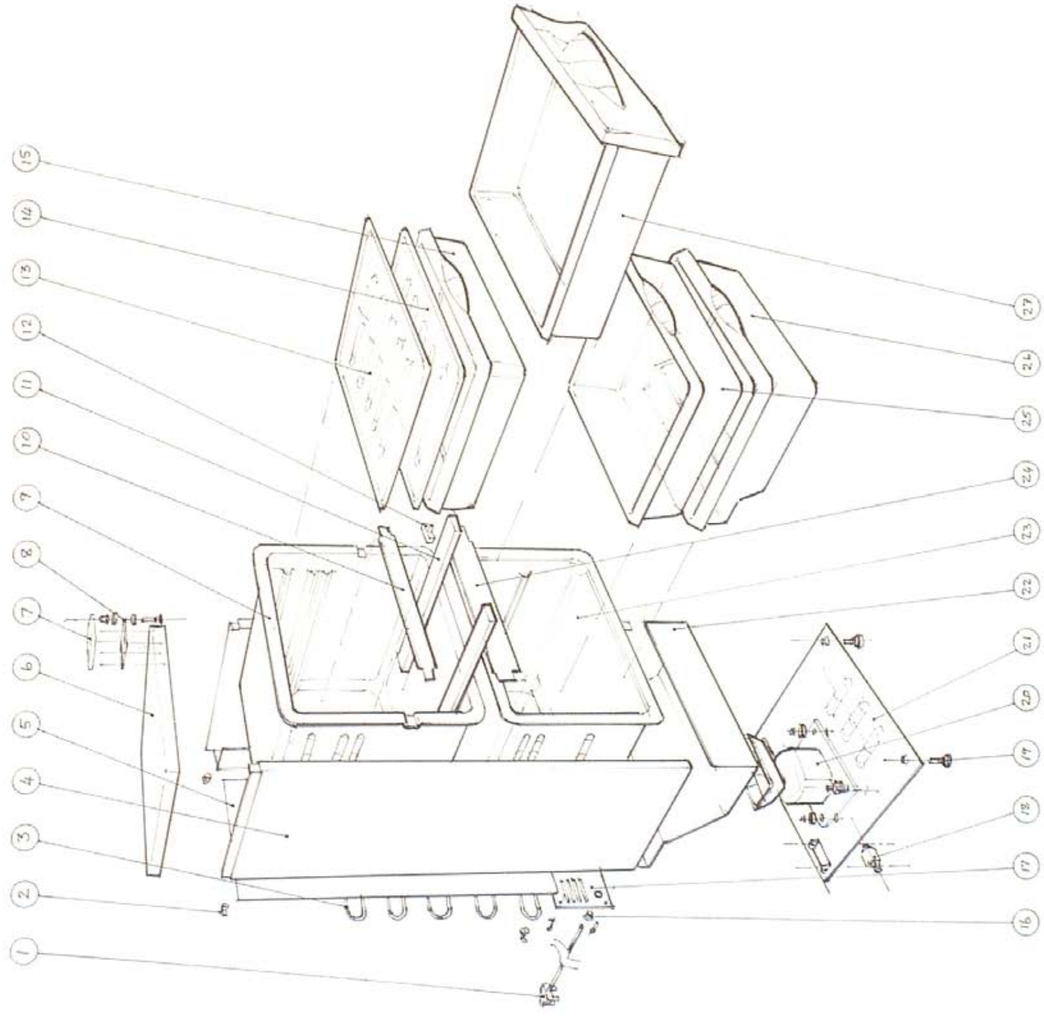
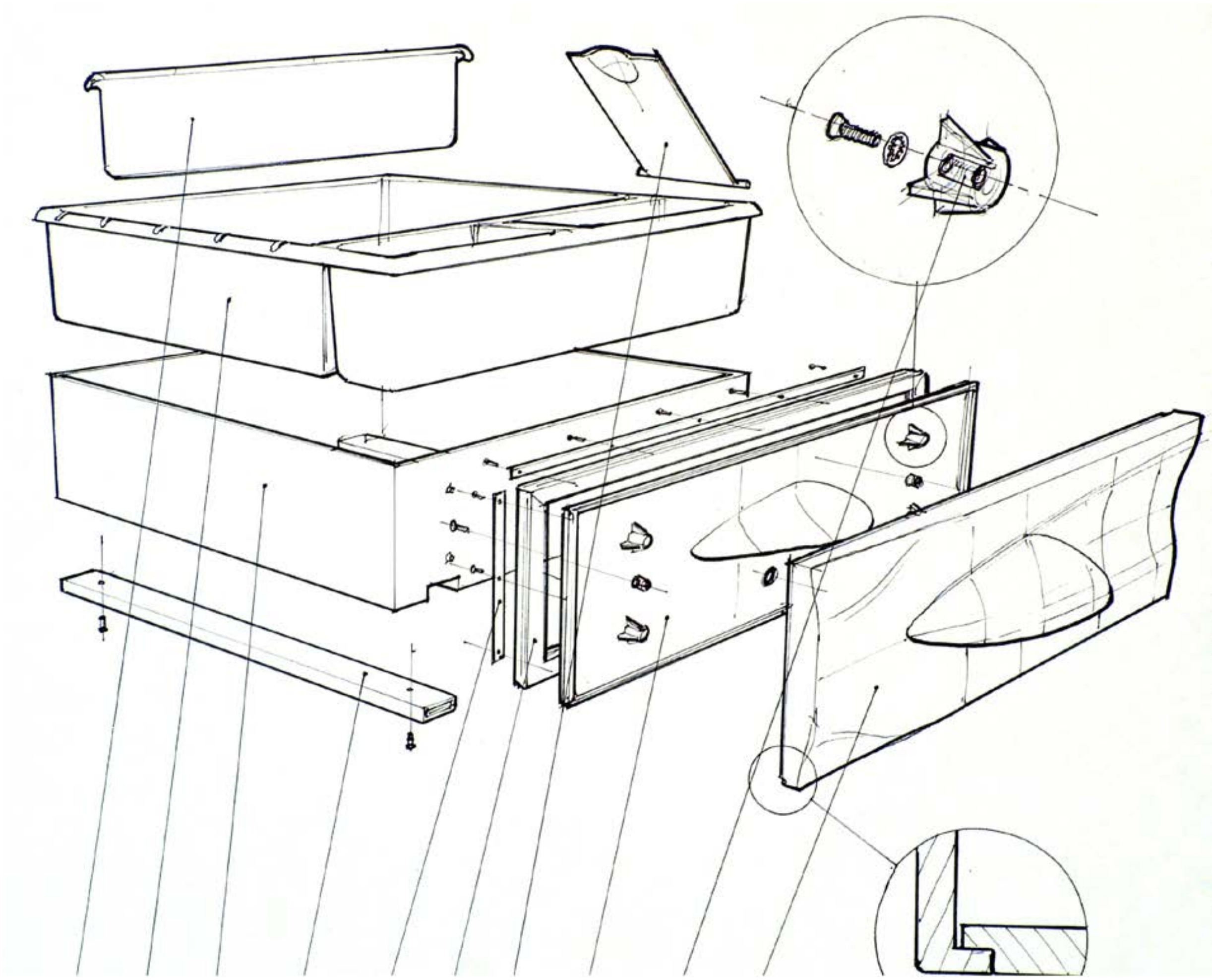
NR.	DESCRIPTION
1	POWER
2	POWER CABLE HOOK
3	CONDENSER
4	METAL SIDES (POWDER COATED); BENT
5	CORRUGATED PLASTIC SHEETING
6	METAL TOP (BENT, BRAZED AND P.C.)
7	HINGE COVER (PLASTIC INJECT. MOULD) → P.E.
8	HINGE
9	VAC FORMED LINING: FRIDGE
10	CROSS MEMBER : DRAWER SEALING (METAL)
11	RAILS
12	LIGHT SWITCH
13	TOP SHELF (INJECT. MOULD, P.S. CLEAR)
14	MIDDLE SHELF " " "
15	HUMIDITY DRAWER " " "
16	GROMMET
17	COMPRESSOR COVER PLATE (GALV. STEEL) PRESSED
18	ROLLER
19	HEIGHT - ADJUSTABLE FRONT FOOT
20	COMPRESSOR
21	BASE PLATE (GALV. STEEL); PRESSED
22	INNER BASE PLATE (P.C. STEEL, BENT
23	LOWER VAC-FORMED LINING
24	CROSS MEMBER : FREEZER SEALING
25	TOP DRAWER : FREEZER (SAME AS HUM. DRAW.)
26	BOTTOM DRAWER (FREEZER) : INJECT. M. P.S.
27	DRAWER (SEE DRAWER SUB-ASSEMBLY

MAIN BODY





2. TITLE BLOCKS

A standard title block is required for all Engineering Drawings. This Title Block will be located in the bottom right corner of the drawing sheet (A0, A1, A2, A3 and on the rare occasion A4). The various size drawing sheets will have the same size Title Block appearing in the same corner.

Engineering Drawings only ever appear in the landscape format. The Title Block's outer parameters must be of a size that will fit within a portrait A4 sheet – the reason for this is to accommodate the folding up of the drawing for postage, ease of accessibility when filing drawings, and a convenient way to transport these drawings etc. ***Make sure when folding your drawing that the title block sits at the bottom and front of the folded portrait A4 sheet, no matter what the size of the Engineering Drawing.***

All text in an Engineering Drawing will be **uppercase only** – the only area that may have any lower case is the advertising block.

