Student provided image of golfers
Image removed due to copyright.

SYSTEMS & CONTROL PRODUCTS

MAJOR PROJECT FOLIO

Student provided image of golfers
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Student provided image of golfers
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CONTENTS

INVESTIGATE (RESEARCH)

IDENTIFY THE CHALLENGE	3
DESIGN BRIEF	3
PRODUCT ANALYSIS	4
MATERIALS & PROCESSES	5
IMPACT ANALYSIS (3D PRINTING)	6

PLAN (DESIGN, TESTING & REFINEMENTS)

BRIEF REFINEMENT	7
PLAN	8-9
MATERIAL COSTING	10
CONCEPT SKETCHES	11-14
C.A.D. EVOLUTION	15
TEST MODELS & MODIFICATION	16-24
ENGINEERING DWGS/RENDERS	25-32
CREATING THE FINAL MODEL	33-35
FINAL CONCEPT MODEL	36

EVALUATE (CRITICAL ANALYSIS & RECCOMENDATIONS)

EVALUATION	37
REFERENCES & APPENDICIES	38-39

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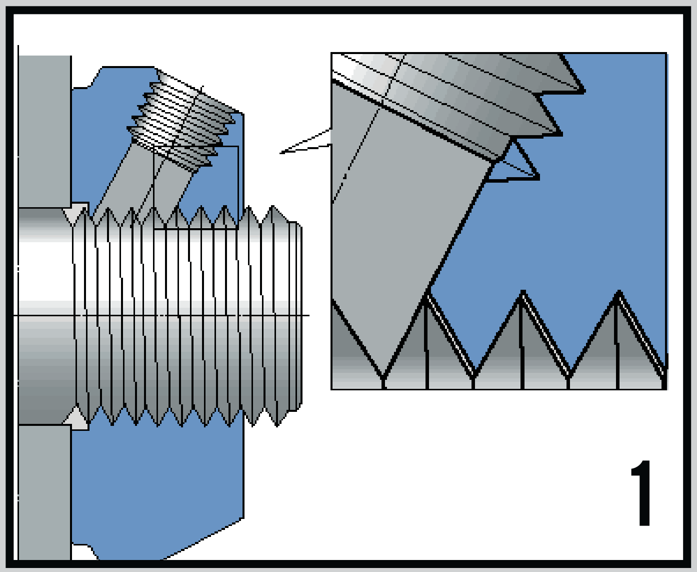
IDENTIFY THE CHALLENGE

Clear evidence of a well considered identification of a need has enabled the student to create an insightful design brief.

The excessive weight of a golf bag and all the clubs can be restrictive to manage when playing a casual round of golf. A solution to this problem would be to have a series of interchangeable golf heads (driver, irons, and a putter) fitted to one club/stick. A simple thread locking system will be installed on both the shaft and the head. This solution would reduce the amount of equipment required, & the overall sizing and weight of the carry case/bag.



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1 - Simple grub screw locking system.
2 - Various clubs & carry bag.
3 - Different types of possible carry cases that could be addapted.

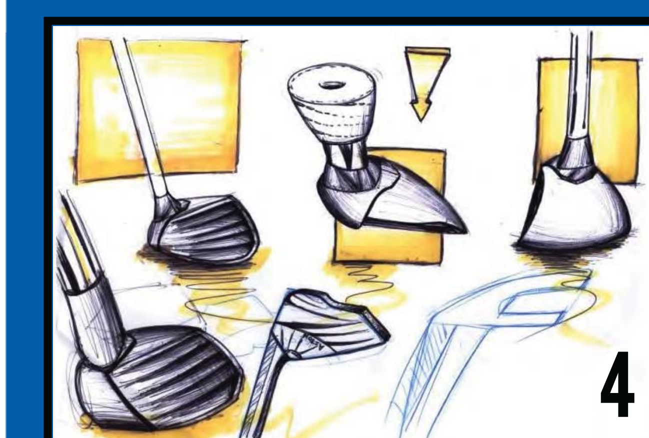
DESIGN BRIEF

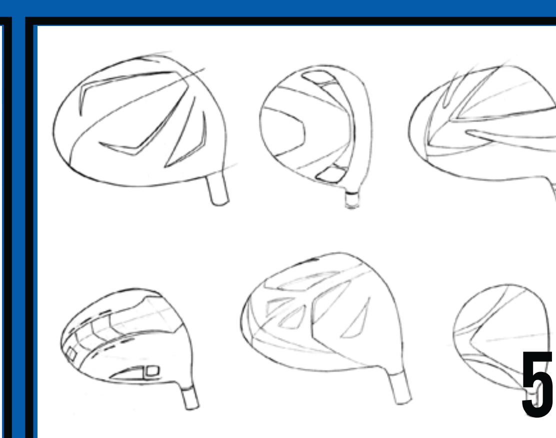
I intended to create an interchangeable golf club & carry mechanism that will irradicate the excessive weight of a golf bag. The solution will need to be functional as well as aesthetically pleasing. Following the guidelines below I will investigate and create a new concept for a traditional golf club/carry bag.

Table 1 - Research proposal, constraints and outcomes

Research Proposal	***Constraints***	***Outcomes***
• In depth product analysis • Material testing – CNC mill, 3D printing	• Restricted to $200 • 10 weeks constructing • Design will be limited to facilities • Golf heads manufactured in ABS plastic • Carry case in chemical wood (MD) • Actual size 1:1	• Produce one prototype carry case • Produce three prototype golf heads (Driver, putter, iron) • Produce a series of test models (Styrofoam, chemical wood, ABS plastic) • Club attachment system solution

CONCEPT SKETCHES OF A DRIVER





4 - 5 Concept sketches highlighting possible driver shapes

PRODUCT ANALYSIS

The information provided in the tables and associated images shows evidence of purposeful investigation of existing products. Critical analysis is provided in a summary below.

PRODUCT 1 – DRIVER

Image removed due to copyright

PRODUCT 2 – CARRY CASE

Image removed due to copyright

PRODUCT 3 – PUTTER

Image removed due to copyright

Table 2 - existing product analysis

	AESTHETICS (Colour, Presentation, Form... Is it visually appealing?)	COST Does this product offer good 'value for money'	CONSUMER Is the product suitable for the intended user?	ENVIRONMENT Is the product Environmentally friendly?	SAFETY Is the product Safe to use?	SIZE Is the product an appropriate size?	FUNCTION How effective is the product ?	MATERIALS Have suitable materials been used for the product?
Product 1	4	4 ($80)	5	3	4	4	5	5
Product 2	3	3 ($32.99)	4	3	5	4	5	5
Product 3	3	4 ($40)	5	3	4	4	4	5

Table 2 - Analysis of products rated from 1 to 5 on all key criterias.

Table 2 - ranking of importance

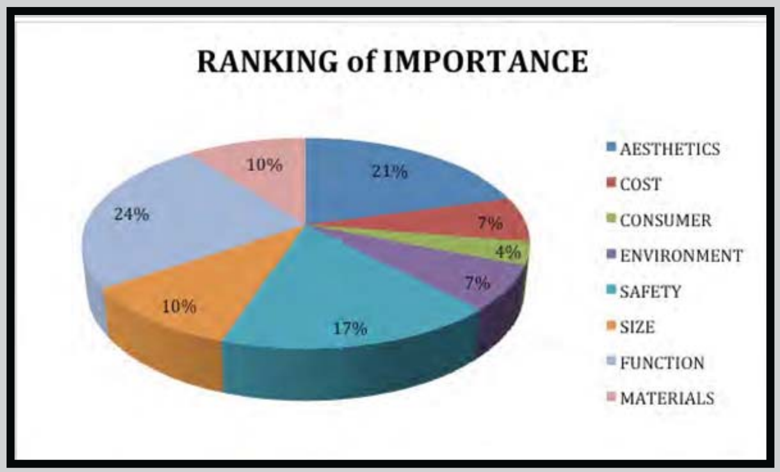
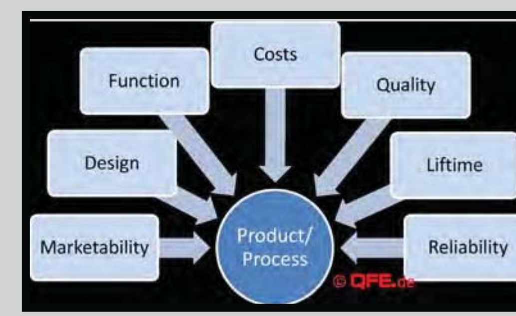


Table 3 - Represents the importance of each key criteria in a pie chart, with percentages to highlight what is the most important to the least.



Analysis summary: Safety, functionality and aesthetics are the key design features that have been identified as most important. Product 1 and 3 integrate slick design features and ensure that the product is safe to use. I consider functionality to be the most influential aspect on my project. The product may look aesthetically pleasing but it is critical that the product works as intended. Therefore I propose to incorporate these design features equally to ensure that my major product is highly successful.

MATERIALS & PROCESSES

Reference to materials testing, conducted previously, provides evidence of in-depth investigation.

A rigorous material analysis was conducted to demonstrate knowledge & understanding of relatively common manufacturing materials and manufacturing process'. The results produced were used to influence decisions on what materials and process' would be best to produce my major project.