All **General Assembly and Exploded View Drawings** must include specifying information including a **Title Block; Issue Blocks; Parts Lists;** informative **Notes;** information on the author of the drawing etc. these types of drawings are discussed in the chapters following this one.

All **Detail Component Drawings** must include other specifying information including **Title Block; Issue Blocks, a Surface Finish Table;** highly informative **Notes;** information on the author of the drawing etc. These types of drawings are discussed in chapters following this one.

Here are the following specific guidelines for advanced title blocks for Engineering Drawing:

2.1 DRAWING NUMBERS

The point of drawing numbers is for you to be able to file your drawings properly, as well as make sure your clients have an easy way of accessing which drawings you are working on when you phone them etc. When you leave here after your third or degree year, you will need to develop your own system of drawing numbers. For our convenience we have devised a system for you to use while here.

The format during this course will be: **UJ** (University of Johannesburg)/ the current year: 2010 (**10**)/ the students year group (e.g. **03**)/the project no. (e.g.: **07**)/ the drawing no. (e.g.: **001**) i.e. **UJ/05/03/07/001.**

A range of drawings may be required for a project and it is good practice to be able to quickly cross-reference these drawings with specific drawing numbers.

Be aware that each drawing will have its own drawing number. A set of drawings will be allocated drawing numbers in the following manner:
General Assembly Drawing: 001; Exploded View Drawing: 002; Detail Drawings: 003 – 00?.

2.2 SHEET NUMBERS

The information required for a General Assembly Drawing or Detail Engineering Drawing of a component may be too large to fit onto one standard drawing sheet therefore the designer will be required to use a second page for the extra information.

Please note that the drawing number for both these pages will remain the same, but the sheet numbers will differ e.g.: Sheet No.: 1 of 2 (on page 1) and for the second page Sheet No.: 2 of 2 (on page 2).

All the drawings of components **surrounding** this component will all have different drawing numbers – only these 2 pages describing this particular component will have the same drawing number

For Detail Drawings do not include other components on the same page – only 1 component to a drawing page (unless under very special circumstances)

2.3 PROJECT/TITLE

Each drawing must have a full and descriptive name of the project and type of drawing
E.g.: PROJECT: **REMOTE CONTROL**; **T**ITLE: **GENERAL ASSEMBLY**
PROJECT: **REMOTE CONTROL**; TITLE: **TOP COMPONENT DETAIL DRAWING**

Never just name a drawing: DETAIL DRAWING
Each drawing must be described in full

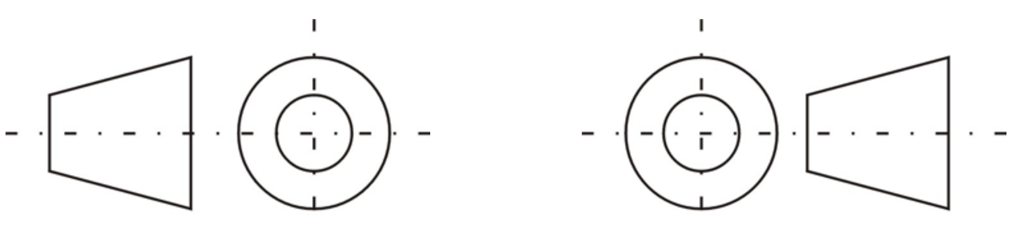
2.4 SCALE & PROJECTION

The scales used must only be those standard scales recognised by the **SABS (ref.: 0111) 1:1; 1:2; 1:5; 1:10 and 2:1; 5:1; 10:1 etc.** An easy way for you to figure out which way to place these scales around is to simply place the first figure over the second and use it in the same way that fractions are calculated, i.e. 1:2 = $^1/_2$ or half true size and 2:1 = $^2/_1$ or 2 times true size.

When indicating the scale of the drawings always suffix it with **(UOS)** in brackets. **UOS** = **Unless Otherwise Specified**. This allows you to include views that are not necessarily to the base scale of the drawing.

E.g. **SCALE:**
1:2 (UOS)

In this course students will be required to produce only ***3rd angle projection*** drawings after First Year, as this is the standard used internationally. Unfortunately 3rd angle is slightly more complicated than 1st angle, but it is the recognised international standard layout for Engineering Drawing and we must stick to it. Fortunately the CAD software we use has a quick and convenient way of converting your 3D files into this type of layout. The tricky part comes in when you need to do 2D drawings on paper for yourselves and making sure when you move views around that you kep them in the correct projected orientation.



FIRST ANGLE **THIRD ANGLE**

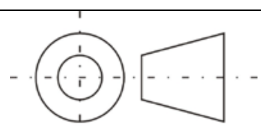
2.5 Advertising Space

A small area is allocated to the designer and engineer of the product to advertise their company – use this space to your advantage as often toolmakers, managers etc. who have not already come into contact with you may require more information from you or consider your services for future projects.

Included in this block are: Logo, Telephone numbers, Fax number, Email address if any, Physical Address, PO Box number, and most importantly a copyright clause of some sort.

An example of a correct Title Block:

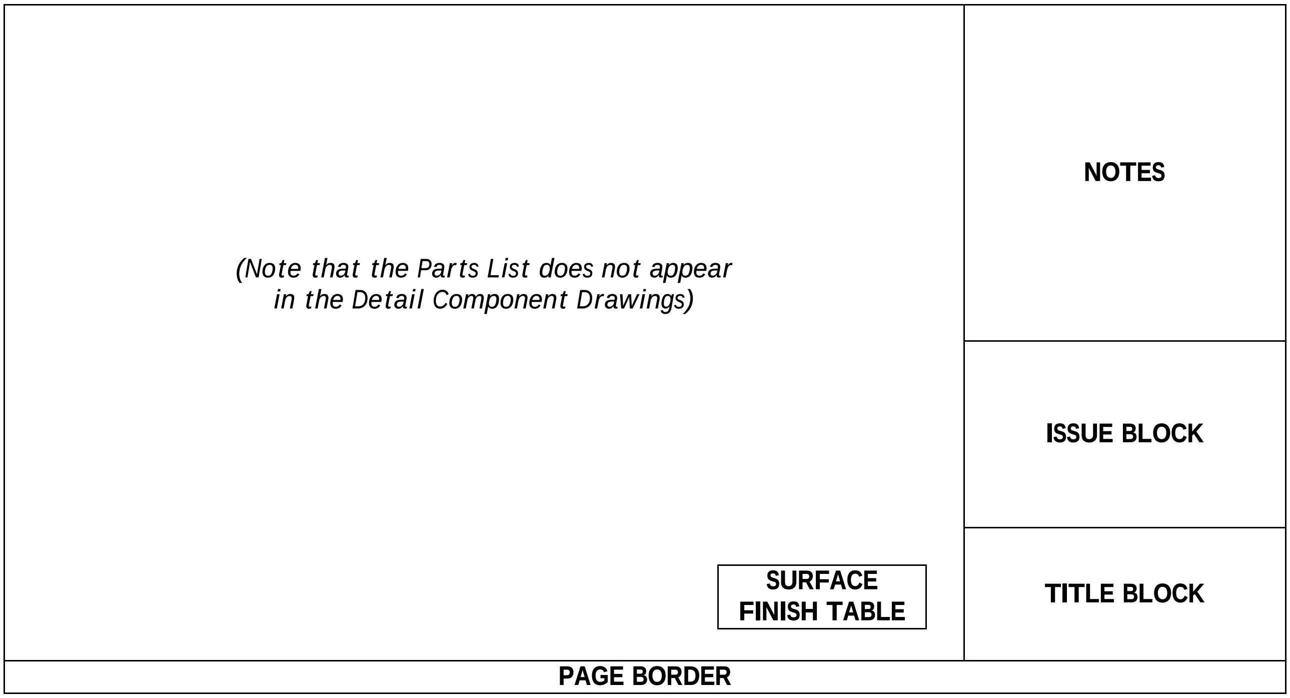
<table>
<tr><td colspan="3" rowspan="3">MR BOBS INDUSTRIAL DESIGN CC
ADDRESS/PO BOX NUMBER

TELEPHONE NUMBER
FAX NUMBER
EMAIL ADDRESS</td><td>CLIENT NAME: XXXXX</td></tr>
<tr><td>CLIENT CONTACT: XXXXX</td></tr>
<tr><td>CLIENT DWNG NO.: XXXX</td></tr>
<tr><td colspan="2">PROJECT: REMOTE CONTROL</td><td colspan="2">TITLE: TOP COMPONENT DETAIL DRAWING</td></tr>
<tr><td></td><td>SCALE:
1:1 (UOS)</td><td>SHEET NO.:
1 OF 1</td><td>DRWG NO.:
UJ/05/03/01/003</td></tr>
</table>

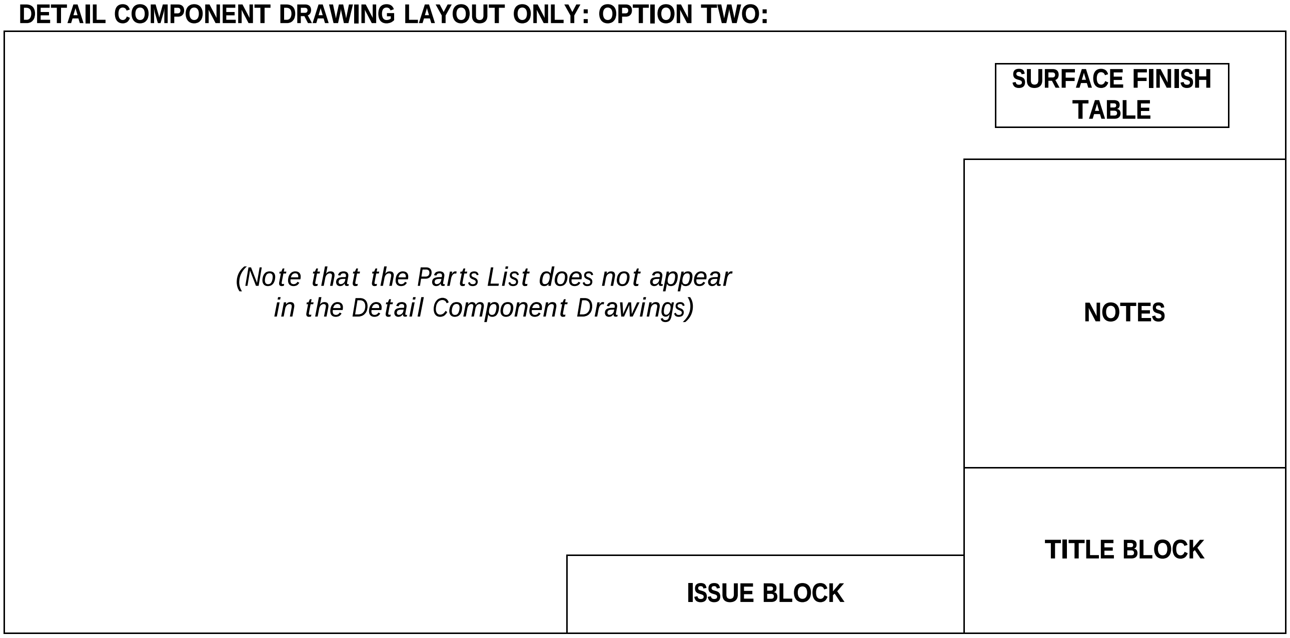
3. DRAWING PAGE LAYOUT

The following are potential drawing layouts for you to consider.
The Title Block cannot be moved from its position, the Notes area, Issue Block, Surface Finish Table (only on Detail Component Drawings), Parts List (only on General Assembly and Exploded View Drawings) etc. can all be moved around, but use the least space in the following configurations:

DETAIL COMPONENT DRAWING LAYOUT ONLY: OPTION ONE:

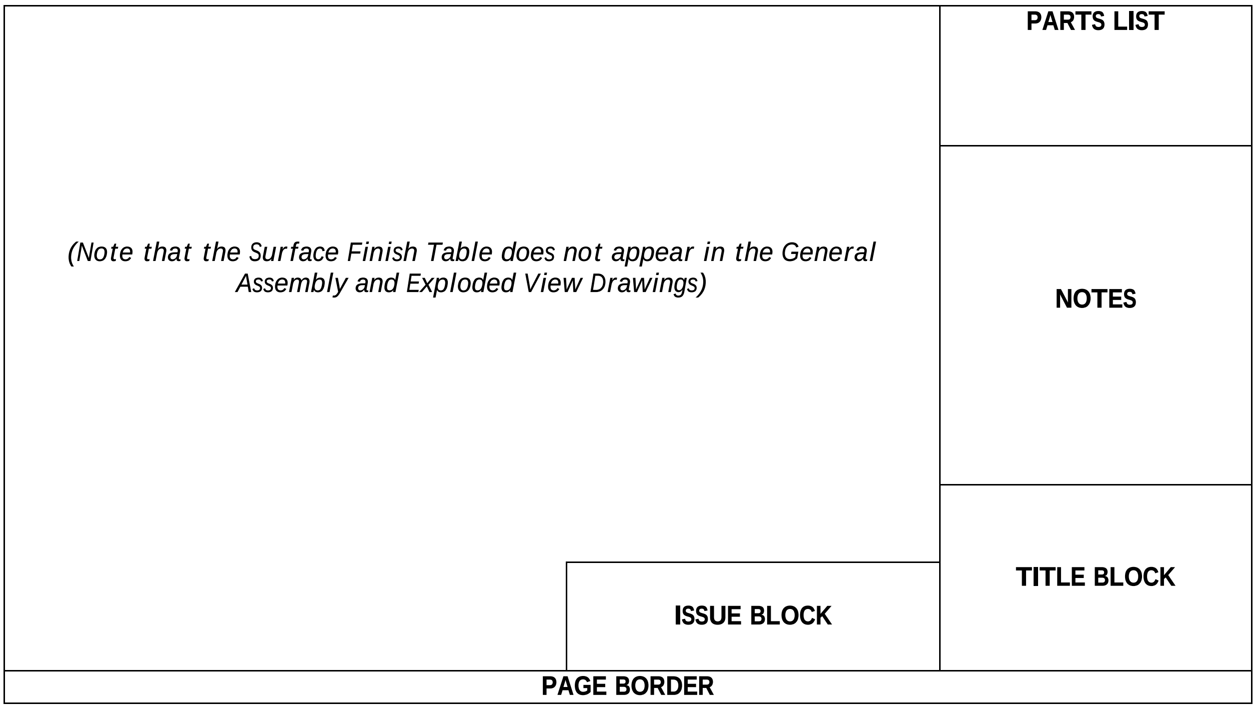


DETAIL COMPONENT DRAWING LAYOUT ONLY: OPTION TWO:

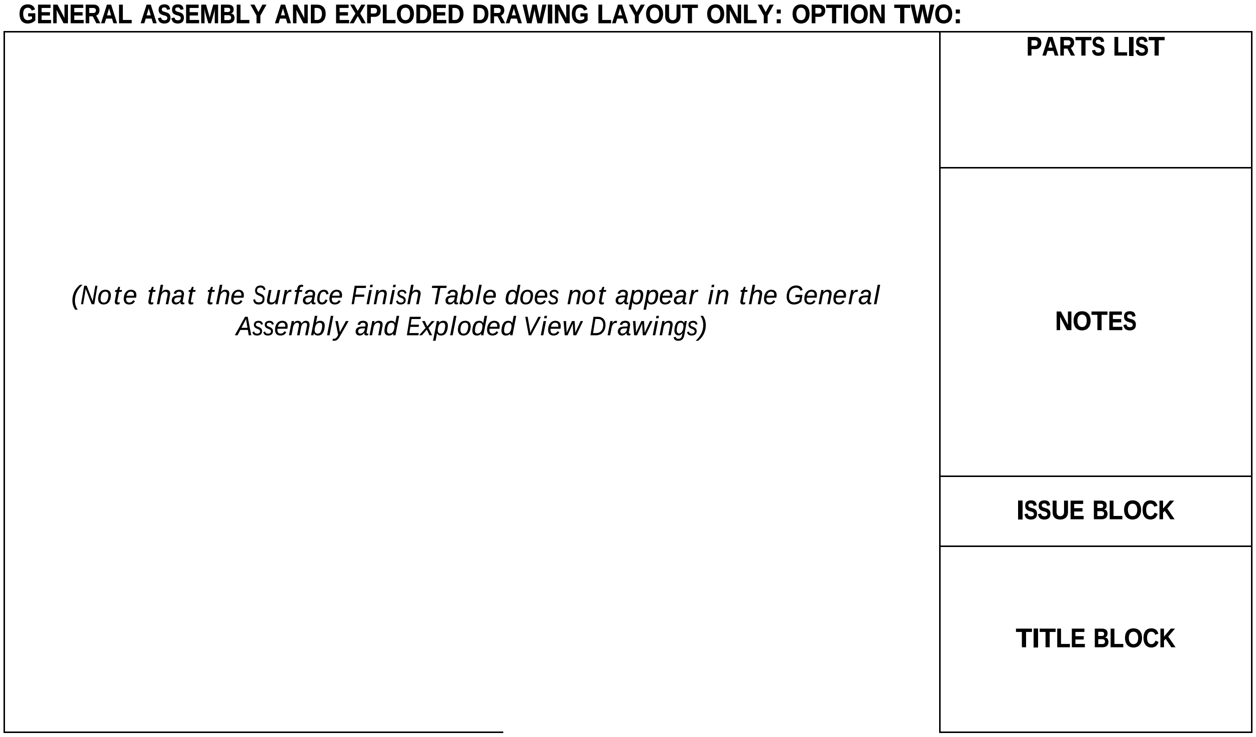


PAGE BORDER

GENERAL ASSEMBLY AND EXPLODED DRAWING LAYOUT ONLY: OPTION ONE:



GENERAL ASSEMBLY AND EXPLODED DRAWING LAYOUT ONLY: OPTION TWO:



PAGE BORDER

4. NOTES

The Notes area on a General Assembly/Exploded View Drawings and Detail Component Drawing will differ substantially.