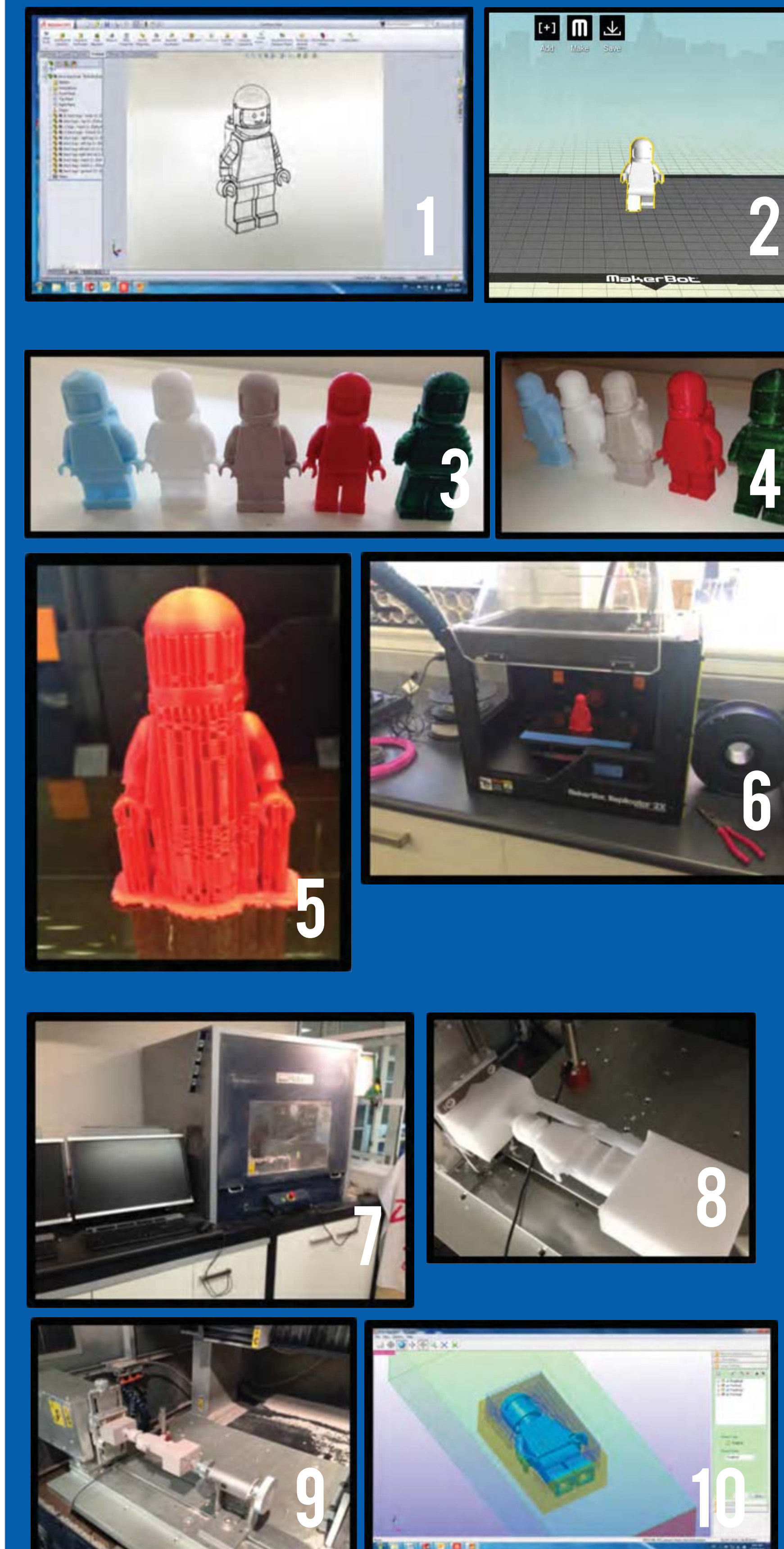
Table 4 - Material analysis

MATERIAL	MANUFACTURE METHOD	TIME	TOTAL SIZE (mm)	TOTAL WEIGHT	WEIGHT (part only)	COST (part only)	COST (total)	MATERIAL WASTAGE %	ACCURACY (to 3d model) %	POST PRODUCTION
ABS	Rep 2X (3DPnt)	3.0 hrs	39x25x67	32g	23g	$1.38	$1.92	28%	95%	Remove Supports
PLA	Rep 2X (3DPnt)	3.0 hrs	39x25x67	25g	22g	$1.32	$1.50	12%	20%	Remove Supports
CHEM WOOD (MD)	MDX-540 (CNC)	5.7 hrs	175x50x33	113g	23g	$0.82	$4.08	80%	70%	Cut Supports/ Sand
STYROFOAM (BLUE)	MDX-540 (CNC)	1.9 hrs	175x50x33	9g	1g	$0.06	$0.53	89%	65%	Cut Supports/ Sand
ACRYLIC	MDX-540 (CNC)	9.6 hrs	175x62x38	243g	45g	$0.43	$2.26	81%	70%	Cut Supports/ Sand

Summation of the material analysis concluded that Acrylonitrile Butadiene Styrene (ABS) plastic and Acrylic are the ideal materials for my major project. Supporting evidence can be located in Appendix 1 (located on USB). Testing results proved that these materials incorporate characteristics that are suitable for the product, as they provide strength and a flexible structure. However, material cost and manufacturing complexites (time/cost/resolution) may mean using chemical wood as a substitute for final concepts models.

*NOTE *All material used will have little impact on the environment.*

Critical analysis evident in the above comments.



1 - 10 [redacted]man material testing; styrofoam, acrylic, medium density chemical wood, ABS & PLA plastic.

IMPACT ANALYSIS (3D PRINTING)

3D printing is an innovative technology that is responsible for evolving modern day manufacturing. According to *Eric Duoss*, a materials scientist he believes that, "It's (3D printing) going to revolutionize manufacturing." *(Gaudin, 2014)* The purpose of this issues analysis is to investigate the impact that 3D printing has socially and environmentally. The analysis will offer insights into the controvercial world of 3D printing with the intention of determining what (if any) affects the manufacturing processes may have if used when manufacturing products associated with my major project.

The evolution of 3D printing over the past 10 years has been rapid (*Gilpin, 2014).* The last ten years have seen 3D printers become highly accessible to the wider community, thus negatively impacting on the core companies that focus purely on manufacturing parts using 3D printing. The innovative trend of having 3D printers within schools is becoming reality with the well-known company MakerBot announcing that they have formed a MakerBot Academy; with a mission to have a 3D printer in every school in the United States *(Gilpin, 2014).* Bre Pettis, the Chief Executive Officer of MakerBot stated that, "It can change the whole paradigm of how our children will see innovation and manufacturing in America." The Administrative Conference of the United States (ACUS) released a report in October 2011, outlining that this evolving technology is transforming many elements of the industry, from medical to education, music to manufacturing *(McCue, 2011).* Although 3D printing in schools in still relatively new, it provides students with hands on learning, allowing them to produce realistic prototypes and express there thoughts in a physical product *(Kharbach, 2013)*.

Prototyping and manufacturing using 3D printers within schools can stem to many different subject areas. Scientific subjects such as biology, chemistry and physics can all be associated with 3D printing. The construction of 3D cell structures, viruses, molecules and proteins allows students to physically piece together models assisting in a better understanding of the topic *(Andy, 2011).* As 3D printing evolves in education, the technology will progress allowing students to express all thought in a physical form.

With any new technology, 3D printing will come with its own environmental impacts *(Kovac, 2013)*. 3D printing allows objects to be customized to user choice, drastically improving waste. John Barnes, leader of CSIRO's titanium technologies research, says "using 3D printing to make fish-tracking tags saves up to 90 per cent of the waste generated by the conventional manufacturing process of machining solid metal blocks." *(Kovac, 2013)*

In-text referencing and a significant bibliography support the focused and perceptive investigation of the impact of a system on the individual and society.

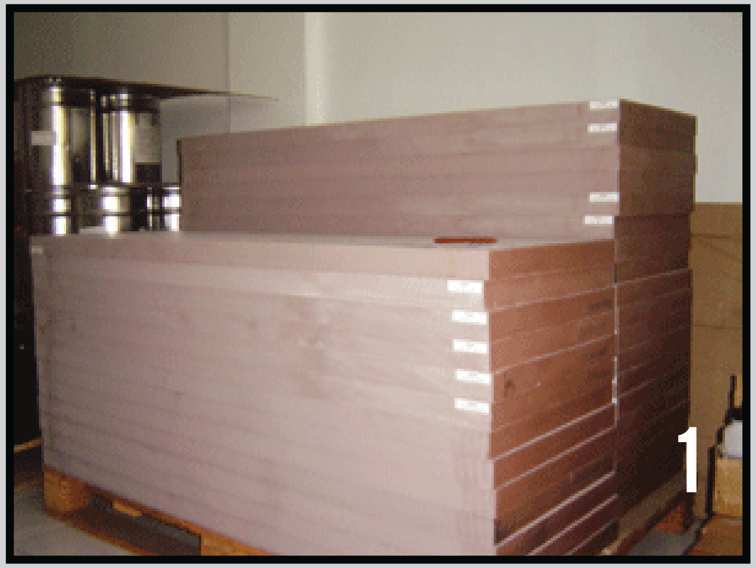
In 2008 a UK study highlighted that 3D printers are 50 – 100 times more 'energy hungry' then conventional injection moulding for similar objects. *(Kovac, 2013)* Contrastingly, Professor Pierce and his team's research on desktop 3D printing have shown that desktop 3D printers are defiantly not 'energy hungry.' (Kovac, 2013) Environmental impact can vary depending on the material that is used in constructing a 3D print. Acrylonitrile butadiene styrene (ABS) and Polylactic acid (PLA) are the two most commonly used plastics for 3D printing. ABS plastic has higher environmental impacts as it is petroleum based, whereas PLA is made from a biodegradable cornstarch (Plastipedia.co.uk, 2013). Environmental impacts of 3D printing will always vary depending on size, shape and material.

Societal shifts into the 3D printing world has highlighted some ethical implications. 3D printing doesn't have any rules and regulations in stopping someone from printing what they like. Weapons can be printed, parts for bikes, parts for cars, there are no occupational health and safety rules surrounding the printing of these items (Gilpin, 2014). This issue prompts the question in who is responsible if these items have a negative impact. If someone is shot dead or severely hurt with 3D printed weapon who is held accountable for the responsibility of this item? 3D printers can be used within a person's home leaving all avenues open to create items that may not be welcomed by society. 3D printing will highlight many ethical issues within society that need to be addressed before the world of 3D printing over takes manual manufacturing.

3D printing will positively impact many aspects of the technology world. All technology assisting society can be seen in a negative way but from investigating the educational, environmental and societal implementations of 3D printing it is portrayed as being a positive element to modern society. This issues analysis has allowed me to see many aspects of 3D printing and will certainly drive me to use all available 3D technology for my major project.

BRIEF REFINEMENT

Based upon my in depth research I will attempt to fulfill the initial brief to the best of my abilities. Once beginning my project it was identified that ABS plastic was not the ideal material, as manufacturing time was too long resorting to using a medium density chemical wood being manufactured in a Roland MDX-540 Computer Numerical Control (CNC) milling machine.



1. sheets of chemical wood, they are manufactured in 25mm,50mm and 100mm.

2. Roland MDX 540 CNC mill, which my project will be milled with.

3. CNC mill following a computer generated path creating the intended shape.

Table 5 - Brief requirements

TASK(S)	COMPLETED (✓)
Will not be a working model, but will be to scale and finished as per the design intent.	
Will use ‘functional’ locking mechanism(s)	
Will make only 3 clubs (driver, putter, iron)	
Carry case will hold all three clubs, including two golf balls and tee’s	
Magnetic connections between clubs and case	
Producing a serious of test models (styrofoam, chemical wood, ABS + PLA plastic)	
Budget of $200	

PLAN

WORK SCHEDULE

DATE (dd/mm)	**TIME est.** (min)	**TASK/STEP** (what will be achieved)	**MATERIALS NEEDED** (consumables)	**EQUIPMENT NEEDED** (resources)	**OUTCOMES** (amendments/notes)
21/7/2014	80	Brain storming possible ideas – Concept drawings	Paper	Blue pen, lead pencil	Rough ideas and small concepts
22/7/2014	120	Concept drawings - driver, putter, iron	Paper	Blue pen, lead pencil	Advanced concept drawings, including detail
25/7/2014	120	Concept drawings – including different locking mechanisms	Paper	Blue pen, lead pencil	Locking mechanisms placed into all different concepts and annotated
28/7/2014	120	SolidWorks – CAD drawing	Electricity	Laptop computer (SolidWorks)	CAD drawing all clubs
29/7/2014	120	SolidWorks – CAD drawing	Electricity	Laptop computer (SolidWorks)	CAD drawing all clubs
1/8/2014	150	Test model – Iron (material testing)	ABS Plastic	2X Replicator 3D printer	Adjustment of the angle of connecting piece
4/8/2014	120	SolidWorks – CAD drawing	Electricity	Laptop computer	CAD drawing all clubs - modifications
5/8/2014	150	Test model – iron (material testing i.e. quality)	Styrofoam	Roland MDX 540	Material testing – quicker method
8/8/2014	150	SolidWorks – CAD drawing	Electricity	Laptop computer (SolidWorks)	CAD drawing all clubs – modifications
11/8/2014	120	Test models + modifications (driver, iron, putter)	Styrofoam	Roland MDX 540	Testing different models of each club
14/8/2014	120	Test models + modifications (driver, iron, putter)	Styrofoam	Roland MDX 540	Testing different models of each club
15/8/2014	150	Test models + modifications (driver, iron, putter + locking systems)	Styrofoam, ABS Plastic	Roland MDX 540, 2X Replicator 3D printer	Testing different models of each club and locking systems
18/8/2014	150	Test models + modifications (driver, iron, putter + locking systems)	Styrofoam, ABS Plastic	Roland MDX 540	Testing different models of each club and locking systems
19/8/2014	100	Test models + modifications (driver, iron, putter + carry case)	Medium density chemical wood, Styrofoam	Roland MDX 540	Testing different models of each club and carry case
22/8/2014	100	Test models + modifications (driver, iron, putter)	Medium density chemical wood	Roland MDX 540	Testing different models of each club
25/8/2014	250	Test models + modifications (driver, iron, putter + locking systems)	Medium density chemical wood, ABS Plastic	Roland MDX 540, 2X Replicator 3D printer	Testing different models of each club and locking systems – close to finalizing

PLAN (CONTINUED)

26/8/2014	200	Test models + modifications (driver, iron, putter)	Medium density chemical wood	Roland MDX 540	Testing different models of each club
29/8/2014	200	Test models + FINAL modifications (driver, iron, putter)	Medium density chemical wood	Roland MDX 540	Final touches of modification of each club
1/9/2014	540	Milling + printing of final clubs (driver, iron, putter)	Medium density chemical wood, ABS Plastic	Roland MDX 540, 2X Replicator 3D printer	Final milling and printing of clubs ready to hand sand etc.
2/9/2014	200	Printing of final locking system (thread lock)	ABS Plastic	2X Replicator 3D printer	Locking system printed in ABS plastic – thread works well
5/9/2014	120	Removing of tabs off all clubs – hand sanding, spray puttying, wet rubbing	Medium density chemical wood, ABS Plastic	Ban saw, sand paper, spray putty paint, wet rub sand paper, paint	Manual application to products
8/9/2014	120	Hand sanding, spray puttying, wet rubbing and painting	Medium density chemical wood, ABS Plastic	sand paper, spray putty paint, wet rub sand paper, paint	Manual application to products
9/9/2014	120	Hand sanding, spray puttying, wet rubbing and painting	Medium density chemical wood, ABS Plastic	sand paper, spray putty paint, wet rub sand paper, paint	Manual application to products
12/9/2014	200	Milling of final carry case - Hand sanding, spray puttying, wet rubbing and painting	Styrofoam, medium density chemical wood, ABS plastic	sand paper, spray putty paint, wet rub sand paper, paint	Milling the final carry case – manual application, tab removal
15/9/2014	200	Hand sanding, spray puttying, wet rubbing and painting – 'Roland' custom sticker maker	Medium density chemical wood, ABS Plastic	sand paper, spray putty paint, wet rub sand paper, paint, 'Roland' custom sticker maker	Manual application to product + learning how to use a new machine
16/9/2014	120	Hand sanding, spray puttying, wet rubbing and painting	Medium density chemical wood, ABS Plastic	sand paper, spray putty paint, wet rub sand paper, paint	Manual application to products
19/9/2014	200	Re-milling final carry case (machine mistake)	Medium density chemical wood	Roland MDX 540	Mistake (fix) - Manual application to product
22/9/2014	80	Final Coats of paint, wet rubbing	Medium density chemical wood, ABS Plastic	paint, wet rub sand paper	Manual application to products
23/9/2014	80	Final Coats of paint, wet rubbing	Medium density chemical wood, ABS Plastic	paint, wet rub sand paper	Manual application to products
26/9/2014	40	Placing stickers on all items - gloss paint	Medium density chemical wood, ABS Plastic	Gloss paint, stickers	Manual application to products
Total Time: 75 hours 39 minutes (4540 mins)					

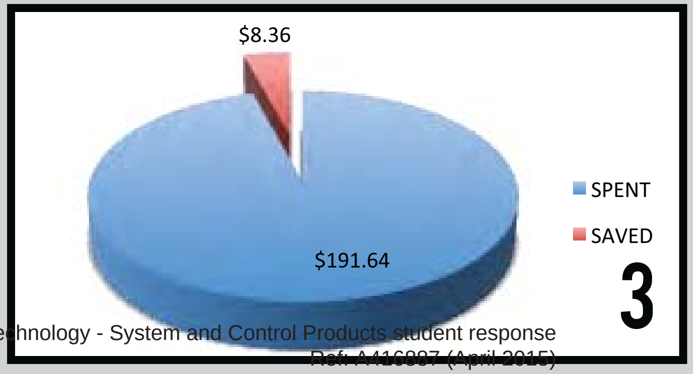
A time plan was essential as it guided me in a direction in what i wanted to achieve in each lesson allocated to making my major project. It provided a sense of organisation as each lesson had an allocated task that needed to be achieved in order to stay within the time frame.