In the **General Assembly and Exploded View Drawings** include only basic notes about general areas that are to be discussed. ***No*** information about colour, manufacturing processes, surface finishing etc. are included as these will appear in the Detail Component Drawings. ***Some reference to dimensioning, inclusion of standard components, packaging references etc may be included***.
An Example of a Notes Block for a **General Assembly and Exploded View Drawings**:

NOTES:

1. **ALL DIMENSIONS IN MM**
2. **etc.**

Included in the **Detail Component Drawing Notes** must be all the information pertaining to:

NOTES:

1. **MATERIAL DESCRIPTION:**
2. **COLOUR:**
3. **GENERAL TOLERANCES:**
4. **GENERAL WALL THICKNESS' (WHERE APPROPRIATE):**
5. **SURFACE FINISH – REFER TO SURFACE FINISH TABLE**
6. **ANY CROSS-REFERENCES TO OTHER DRAWINGS – IF THE DRAWING NEEDS TO BE READ IN CONJUNCTION WITH ANOTHER DRAWING ETC.**
7. **ALL DIMENSIONS IN MM (ESPECIALLY WHEN DEALING WITH USA, UK ETC.)**
8. **BREAK RADII INFORMATION**
9. **FOR WOOD, METAL OR PLASTIC COMPONENTS - ALL INFORMATION RELATING TO HOW THE SURFACES SHOULD BE FINISHED OFF BEFORE BEING SENT OUT TO MARKET E.G. MOULDINGS TO BE FREE OF BURRS FLASH AND SINK MARKS, MOULDINGS TO BE FREE OF DISTORTION AND TWISTS (FOR PLASTIC) – THIS INFORMATION GIVES THE MANUFACTURERS AN EXACT INDICATION OF YOUR EXPECTATION FOR THE FINAL OBJECT LEAVING THEIR FACILITY.**

The example is a very basic layout of what should appear in your notes column. For other materials you may specify finishes and other notes directly related to how you would like your product finished off.

Leave no clues for toolmakers or manufacturers in terms of the intention of the expected result of your end product. These notes will be read and must be adhered to by the toolmaker or manufacture – it is expected that if your finished product has any dispute, that it is you who should have covered yourself by providing all the required information in the notes areas of your engineering drawing.

In more detail:

Included in the Detail Component Drawing NOTES ***must*** be all the information pertaining to:

Material description e.g.: MATERIAL: POLYPROPOLENE (PP)

Colour e.g.: COLOUR: RED (PANTONE REF.: 185) – there are other possible colour reference systems: COATES, DULUX etc. Pantone is the most commonly used though. You must include a complete reference to the colour in order for it to be specified properly.

General Tolerances e.g.: GENERAL TOLERANCE = +/- 0.5mm (UOS). The UOS referring to unless otherwise specified as may be the case when wanting specific tolerances on interface parts – these will then be dimensioned on the drawing in the correct area.

General Wall Thickness (where appropriate) e.g.: GENERAL WALL THICKNESS = 2.40mm (UOS). Again the UOS referring to the fact that in certain specific areas the wall thickness may need to vary – only these varying thickness areas will be dimensioned, in all other areas the wall will remain un dimensioned as the notes give reference for these.

Ribbing dimensions are given at their root e.g. RIB DIMENSIONS = 1.20mm (AT ROOT - UOS) – for plastic components

Surface Finish – SURFACE FINISH: REFER TO SURFACE FINISH TABLE

Any cross-references to other drawings – if the drawing needs to be read in conjunction with another drawing etc. DRAWING TO BE READ IN CONJUNCTION WITH UJ/05/02/01/002 – CALCULATOR BASE DETAIL DRAWING

ALL DIMENSIONS IN mm (especially when dealing with UK/USA) Telling the reader that this drawing is metric and the dimensions are in millimetres.

Break radii information e.g.: BREAK RADII = R 0.5mm (UOS). For specifying that all un-dimensioned corners with radii have this specific dimension

For plastic components: ALL MOULDINGS TO BE FREE OF BURRS FLASH AND SINK MARKS
MOULDINGS TO BE FREE OF DISTORTION AND TWISTS etc.

For metal components: ALL SHARP EDGES, BURRS ETC. TO BE REMOVED
PARTS TO BE FREE OF TWISTS, PRESSING MARKS etc.

For other materials look at problems that occur in the process and try to write a specification that results in the best possible product for your design.

Leave no clues for toolmakers or manufacturers in terms of the intention of the expected result of your end product.

5. ISSUE BLOCK

The Issue Block usually appears above the main title block. The issue block ***will appear on all drawings*** – General Assembly Drawings, Exploded View Drawings and Details Part Drawings.

The Issue Block will start from the bottom at number 1 and work its way up through numbers to the top – note if you are asked to produce a second or third issue you must show what happened in all previous issues. What this means is that you will leave Issue 1 with its description left in place and in Issue 2 you will describe the changes you have made or reasons for submitting a second issue.
The ISSUE BLOCK will have the following titles running from left to right:

2	-	15/03/05	FOR PRODUCTION	M.B.		
1	-	21/02/05	FOR DISCUSSION PURPOSES ONLY	M.B.		
ISSUE	**CHNG**	**DATE**	**DESCRIPTION**	**DRAWN**	**CHECKED**	**APPRVD**

5.1 ISSUE

Indicates the latest issue of this drawing that is current for whichever purpose you have described in your description block.

5.2 CHANGE

For any revisions made to the drawing – a letter will appear within a circle e.g. A, this will also appear on the drawing where the change took place. A full description of this physical change to the product will be shown in the description area.

5.3 DATE

The date the latest issue was completed.

5.4 DESCRIPTION (e.g.: NOT FOR COMMERCIAL PURPOSES, FOR DISCUSSION ONLY etc.)

Fully describes either changes or the purpose of this specific issue. For changes such as layout, dimensioning placement, labelling etc the change will only be reflected in writing in the description area. For any physical change made to the product a letter in a circle will appear in the change block and where the physical change took place on the part (in the drawing) and then a full description of this change will be given in the description area.

5.5 DRAWN (Drawn By)

The initials if the individual who completed changes etc. on the latest issue e.g.: M.B., if you happen to have a student in your year with the same initials, include the initials of your middle name e.g.: M.J.B.

5.6 CHECKED (Checked By)

Usually for a senior designer in the office or any person wishing to take responsibility for the exactness of the presented drawing (this will be signed on each drawing). The process of checking is known as redlining a drawing. This area will be signed by the individual redlining your drawing, approving that all aspects of the drawing are correct.

5.7 APPRVD (Approved By)

This will be the clients' final approval and will only be signed by the client before production of the component begins.

6. PAGE BORDER

6.1 DISCLAIMER

A disclaimer must appear in the drawing (a good area for this is along the border at the bottom of the drawing)
This disclaimer is to protect the author:

NOT TO BE USED FOR MANUFACTURE UNLESS APPROVED AND SIGNED BY THE CLIENT

6.2 COPYRIGHT

The author of the engineering drawing will reserve the copyright – as all Engineering Drawings are legally binding documents the author has the right to retain his/her rights to the information supplied in the drawing unless an agreement has been reached with the client. The copyright is also to protect the author from the illegal use of the drawing by companies other than their clients and/or by a client who has not paid for the work

This will appear under the Title Block in the following format:

COPYRIGHT (or **©**) **2010** (year) **MR BOBS INDUSTRIAL DESIGN CC**

6.3 DIMENSION/SCALE

DO NOT SCALE OFF DRAWING – to inform users not to directly derive info from their own measurements off the drawing. Printing may scale the drawing slightly and if measurements are taken off the printed drawing they will be inaccurate, rather have the toolmaker contact you if measurements are missing.

DO NOT CHANGE BY HAND – any physical changes made on a computer-generated drawing must render that drawing redundant.

6.4 PAGE SIZE

Indicate in the bottom left hand corner the page size: **A1, A2** etc – for reference in the event of someone reducing the drawing.

6.5 CAD PROGRAMME USED

Indicate what CAD package has been used as the client, toolmaker etc. may be using a compatible system and files could be sent by Email or on disk.

E.g.: **SOLIDEDGE V15 COMPUTER-GENERATED DRAWING;**
SOLIDEDGE V15 CAD GENERATED DRAWING

7. GENERAL ASSEMBLY DRAWINGS

General Assembly Drawings are used for the express purpose of describing to the reader exactly how the product is to be assembled. **All details of the parts being assembled must be revealed.** There must be no assembly details left uncovered. This is an opportunity for the manufacturer, client and designer to understand what components fit where and how best to go about assembling the product.

Accompanying this will be a parts list detailing to the reader where the components assembled on this page can be found – by giving reference drawing numbers for the designed components and giving specification details for the pre-manufactured or standard components.

General Assembly Drawings include a Title Block, an Issue Block, a Notes area and a Parts List. They do not have a Surface Finish Table.

7.1 Views

The purpose of the drawing must be kept in mind. As economically as possible describe exactly where and how components fit together (not the specifics of the individual components – detail drawings are drawn up for this purpose). Try to clearly show what parts are to be assembled – usually the best approach is to start with the three orthographic views in the top left of the page, thereafter the ***sectional views*** (needed to describe assembly) are arranged in a carefully designed layout across the rest of the page. When laying out Engineering Drawings it is helpful to think about the individual who will be reading this drawing, try to make all the information accessible and logical in the layout.

7.2 Sections

Never show any hidden line in a General Assembly Drawing, ***use sections*** to peel back the outside of your product to reveal your assembly mechanisms. Section views can be straight lines or could be slightly more complex lines that change direction at 90° with thicker leaders. These must however not be too confusing for the reader and as far as possible must go through obvious assembly areas. For section views solid and thick line work arrows are used to show the direction in which the section is being shown. Lettering will appear indication the section being shown e.g. “A”. This must always start at “A” for each drawing. The sectioned view will only ever be placed in the same layout as the section indicated (never at 90° to its section direction). Below the sectioned view a label will appear: SECTION “A-A” etc. no scaling factor will appear, as section views are not generally scaled up or down. ***A sectioned view will never appear within the orthographic set, it will appear outside of the three main views.***

Once sufficient sections have been included to show assembly, detail views can be used to scaled up and clarify any information that may be too small or confusing to see at the page scale.

Note: Sectioned areas will have hatch lines through the wall thickness of the material being sectioned – these section lines are only ever evenly spaced lines of a line weight of +/- 0.25mm and at 45° or -45° to the page vertical. The spacing of these section lines will differ for the various components in order to indicate the different assembled parts.

7.3 Detail Views

Detail views are ballooned areas that are used to scale up details in order to clarify a portion of the drawing. The CAD programme will perform this operation fairly painlessly but may include its own format for Detail Views. You are required to change this to the following format:

For Detail Views an arrow line is pointed to the broken line circle that surrounds the detailed area and at the end of the leader a clear statement indicates: SEE DETAIL “A” or whatever detail number is being discussed. Note: the details are only ever indicated by lettering. Below the area where the detail is shown a label will appear: DETAIL “A” and underneath it will be SCALE: 2:1 or whatever scale you have increased this detail to. Be aware that the detail must be labelled and that the scaling must appear for this detail. Sometimes this specific detail may be typical of a number of similar assembly points. If this is the case place a statement in brackets below the label stating for example: (TYP. X 12); or (TYP. ALL ROUND) etc.

7.4 Dimensioning

The only dimensions necessary in General Assembly Drawings are overall “X”, “Y” and “Z” dimensions for quick understanding for packaging and/or scale. Generally other dimensions are not given since they will appear in the Detail Component Drawings for each individual part.

7.5 Identification of individual components

All of the components that make up an assembly must be indicated. These will appear in the Pats List. If there are repeat parts, which are obvious to the reader of the drawing, these will only need to have one part labelled. Try to align the identification balloons as far as possible for ease of legibility. The balloons should be +/- 10mm to 15mm in diameter and use a 0.7 mm line thickness with the numbering centred in the balloon. The leaders for these balloons will be +/- 0.25mm with either an arrow pointing to the balloon or a solid dot. Note: the same balloons must also appear in the PARTS LIST block so make them a size that will fit well in the page ***and*** in the PARTS LIST. It may not be necessary to balloon parts that appear more than once unless there are a number of similar sized components and not labelling each one could lead to confusion.

7.6 Parts List

The Parts Lists will appear in General Assembly Drawings and Exploded View Drawings only.
These lists are to give comprehensive details of all the components that make up the products assembly. ***All of the parts in the General Assembly must be listed.*** All of the parts must also be shown either through sections where there is a more complex assembly or through a variety of different views allowing the reader to see all the components. Only when components repeat themselves, and this is obvious to the reader, do you not need to show these. Typically this might be a screw that is repeated several times in the assembly etc.

Where the design includes moulded clips or clever assembly mechanisms that work across more than one part – these need to be explained in the General Assembly Drawing in their assembled format. Details of dimensioning etc. will appear in the Detail Component Drawings.

The parts list block will have a title: **PARTS LIST**
It will be divided up into 5 blocks titled:

7.6.1 KEY

A number for each part number, starting at “1” – this will appear in balloons underneath this column - +/- 10mm to 15mm diameter.

7.6.2 TITLE / DESCRIPTION (Specification)

A title for the newly designed part or if it is a specified (standard) item then the following applies:

In General Assembly and Exploded View drawings we often use components that are shelf bought standard items (machine screws, self tappers, nuts, bolts etc.) and on occasions parts which will be obtained only from specification manuals (inserts – PSM etc., castors from a variety of companies, ports from electronics manuals etc.) these must all be specified to a precision that will ensure that your design includes the correct components.

Standard shelves purchased items are relatively easy to specify:
E.g. bolts: **STANDARD BOLT M6 X 24mm**, where the "**M"** stands for metric; "**6"** refers to the bolt thread diameter; and "**24mm"** is the length of the bolt from shoulder to tip. Occasionally the bolt may require the thread to run a shortened length or a special type of head; this will also be described in the **Description** block in the **Parts List**.

Other types of standard fasteners can be referred to in the same way, but the designer must indicate exactly what type of fastener and the head type that is being referred to. Examples: machine screws, wood screws, Alan cap screws, chipboard screws, self-tapping screws etc. All of these can come in a variety of head types: pan head, countersunk head, dome head, Phillips head, carriage bolt etc. Additionally reference must be made as to what type of material this standard item is to be made of – this will depend on its application and the environment into which this product will be placed. Typical materials include mild steel, galvanised mild steel, stainless steel, titanium, brass etc.

When referencing in specialised items the name of the type of product must appear in the **Title / Description** block in the **Parts List** followed by manufacturers' details, reference numbers etc. In the **Drawing Reference No.** column The material the specified component is manufactured from must also appear complete with special finishes where necessary in the **Material** column.

The manuals used usually indicate how to specify these sorts of items, however the designer must indicate from which company the item is referenced from and in some cases the year the manual was published. Getting details like this right will save the client and the designer all sorts of problems later if any dispute arises.

7.6.3 MATERIAL

Describing what the part is made of – gives full names to materials. If this is a PC Board for example then leave this blank.

7.6.4 DRWG REF. NO. (Drawing Reference Number)

For designed components a drawing number that fits within your set. If the part is a standard component a part reference number may be placed within this area.

7.6.5 NO. OFF (Number of times the same component is repeated)

Will describe how many of these parts are to be used in this particular assembly.

The parts list is usually placed in the top right area of the drawing page and will be listed from 1 at the top down.

Note: Parts Lists will only appear in General Assembly Drawings, Sub Assembly Drawings, Exploded View Drawings and occasionally Engineering Sketches.

PARTS LIST				
KEY	**TITLE/DESCRIPTION**	**MATERIAL**	**DRWG REF. NO.**	**NO. OFF**
1	SCOOTER BASE	ABS	UJ/05/03/01/002	1
2	WHEEL HUB	STAINLESS STEEL	UJ/05/03/01/003	2
3	COUNTERSUNKHEAD MACHINE SCREW – M6 X 60MM	MILD STEEL	STANDARD COMPONENT	6

7.7 Notes

Use notes to describe as much as you think is necessary within the context of the General Assembly. Remember that comprehensive information of the individual component details will appear in the Detail Component Drawings – but the reader of the drawing must be given a complete understanding of all details of the assembly of the product.
The notes that appear here will include information such as: all dimensions in mm. any information on cross-referencing other drawings such as Exploded View Drawings, possibly an indication of where some of the standard components come from and other general information that might be useful when over-viewing the design assembly.

8. EXPLODED VIEW DRAWINGS

With the progresses in 3D CAD software it is now relatively easy to produce three- dimensional Exploded Views. These are very useful in allowing the reader to easily see each individual component that makes up an assembly of a design

The engineering rules are still in development, but as designers we could say that these are Technical Illustration drawings that could be used to describe how the design is going to be put together. Therefore, when deciding how best to layout your Exploded View try thinking about a first time reader of your drawing and what will be the easiest and most descriptive way of allowing them to understand the assembly of your product. Try to keep the layout in the format that the component would be used in. Move to a larger format if necessary.

8.1 Parts List

In the same way that the General Assembly Drawing has a parts list an Exploded View Drawing will have exactly the same Parts List. Each component will be numbered with its balloon (preferably all in a vertical line) and these balloons will appear next to the components name etc. in the Parts List. All information in the parts list should be identical to the General Assembly Drawing.

8.2 Centre Lines etc.

Centre lines (long dash, short dash line) on an exploded view should indicate how the part was exploded - screws are very easy to work with: a centre line through the centre of the machine screw directed into its accompanying hole. Try not to have the centre line drawn through the components but rather stopping each side as it goes through the component. Do not use an excessive amount of centre lines to avoid confusion.

8.3 Technical Illustration type line work

For clarity it would be good if you could vary the line thickness in this exploded drawing – i.e. shadow line with 0.7mm line used as outside thickness line and 0.35 used for all facing surface lines. No hidden lines should be shown.

8.4 Use of Perspective

Where possible (if the CAD programme is capable) use perspective in a sensitive way in the drawing. Traditionally isometric drawings were used because the drafting practice had a simple means to do this. With CAD the designer is able to convert the solid models into visually pleasing perspective drawings. Try not to over exaggerate the perspective as this may confuse the entire drawing. Choice of views is left to the discretion of the designer, but bear in mind that this drawings purpose is to explain how the object is assembled using a three dimensional environment.

8.5 Detail Views

You ***cannot*** show a Detail View of a 3 dimensional part.