MATERIAL COSTING (BUDGET)

MATERIALS										
MATERIAL (MM)					BLOCK SIZE (MM)			TOTAL COST ($)		
Name	Cost	X	Y	Z	X	Y	Z	Cost per layer	#layers	Block cost
ChemWood MD (Brown)	$240.00	1500.00	500.00	25.00	250.00	150.00	50.00	$12.00	8	$96.00
Foamie (Blue)	$90.00	2500.00	600.00	75.00	250.00	150.00	50.00	$2.25	10	$22.50
3D Printer (Blue/Red)	$125.00	160.00	210.00	135.00	20.00	20.00	20.00	$1.49	9	$13.39
										TOTAL COST: $131.89

EQUIPMENT			
ITEMS	PRICE	QUANTITY	TOTAL
Spray Paint (Squirts)	$8.95	2	$17.90
Grey Primer	$7.95	1	$7.95
Colour Spray (Montana)	$7.00	2	$14.00
Paint brush	$1.50	1	$1.50
Filler spray	$12.00	1	$12.00
Sand paper (A4 paper)	$0.80	2	$1.60
Acrylic 3mm (Various)	$4.80	1	$4.80
			TOTAL COST: $59.75

BUDGET $200 TOTAL = $191.64 (SAVED $8.36)

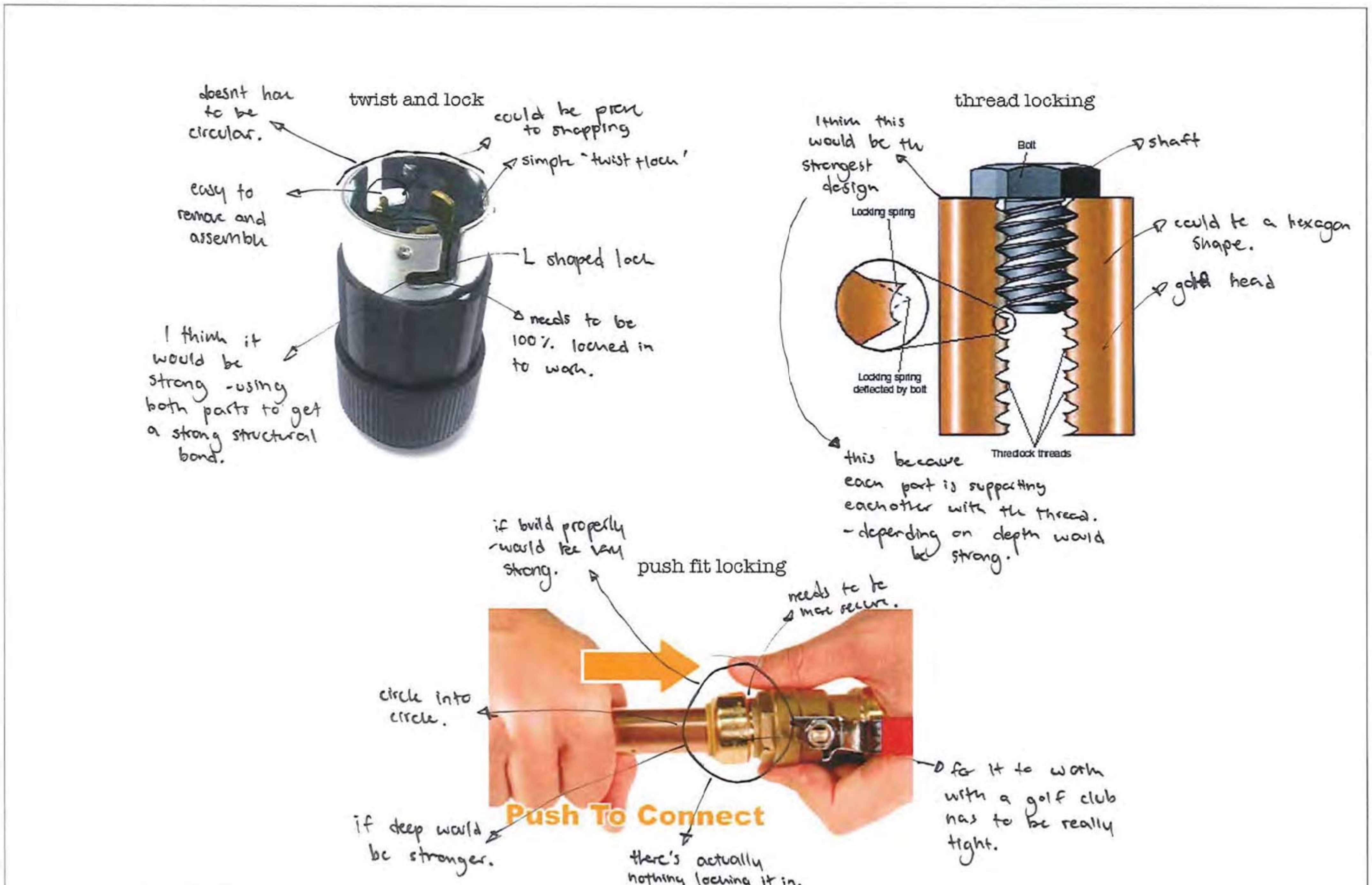


1. Cans of paint, a grey primer, a clear gloss, a matte black and a space blue.
2. Styrofoam test models including a driver, putter, iron and carry case.
3. A simple pie chart highlighting the amount of money left in the budget ($8.36)

CONCEPT SKETCHES (LOCKING SYSTEMS)

LOCKING SYSTEMS – THREAD, TWIST & LOCK, AND PUSH FIT

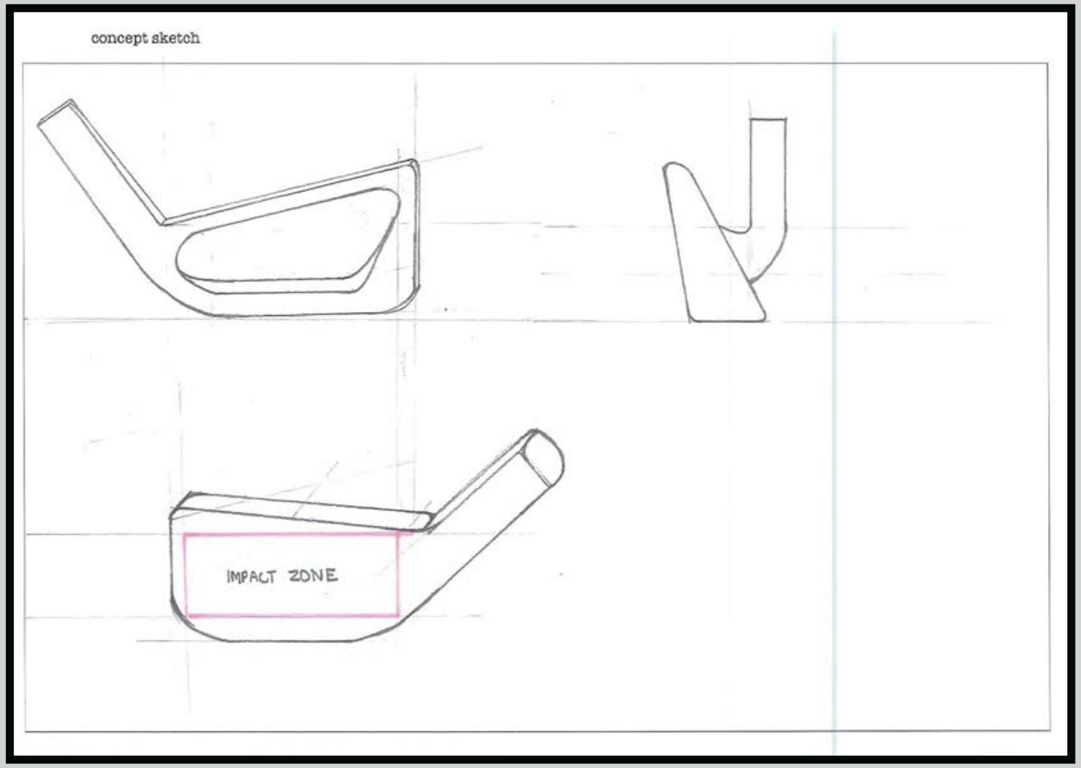
locking systems



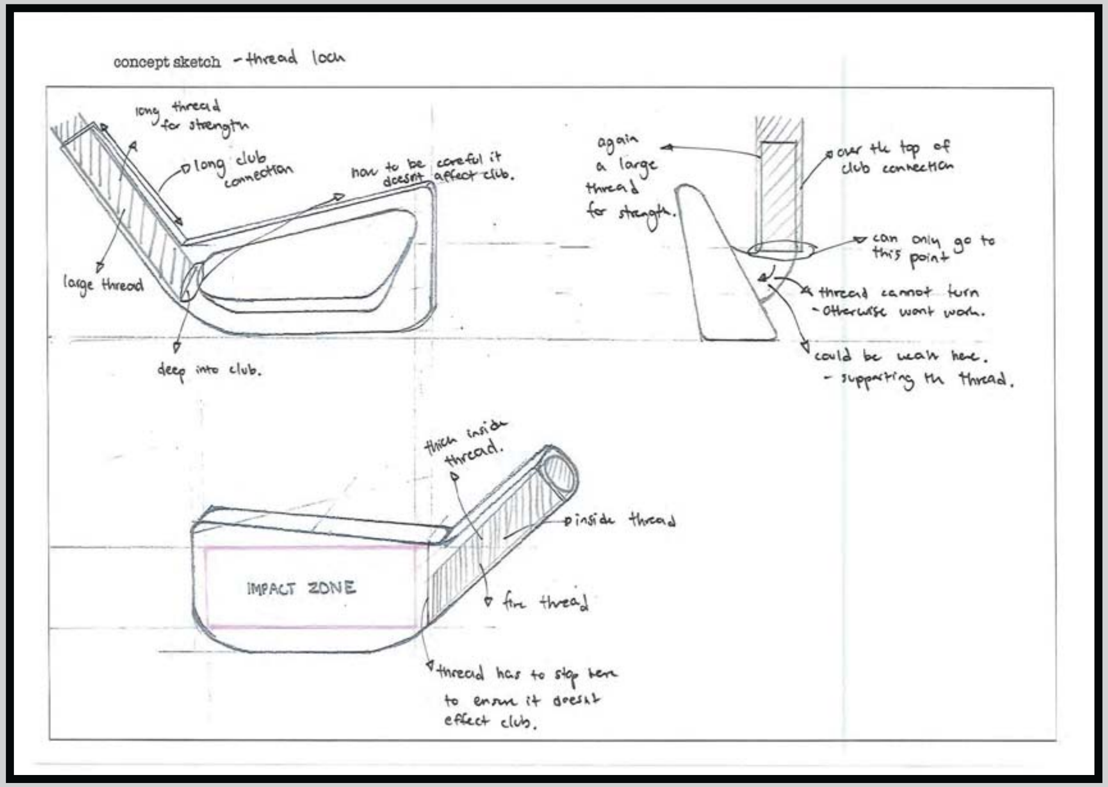
CONCEPT SKETCHES

The following pages provide instances of in-depth analysis of information used to create imaginative and innovative solutions to the design brief.

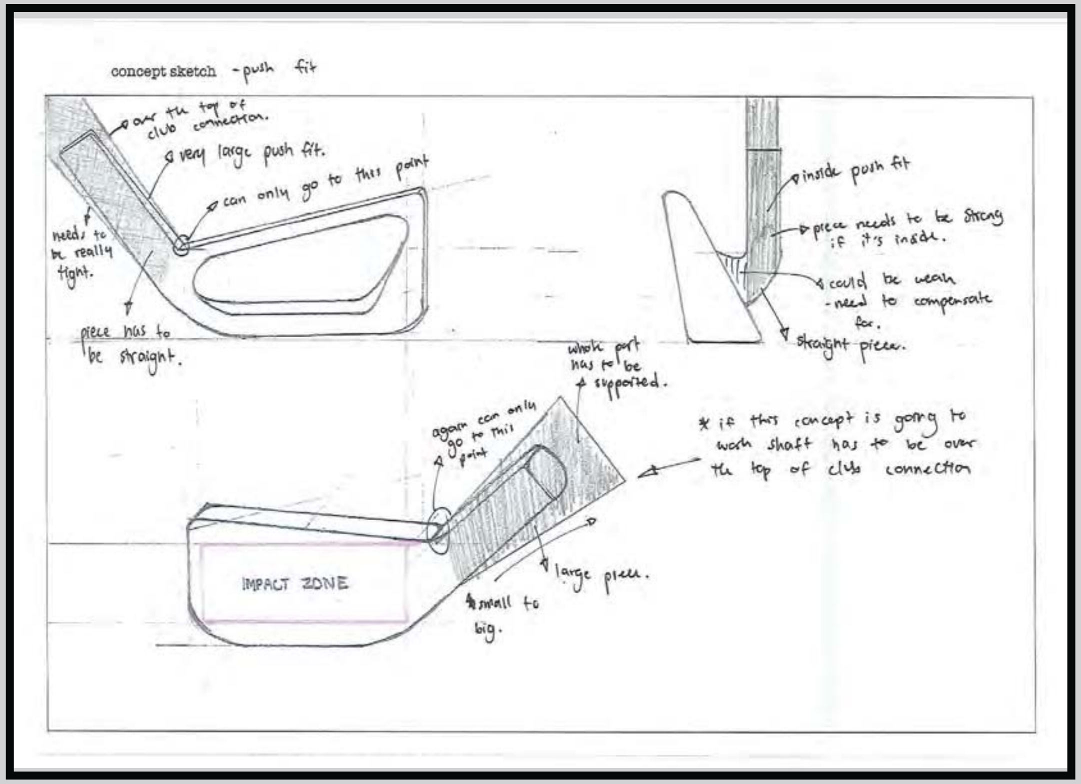
ORIGINAL SKETCH – IRON



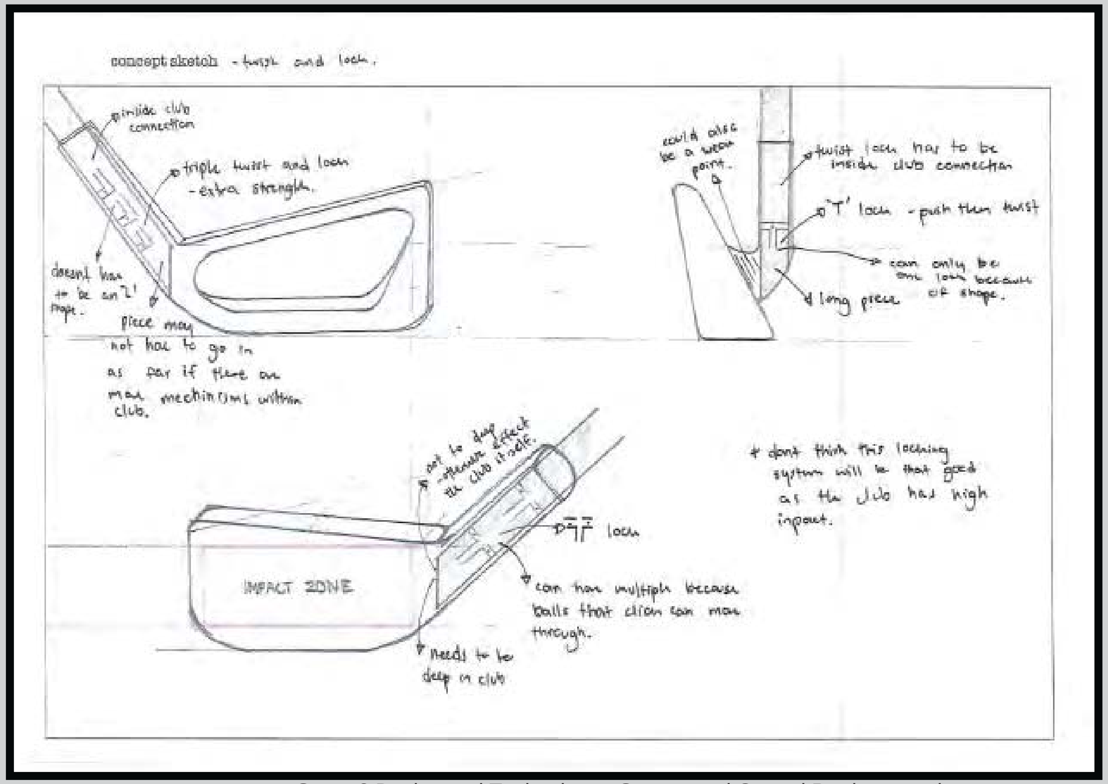
THREADLOCK – IRON



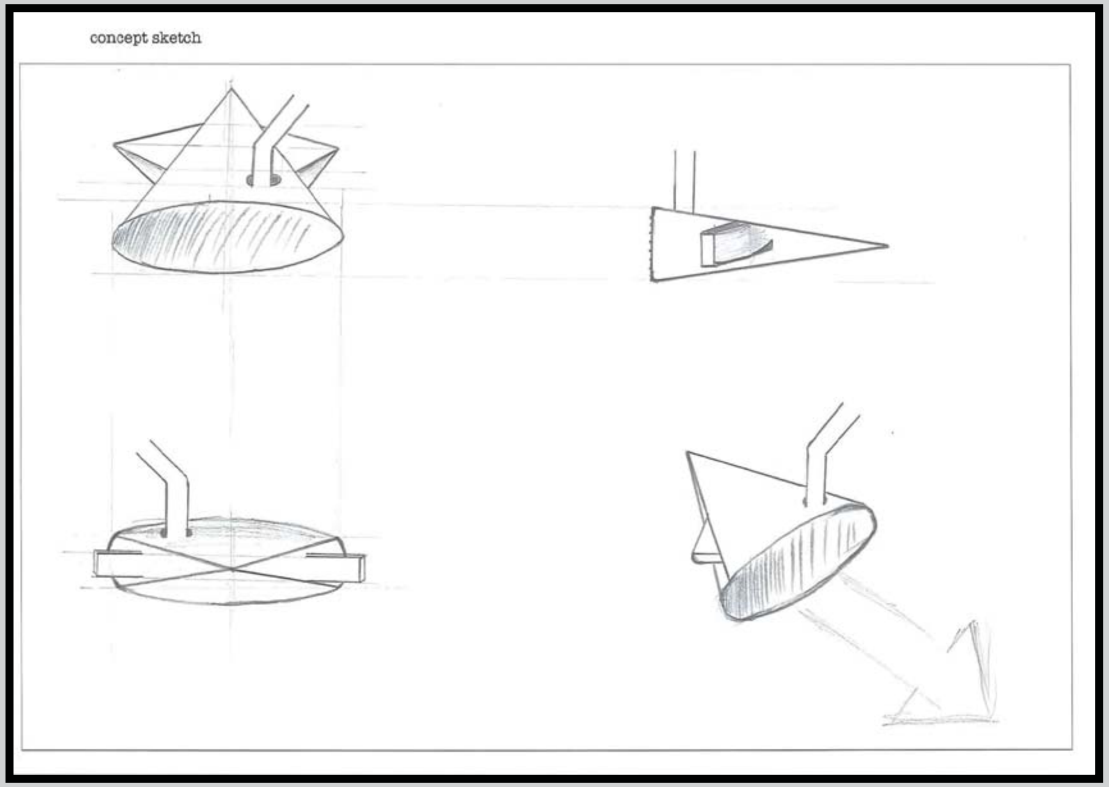
PUSHFIT – IRON



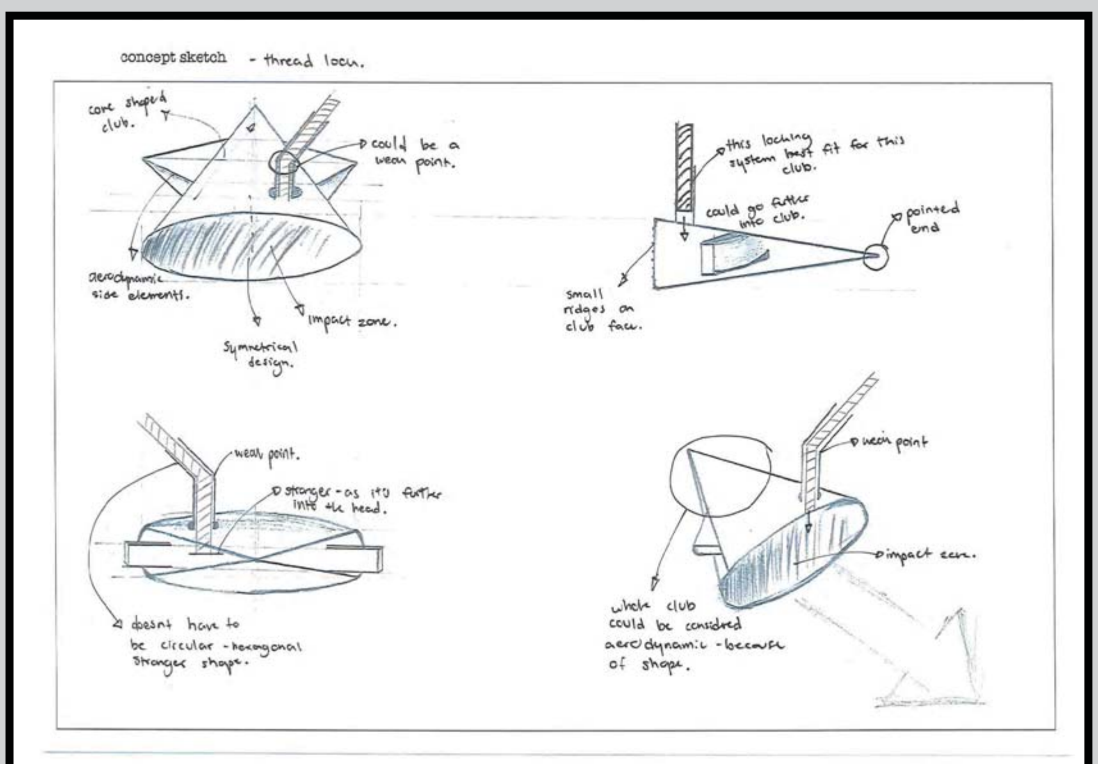