9. GENERAL RULES FOR DETAIL ENGINEERING DRAWINGS

9.1 Plan and design your drawing layout to assist the reader to clearly understand what you are trying to describe. Choose areas or views to completely describe certain aspects of your design.
9.2 Do not draw views that are unnecessary.
9.3 Draw only half a symmetrical part when space doesn't permit for a complete view to be shown.
9.4 Draw the basics of standard components and list them in specification and Parts Lists.
9.5 Do not overcrowd a drawing with too much line-work (leave out all hidden detail – it only serves to confuse the reader).
9.6 Make sure (as economically as possible) that the views you choose describe your product completely.
9.7 See that the chosen scale of the drawing is large enough to show all details clearly – if your drafted drawing is larger than 1:1 include at least one 1:1 detail of the complete component for scale reference.
9.8 Make sure dimensions used describe the component completely – but do not duplicate any dimensions.
9.9 Use one datum for each of the three axis – i.e. X, Y and Z.
9.10 Use Reference Datum's only in exceptional circumstances.
9.11 Make sure your specifications for surface finish and tolerance are not over engineered for your product (value engineering).
9.12 Use written description in place of drawing wherever practical.
9.13 Add three-dimensional views of the objects to clarify the product to the individual reading the drawing – often both a top three-dimensional view and an underside three-dimensional view will be necessary.
9.14 Label any views that fall outside the orthographic sequence. You cannot include sectional views within the orthographic sequence, place these outside of this area and give a label for this view. This labelling will apply to three dimensional views. In the area where a three dimensional view is shown label this view and make sure that DO NOT SCALE is included under this label.
9.15 Use SABS standards throughout drawings – even on the computer generated drawings use only the standard typefaces, dimensioning etc. that are recommended by the SABS 0111.
9.16 All type in an Engineering Drawing is UPPERCASE only.
9.17 Fold drawings in the correct manner prescribed

10. MODEL MAKERS DRAWINGS

Model Makers' drawings are developed by designers for several reasons:

- to test the principal of a designed mechanism, button etc.;
- to be able to decide in conjunction with a client whether a chosen design direction is correct or not;
- to evaluate surface finish and exacting details accurately before committing to tooling;
- to be assured that the design and workings actually physically work out before spending money on final tooling etc.

It is very important for the designer to treat Model Makers drawings as a set of drawings that will be used by a specialist prototyper. The language used in a Model Makers drawing must be as official as with any other Engineering Drawing document and must clearly state the designers' intent in any situation i.e. the control of the outcome must be defined by the designer. All relevant dimensions must be in place – the prototyper should not need to contact the designer for any additional information. The designer may be the prototyper at this institution, but the quality of drawings must be of high enough for a third party to manufacture the prototype.

Please be aware these drawings are officially part of the project you are working on and as such will require a fully detailed Title Block, with relevant drawing numbers etc. Your client will be paying for the time it takes to produce these drawings and good practice may require for your client to receive a full set of your Model Makers drawings for their perusal before the prototype is manufactured.

For our purposes we will define the following typical Prototype categories and how and when you, as the designer, will use them as well as describing what will be required as an outcome for a Model Makers drawing for each of the categories.

The categories include:

- ***Block Models***
- ***Visual Appraisal Block Models***
- ***Component Testing prototypes***
- ***Working Prototypes***
- ***Market testing prototypes***

10.1 Block Models

10.1.1 Typical uses

Block Models are typically used to test the physical size of the product and its overall aesthetics – a visual diary for you and your client to evaluate the solution at a reasonably early stage in the design process. The Block Models will usually present the design intent in a basic form – to accurate scale with very basic detail shown. It is also unlikely to be highly finished – some details may even be pasted onto the basic blocks as printed graphics. The innards of the design will not be shown at all – only outside form.

10.1.2 Typical Model Makers drawings for Block Models

The product is likely to be drawn as a whole unit – with specific instructions for the model maker to follow in terms of what materials to use in the production of the model. Typical Model Making materials used for a block model are: Polyurethane foams, Styrofoam, cardboard, foam board, Supa wood etc. The materials may not simulate the finished product materials but the Model Makers will need to be informed of how to go about producing your intent.

2D drafted drawings of the outside form – can be traditional drafting process (pencil or pen on paper or could be the product of a CAD drafting package (2D).
3D sketches – accurately produced three-dimensional sketches showing basic form and using a system of defining all the relevant data for the model maker to carry on with the production of your prototype.
3D solid or surface models of the outside form only – these could be translated into isometric style drawings with dimensions placed in the CAD package or drawn on the printouts afterwards for clarity.
3D solid or surface models drafted into 2D drawing format – typical of most drafted drawings. (Includes 3D views for clarity – back 3 quarters, front 3 quarters, underside 3D view, and top 3D view etc. – whatever it takes to make sure there is no misinterpretation of your design)
All of the above could be used in a mix for the final drawings.

10.2 Visual Appraisal Block Models

10.2.1 Typical uses

These prototype are used to accurately depict surface finish, details etc. of all first impression visual details of a design. The intention is for the designer and client to make informed decisions on colour surface finish and detailing in a 3 dimensional format. Size, scale and proportion must be 100% of the designers' intention. Finish and texture must simulate the final design as accurately as possible. Details must be addressed to finish the design off accurately. Inside and non-visible details are not usually dealt with in a Visual Appraisal Block model unless there are areas that require clear materials – then the visible information under the skin will need to be developed accurately as well.

10.2.2 Typical Model Makers drawings for Visual Appraisal Block Models

This product is also likely to be drawn as a complete unit – with indication for split lines, materials changes etc. will look like. Essentially it is up to the designer to show how the model is going to be made. Make sure that you control the outcome of your design intent.

Clear notes and written instruction will keep the model maker on an accurate path.

2D drafted drawings of the outside form – can be traditional drafting process (pencil or pen on paper or could be the product of a CAD drafting package (2D).
3D sketches – accurately produced three-dimensional sketches showing basic form and defining all the relevant data for the model maker to carry on with the production of your prototype.
3D solid or surface models of the outside form only – these could be translated into isometric style drawings with dimensions placed by CAD or drawn on the printouts afterwards for clarity.
3D solid or surface models drafted into 2D drawing format – typical of most drafted drawings. (Includes 3D views for clarity – back 3 quarters, front 3 quarters, underside 3D view, and top 3D view etc. – whatever it takes to make sure there is no misinterpretation of your design)
All of the above could be used in a mix for the final drawings.

10.3 Component Testing Prototypes

10.3.1 Typical uses

These prototypes are used for the testing of designed mechanical solutions. The configuration of these solutions often needs real testing before they can be integrated into a complete design solution. Examples of these component-testing prototypes would be a new hinge, button design and feel, doorknob, dial system etc.

10.3.2 Typical Model Makers drawings for Component Testing Prototypes

These components will require very accurate component detail drawings to define the object completely. Accompanying this is likely to be a set of General Assembly Drawings that will show the set in a rest position as well as showing how it will be manipulated.

Drawings required – complete set of drawings GA, Exploded View and full set of Detail Component drawings. These drawings will be produced on CAD in solid or surface modelling and tested within the computer system before finite drawings are produced. Often these CAD models will be translated to be produced as Rapid Prototypes – CNC, Stereo lithography, Laser Sintering, Fuse Deposition Modelling, Laser Cutting, Water jet cutting etc.

10.4 Working prototype

10.4.1 Typical uses

These prototypes will be used to test a complete system – examples are: a product that has a pc board, buttons etc., complete fridges, speakers, telephones etc. any product that is a single component or works in conjunction with several other components.

These prototypes are usually made before production and tooling takes place – the reason for this is to confirm all areas of the product are working 100% before committing to expensive tooling.
These prototypes can be made through the various Rapid Prototyping processes or by hand, either way, a comprehensive set of engineering drawings will be required. These drawings will include a General Assembly and Exploded View of all designed components as well as Detail Component drawings of all other components that make up the assembly of this product.

Often this stage would be close to the end of the design process and most visual details will be completely sorted out, but it must be emphasised that this prototype is mainly used for interface testing and assembly testing and may not replicate the visual details of surface finish, texture, colour etc. and other aesthetic solutions.

All the geometry inside and most of the outside will be detailed accurately. This will be used to test the product as a complete system or unit. The engineering drawings will be 3D solid or surface modelled CAD with full drafted engineering drawings generated for cross referencing finished work and checking location of parts, bosses, ribs, cut-outs, bolts, nuts, inserts etc.

All drawings and the solid model will be tolerance accurate.

10.5 Market testing prototypes

10.5.1 Typical uses

Exact replica of final design – every detail sorted out 100% inside and outside. Essentially the drawings and model used to create this prototype will be used in final production. This is a way of testing the market reaction to the product before it is launched. Often clients will have this stage produced while tool making is progressing as a way to verify colour choices, surface finishes etc.

This can only be done through a CAD generated Solid/surface model which will be used for Rapid Prototyping or for exceptionally accurate handmade models to be produced. The set of Engineering Drawings produced for this stage will be production ready GA, Exploded View Drawing and comprehensive Detail Component Drawings.

The same accuracy as expected for final set of production ready Engineering Drawings would be expected. This is usually a grown prototype or machined prototype. Soft tooling is usually developed from the original model (if plastic) or light tools (pressings etc.) are specially manufactured to produce the number of prototypes required. Prototypes will be produced that accurately depict colour, texture, surface finish etc. as well as being absolutely accurate internally and externally.