TWIST AND LOCK – IRON



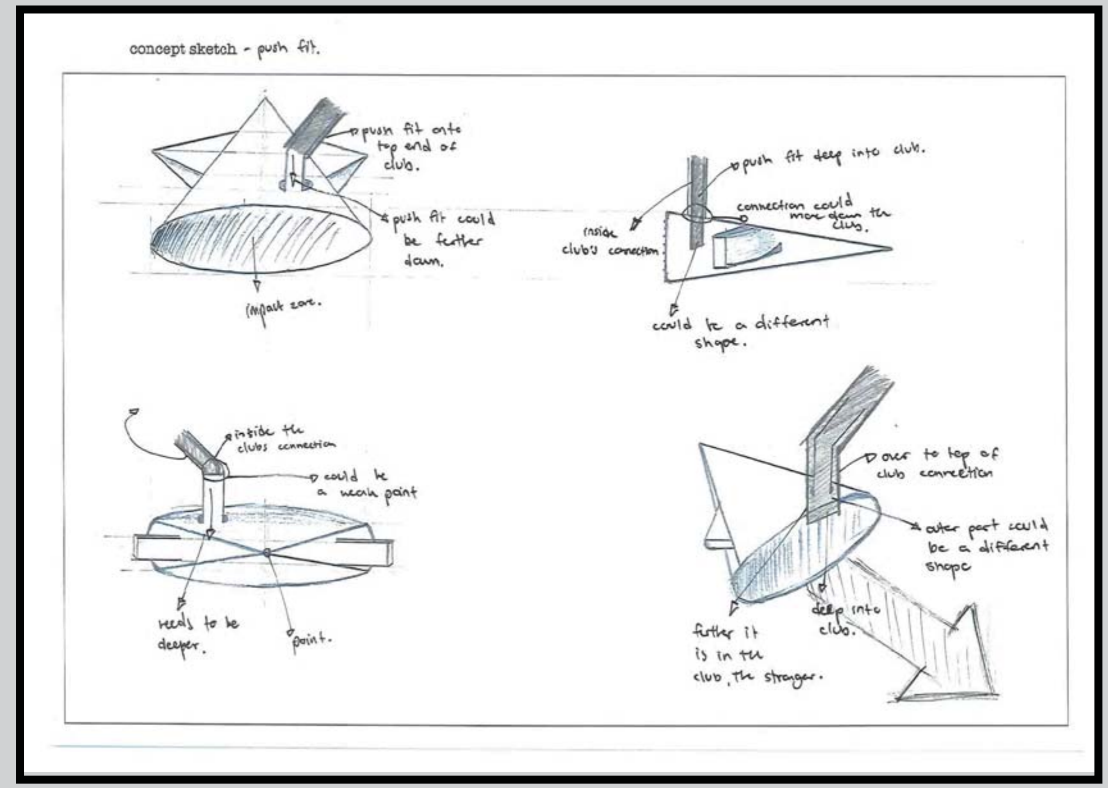
CONCEPT SKETCHES



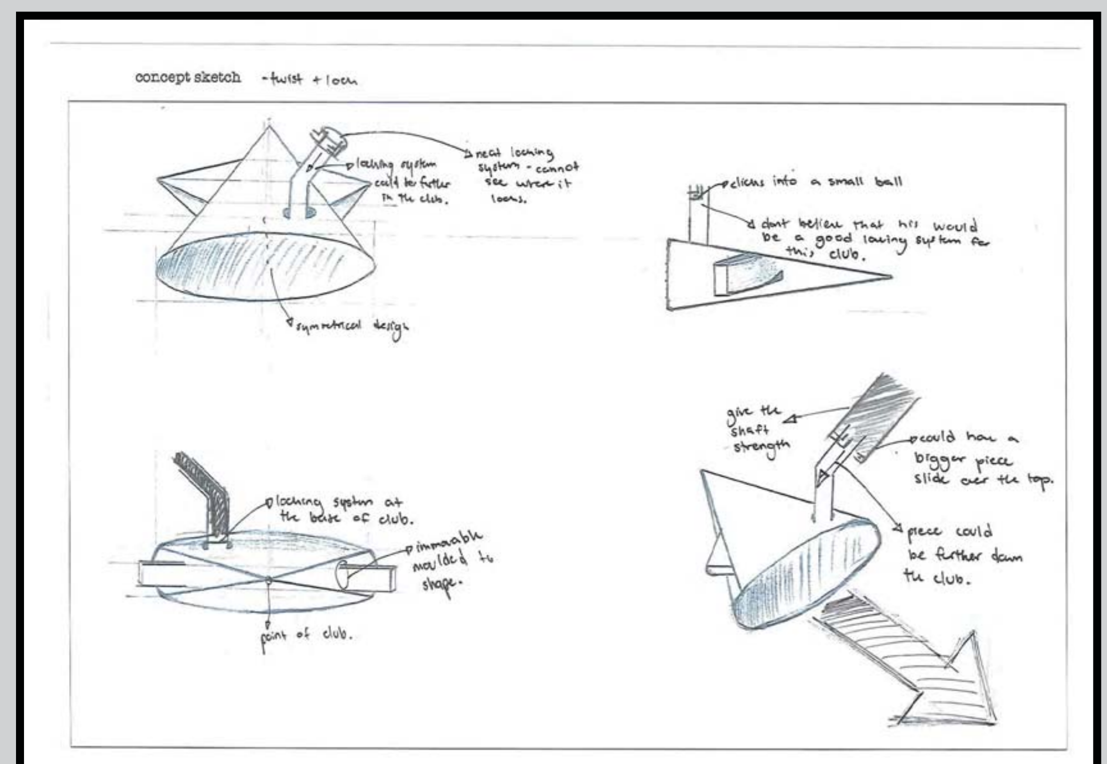
ORIGINAL SKETCH – DRIVER



THREADLOCK – DRIVER

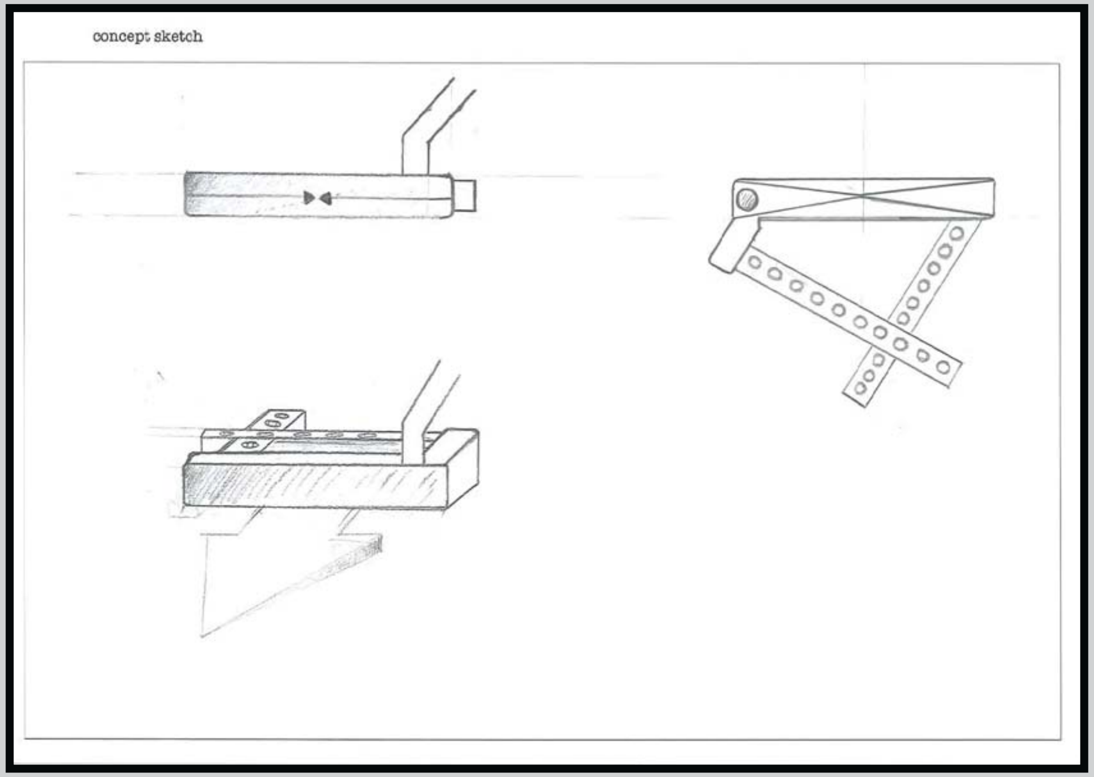


PUSHFIT – DRIVER

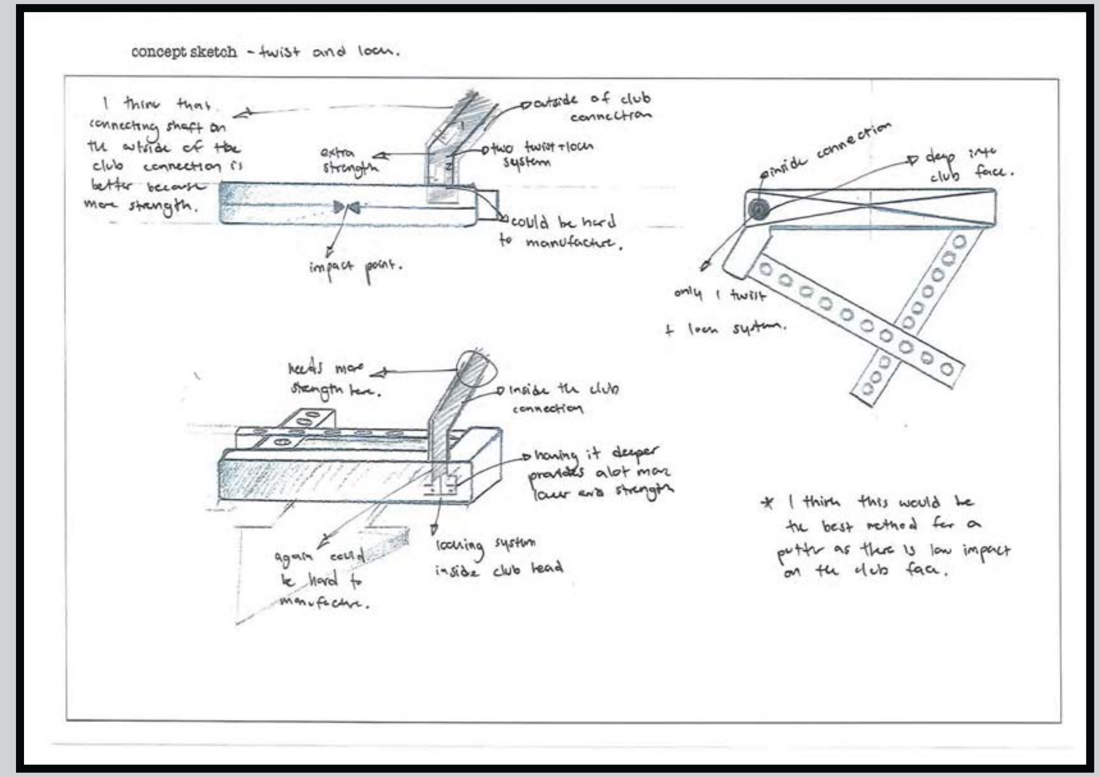


TWIST AND LOCK – DRIVER

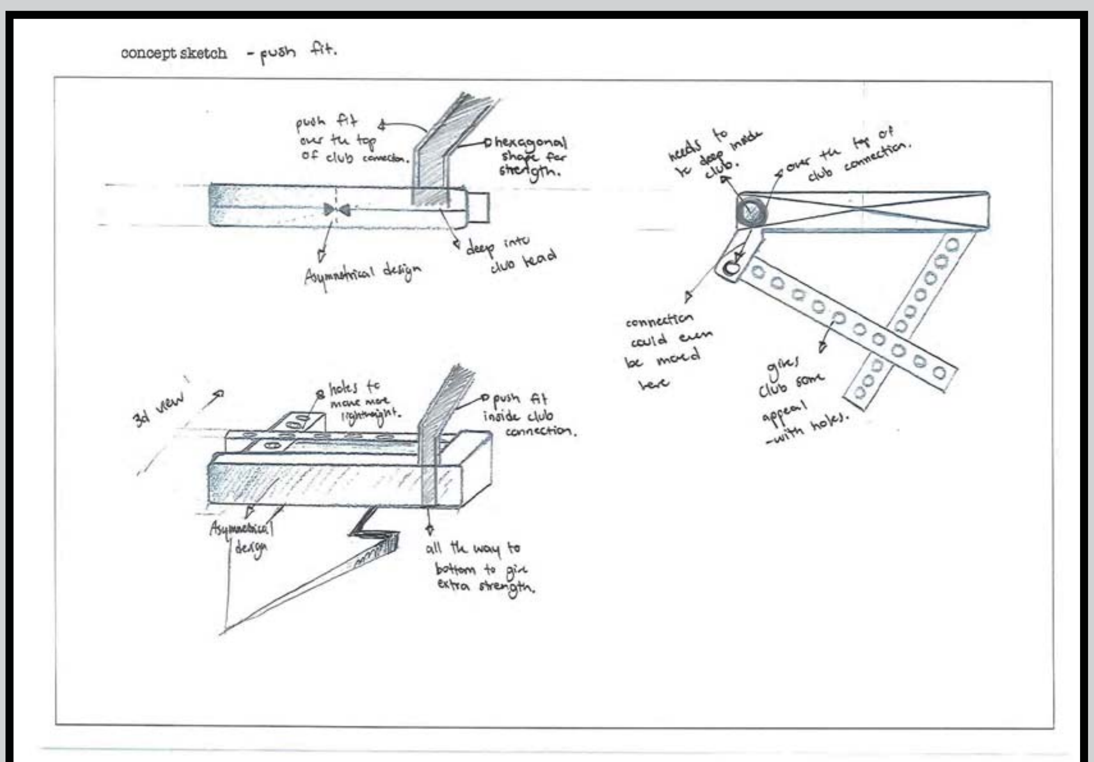
CONCEPT SKETCHES



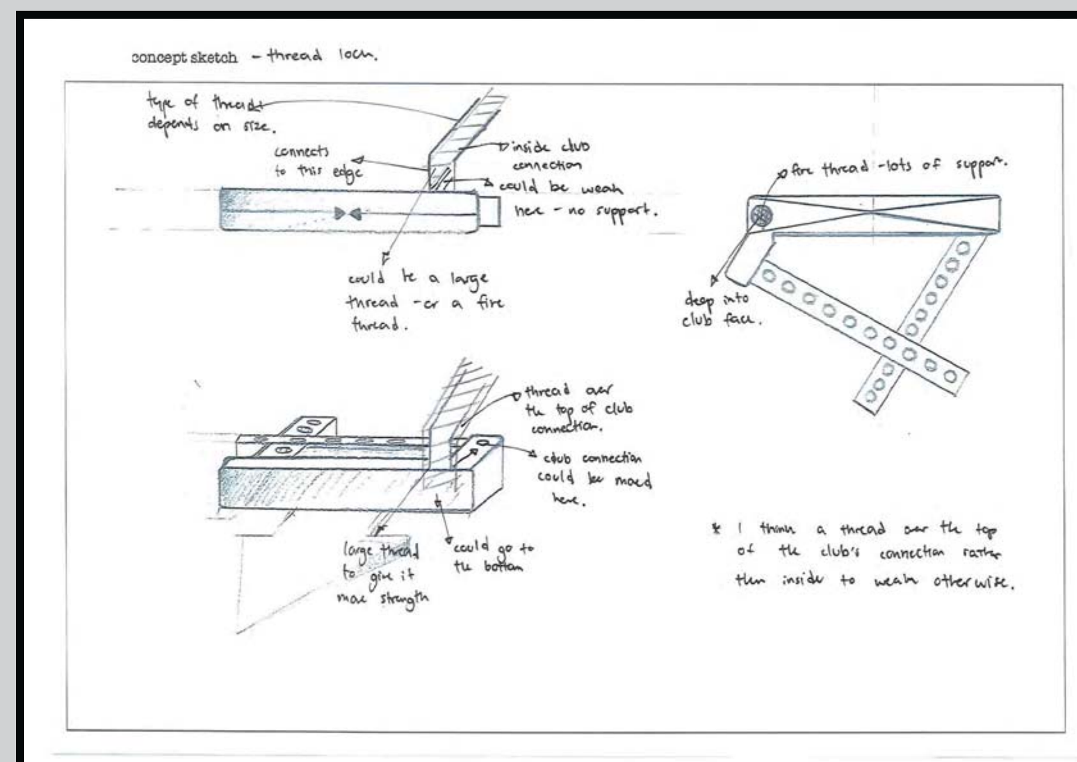
ORIGINAL SKETCH – PUTTER



TWIST AND LOCK – PUTTER