11. DETAIL COMPONENT ENGINEERING DRAWINGS

All Engineering drawings are legal documents – if a manufacturer or toolmaker makes a mistake the Engineering Drawing serves as your protection against prosecution – you must have absolute confidence that what you have produced cannot in any way be misinterpreted.

Detail Component Drawings will include a Title Block, an Issue Block, a Notes area, and a Surface Finish Table. There will be no Parts List in a Detail Component Drawing.

Please note that only one object can be describe on a Detail Drawing - sub-assembly drawings are a form of General Assembly Drawing, they are not detail drawings.

11.1 General Rules for Detail Drawings

When laying out the design of an Engineering Drawing: Detail Component Drawing think about the individual reading the drawing. Place yourselves into their position. The best way to do this is to imagine that you are required to make the product being detailed in the workshop. The choices of datums should be areas it's easy to work from: flat faces of the product, centre lines of the products or the centres of major holes, centres of integral hinges etc. The dimensioning should reflect some thinking about easy ways to read the drawing and a sensible process that the drawings can be read by.

Some guidelines:

Do:	**Don't**
Use centrelines, flat areas, split lines, centres of holes as datums.	Don't choose the edge of radii, the top area of a draft taper away from the split line, an angled face as your datum.
Choose datums that make sense.	Don't place datums arbitrarily.
Use reference datums sparingly – only when it's impossible to work from your normal datums. Give a title on the line: REFERENCE DATUM and not a datum dot here.	Don't call a datum a reference datum just because it happens to be in a detailed area.
Use only three datums: X, Y and Z	Don't switch datums between views.
Use standard orthographic system: third angle for all drawings done.	Do not give a third angle orthographic projection symbol and the show first angle drawings.
Place isometric drawings onto the page, with the title: ISOMETRIC DRAWING (sometimes this could be ISOMETRIC BACK/FRONT VIEW) etc. with DO NOT SCALE underneath this title.	Do not place an isometric drawing and not label it individually or place a scale underneath it.
Take details of the views to explain the component where necessary.	Do not take out details of isometric views and try to use them to explain a part. Do not take out a detail and not use it. Do not show views you are not going to use to give information on.
Try to use a scale that makes sense for the product being detailed. If it's a very small scale object use a much larger scale.	Don't try to detail up tiny parts – it is difficult to read and difficult to work from.
Place as many views as is necessary to describe the part completely. Go to a larger size piece of paper if needed.	Don't try to squash everything into one view – spread this out.
If you need two pages to describe a component use them. Make sure the second page has the	If going to a second page: SHEET 2 OF 2 – do not have section information on the previous page –

same drawing number as the first and that you describe the sheets used in the sheet number areas i.e. SHEET 1 OF 2 on the first page and SHEET 2 OF 2 on the second.	each page must be independent and give its own sections where necessary.

11.2 How is a Detail Engineering Drawing Checked?

11.2.1 The Title Block and borders are checked to see if numbering, titles and general information matches the General Assembly and Exploded View Drawings.

11.2.2 The notes are checked to see if they make sense for the product and gives all relevant information for specifications we won't automatically see on the drawing itself: materials, colour, general tolerances, what system the drawing is done in i.e. mm/inches, orthographic projection and then information about quality control, references for interfacing components etc.

11.2.3 The drawing is checked to see that it doesn't have irrelevant information or information that should appear on a different type of drawing all together: Parts List, prototype manufacturing list etc.

11.2.4 Is there a set of three dimensional views that give quick reference to what the inside and outside of this product looks like.

11.2.5 Are the datums well laid out? Has the designer chosen datums that make the most amount of sense for this particular product? Have centrelines been used as datums, flat and easy to work from areas, centres of integral hinges, centres of larger holes, interface areas that will work well with both components (if this component works with another in assembly) etc.

11.2.6 Then moving onto the drawing itself: The page is looked at in terms of how the designer has laid out information: how easy is it to read the parts, has the designer used the corresponding orthographic project (should only be third angle), has the designer used enough views to competently show the parts and reveal their details without making the drawing too complicated, has the drawing been overcrowded with dimensioning etc.

11.2.7 Has the designer started on top left and given the very basic outside dimensions for quick reference and then worked towards the bottom right of the page with more complicated detailing?

11.2.8 Has the designer then carefully chosen what each view will inform the reader about the product. Is there an overall description of the outside form given in an outside top view and outside side and front view (where necessary)? Is there an inside view that give all information about ribs, bosses and other components hidden inside the product. Does the inside view have sectioned areas to reveal heights of ribs and bosses where we cannot automatically see this in other views.

11.2.9 Are there details to reveal what smaller areas of the product look like and if these are remote from the normal datums are there relevant reference datums to these areas. In detailing does the bubble have a note attached: SEE DETAIL "A" etc attached to it and in the detail itself is there the title: DETAIL "A" and the SCALE attached underneath. If the detail is part of a system of many such details is there information about TYP. ALL ROUND (in the case of a dogleg or edging) or TYP. X 20 (in the case of a repeat detail) etc.

11.2.10 Are there corresponding X and Y dimensions to each point on the product and are these located in the same area?

11.2.11 When dimensioning large radii has the designer used the intersection reference points and not the edges of blend radii.

11.3 Views

Show at least one isometric drawing for clarity. The isometric view may show the inside and the outside of the individual component. This helps as a quick reference for the reader of your drawing to understand what is going on and how details are placed.
Also try to include at least one 1:1 scale view if you are drawing the object in a scale outside of this.
Be economical with your views, do not generate redundant views that show nothing in particular or are used for only one or two dimensions. Remember to layout your drawing, as clearly as possible – as a designer you must think of how best to allow the reader of the drawing a way of understanding your drawing thoroughly, without the possibility of misinterpreting what you want to say. Try to figure out what each view is going to describe – i.e. set your drawing out so that a view fully describes outside form details, perhaps a second will show cut-outs and holes, another will describe only the ribbing and boss location inside or outside the product etc. This clarity will help you to make sense of your own drawing as well as allowing the reader to quickly understand dimensions and details.

11.4 Detail Views

Detail views are ballooned areas that are used to scale up details in order to clarify a portion of the drawing. The CAD programme will perform this operation fairly easily, but may include its own format for Detail Views. You are required to change this to the following format:
For Detail Views an arrow line is pointed to the broken line circle that surrounds the detailed area and at the end of the leader a clear statement indicates: SEE DETAIL "A" or whatever detail number is being discussed. Note: the details are only ever indicated in lettering and always start from "A" in each drawing. Below the area where the detail is shown a label will appear: DETAIL "A" and the underneath it will be SCALE: 2:1 or whatever scale you have increased this detail to. Be aware that the detail must be labelled and that the scaling must appear for this detail. Sometimes this specific detail may be typical of a number of similar assembly points. If this is the case place a statement in brackets below the label stating for example: (TYP. X 12); or (TYP. ALL ROUND) etc.

11.5 Sections

Never show any hidden line in a Detail Engineering Drawing – use sections to allow the areas to be described thoroughly. Even if it is necessary to show complex section details – this is the most acceptable way of revealing details normally hidden by sidewalls. Manufactured details are often hidden beneath the outer surfaces of a component therefore use the correct sectioning details to open up the part for the individual reading the drawing to understand where each detail is located.
Section views can be straight lines or could be slightly more complex lines that change direction at 90° with thicker leaders. These must however not be too confusing for the reader and as far as possible must go through obvious detail areas.
For section views a solid and thick line type arrow is used to show the direction in which the section is being shown. Lettering will appear indicating the section being shown e.g. "A". The first section in a drawing will always be "A". The sectioned view will only ever be placed in the same layout as the section indicated (never at 90° to its section direction). Below the sectioned view a label will appear: SECTION "A-A" etc. no scaling factor will appear, as section views are not generally scaled up or down. ***A sectioned view will never appear within the main orthographic views; it will appear outside of the three main views.*** Sectioned areas will have section lines through the wall thickness of the material being sectioned – these section lines are only ever evenly spaced lines of a line weight of +/- 0.25mm and at 45° or -45° to the page vertical.
Use the sectioned area to clarify its geometry. Use reference datums if the parts' "X", "Y" or "Z" datum is remote from this area (see Reference Datums for clarity). ***Be aware that you cannot section through a rib – give the section for a rib just outside of the ribs thickness.***

11.6 Datums

There are three major datums on a detail engineering drawing for the "X", "Y" and "Z" axis. These three datums will be used to generate all the dimensions from. On occasion a detail bubble will be required to describe an area remote from the datums – in this case a reference datum will be generated to generate the geometry for this area.
Datums are annotated with a +/- 3mm diameter blackened/filled circle appearing on both ends of the datum in all views – this is the datum dot and can easily be spotted when working with a detail engineering drawing.
Centreline as a datum: often if the part is more than 90% symmetrical it makes sense to use the centreline as a datum – in this case the symbol for centreline will appear at both ends of the centreline and a datum dot will not appear on this particular datum line. The symbol for centreline is an uppercase C with an L placed so the L starts at the centre of the C.

11.7 Reference Datums

Reference Datums are used in the case where a Detail View is shown and the regular "X", "Y" or "Z" datums are remote from it. In this case a reference datum will be set up. This datum will work off a set of dimensions given from the major datum in the main drawing view with the suffix (REF.) – if you require two reference datums in that detail area both will have their dimensions followed by the suffix (REF.) e.g. 201.00 (REF.). The Reference Datum in the Detail View will itself have a label REF. DATUM written on it. The reference datum line will be a centreline type line.

11.8 Tolerances

Give tolerances to intersecting parts where appropriate i.e. where two components are connected together in the assembly process. A general tolerance in the Notes Block will automatically help the reader to understand the accuracy to which you expect the product to be produced. Giving specific tolerances in interface or vital areas should secure the accuracy for that area.

11.9 Surface Finish Tables

Surface Finish Tables are used to indicate the exact surface finish required in a specific location on the product. Please not: Surface Finish Tables will appear only in Detail Component Drawings.

The table has a heading: SURFACE FINISH TABLE, sub-headings: SYMBOL and DESCRIPTION and in each of these areas you will indicate the specifics of the finish you require.

If the product has a complex area in which a texture needs to follow a specific geometry then show this by means of a broken line around the geometry – this will also need to be properly dimensioned.

When describing surface finishes for injection moulded products there are a variety of options available to the designer. Injection moulding allows for a number of standard finishes as well as a huge number of specialised finishes. For the specialised finishes like leather grain, in mould mapping etc. you will specifically need to research the naming conventions. For all other standard finishes such as spark eroded, highly polished, satin finish or milled the format is as follows:
SPARK ERODED FINISH – will require a reference number as to the type of finish as well as a reference name from whom you are referring to (usually the manufacturers of spark erosion machines e.g. CHARMILLES 33).
HIGHLY POLISHED and SATIN FINISHES will require an indication in terms of the arithmetic mean deviation of the surface indicated by Ra and measured in microns.
E.g.: HIGHLY POLISHED – Ra = 0.5 MICRONS.
MILLED FINISH will obviously have a higher Ra rating e.g. Ra = 5.0 microns

It is noteworthy that a typical spark eroded finish of Charmilles 33 = +/- Ra 3.5 microns

The following is an example of a typical Surface Finish Table:

SURFACE FINISH TABLE	
SYMBOL	**DESCRIPTION**
A	HIGHLY POLISHED – Ra = 0.5 MICRONS
B	SPARK ERODED FINISH REF. CHARMILLES 33

Note: the surface finish symbol is a double triangle with a letter appearing inside it

11.10 Value Engineering

There are a number of incredible books written on various aspects of Value Engineering.
For our purposes we will deal with Value Engineering only in terms of how you design your product cleverly to reduce costs to the consumer.

If internal surfaces are not going to be seen – then they don't require high levels of finishing. Think about the simplest methods possible to assemble your designed products – this will save time on the assembly line. Reduce the number of components in your assembly – try not to over-engineer where it is not necessary. Where possible use only one type of standard screw, machine screw, insert etc. throughout the design – reducing the variety of stock items will help both the store keepers/buyers and the assembly line. Reduce wall thickness of materials that are being used – this will save material costs as well as reduce wastage. Think carefully about what happens to the product at the end of its life cycle – in many countries it is expected that the manufacturer will dispose of their own products once its time is up.

11.11 Dimensioning

All dimensions must work off datums.
All dimensions must include trailing zeros – i.e. 200.00
Try to simplify the geometry you are working with – it is highly unlikely that toolmakers will work with dimensions that are accurate to one hundredth of a millimetre therefore try to keep your dimensions fundamentally simple e.g. 25.42 would probably be better as 25.50. (This discrepancy could be because you are not using the CAD programme correctly or not snapping to endpoints, centre points etc.) Try to design your components with slightly simpler geometry – the visual difference between 0.25mm and 0.50mm will be very difficult to pick up.
Always give both axis dimensions to their respective datums in the same area. E.g. “X” and “Y” or “X” and “Z” or “Y” and “Z”.
Do not repeat dimensions, unless this will help to clarify a specific area.

When dimensioning radii try to use a start and end point system – where you dimension in both axis from the datum lines to the start and end of the arc.
Do not do this in the case of a corner or break radius – a point of reference might be any dimension less than 15mm. Do not give the start and end of the break radius – rather give a dimension to the intersecting corners.
In the case of a large radius intersecting in a corner with a small break radius - use the reference point of where the intersecting lines in that corner will meet. Give the “X” and “Y” dimensions to this reference intersection point. Give the overall radius dimension and the break radius dimension.

11.12 NOTES

Included in the NOTES must be all the information pertaining to:

- Material description e.g.: MATERIAL DESCRIPTION: POLYPROPOLENE (PP)
- Colour e.g.: COLOUR: RED (PANTONE REF.: 185) – there are other possible colour reference systems: COATES, DULUX etc. Pantone is the most commonly used though.
- General Tolerances e.g.: GENERAL TOLERANCE = +/- 0.5mm (UOS)
- General Wall Thickness’ (where appropriate) e.g.: GENERAL WALL THICKNESS = 2.40mm (UOS)
- Ribbing dimensions are give at their root e.g. RIB DIMENSIONS = 1.20mm (AT ROOT) (UOS)
- Surface Finish – REFER TO SURFACE FINISH TABLE
- Any cross-references to other drawings – if the drawing needs to be read in conjunction with another drawing etc. DRAWING TO BE READ IN CONJUNCTION WITH TWR/02/01/002 – CALCULATOR BASE DETAIL DRAWING
- ALL DIMENSIONS IN mm (especially when dealing with UK)
- Break radii information e.g.: BREAK RADII = R 0.5mm (UOS)
- For plastic components: All mouldings to be free of burrs flash and sink marks
Mouldings to be free of distortion and twists
- For metal components: All sharp edges, burrs etc. to be removed
Parts to be free of twists, pressing marks

For other materials look at problems that occur in the process and try to write a specification that results in the best possible product for your design

NOTES:

1. **MATERIAL DESCRIPTION**
2. **COLOUR**
3. **GENERAL TOLERANCES**
4. **GENERAL WALL THICKNESS’ (WHERE APPROPRIATE)**
5. **SURFACE FINISH – REFER TO SURFACE FINISH TABLE**
6. **ANY CROSS-REFERENCES TO OTHER DRAWINGS – IF THE DRAWING NEEDS TO BE READ IN CONJUNCTION WITH ANOTHER DRAWING ETC.**
7. **ALL DIMENSIONS IN MM (ESPECIALLY WHEN DEALING WITH USA, UK ETC.)**
8. **BREAK RADII INFORMATION**
9. **FOR PLASTIC COMPONENTS) ALL MOULDINGS TO BE FREE OF BURRS FLASH AND SINK MARKS, MOULDINGS TO BE FREE OF DISTORTION AND TWISTS**

12. RED LINING ENGINEERING DRAWINGS

Often it is required that in an office or studio environment that a colleague "red line" another's Engineering Drawing. This is done to ensure that the information sent out by a company for tool quotes, packaging costing or to be used by engineers does not embarrass the company or designer who was the original author of the drawing. This is also a good self-assessment system before handing your drawings in for marking.

A systematic approach to "red lining" the drawing works best:

12.1 Check ***page border*** – make sure the page is the correct size, all disclaimers are in place and the copyright information is correct.

12.2 Check and mark the ***Title Block*** paying special attention to drawing numbers, scale, title (that makes sense and is fully descriptive), company logo etc. (no lowercase).

12.3 Check the ***Issue Block*** – date, issue number and description.

12.4 Check ***Notes*** – that they are correctly descriptive and give all information not already seen on the drawing page – material, colour, tolerances, general wall thickness where appropriate, mm dimensioning, any drawings the product should be read in conjunction with, and any information that relates to the drawing that will assist the reader in fully understanding the components. For General Assembly and Exploded view drawings this will be reduced to only very general information.

12.5 Check ***Parts List*** – drawing numbers must be correct, if standard component then a full description of component with relevant references to where this comes from etc.

12.6 ***General Assembly Drawings***: check overall dimensions: overall/maximum height width and depth of object must be shown.

12.7 ***General Assembly Drawings***: must show sections to fully describe how the product is assembled – no hidden line. If the drawing requires more section these must be noted – this drawing is all about how the product assembles and this must be explained through the drawing***.***

12.8 ***Detail Component Drawings***: Check datums – only three: x, y, and z. these must make sense for the product – if no flat surfaces can be found then the datum will be through a boss, hole or rib. Datums will generally be where the product parts assemble together, if it's a single part then the datum will be around a split line or die cut edging etc.

12.9 ***Detail Component Drawings***: Check that the drawing is to the scale given in the title block, that the layout is in the correct orthographic projection (third angle only), that any additional views that are given have titles on the page, that there are 3 Dimensional drawings that allow the reader to understand the component easily, that all areas are titled correctly including scales for details and "do not scale" for 3 D drawings***.***

12.10 ***Detail Component Drawings***: Check that each of the views is used to fully explain an area of geometry. That there are enough dimensions and that they make sense. Check that the designer thought very carefully about clever ways to let the reader know about the geometry of each area of the engineered product. A good example of this would be to have the overall shape of the object described in outside views, with separate views for ribbing and bosses or internal structures; and still more views to describe inside forms that are hidden. Make sure the author has used the datums to give dimensions to all areas, and that the drawing is not too cramped and difficult to read.

12.11 The final responsibility for the drawing will be the authors as their name will appear on the drawing – good "red lining" can however save your company and the client millions of Rand if the drawing is correct. It will also save the embarrassment of smirking engineers, toolmakers and clients finding mistakes.