PUSH FIT – PUTTER



THREAD LOCK – PUTTER

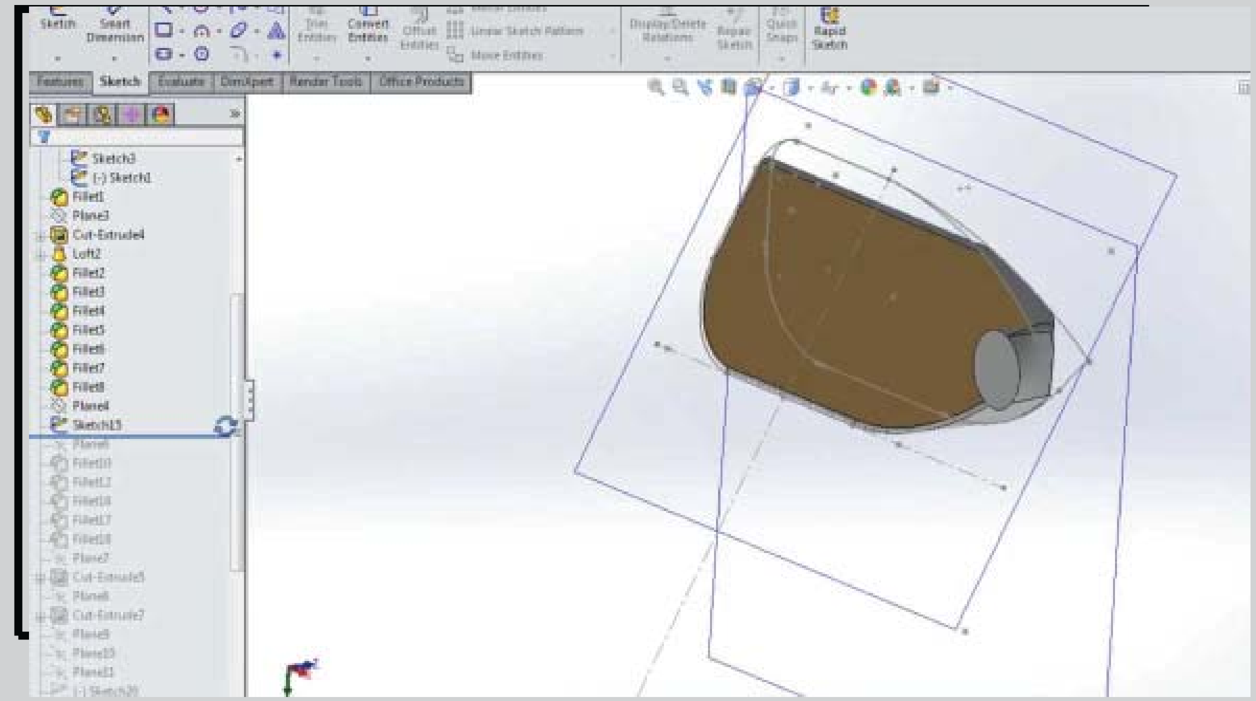
C.A.DEVOLUTION

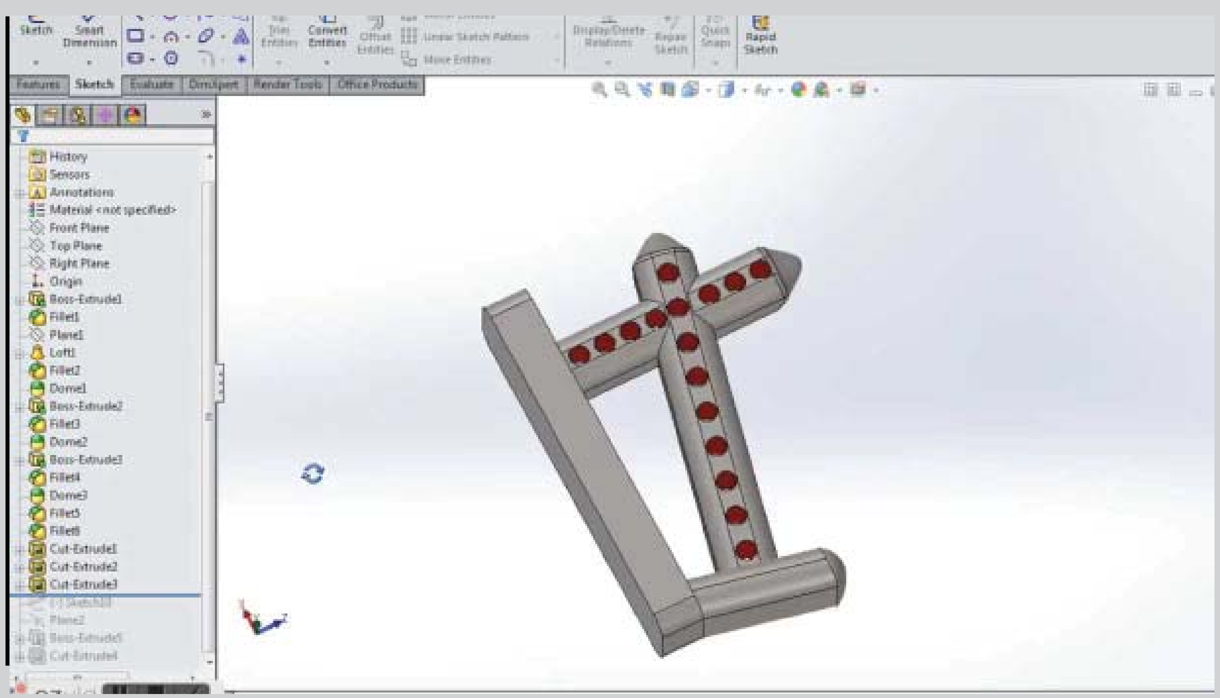
Computer Aided Design

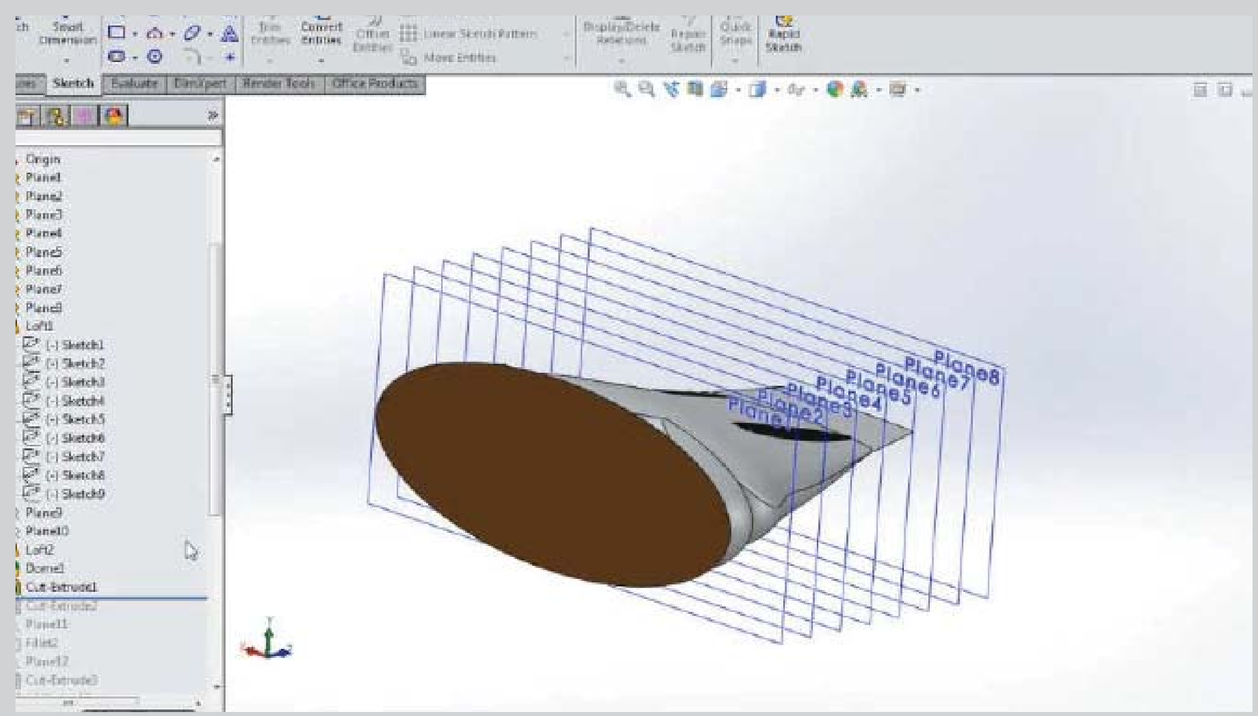
Please see videos for the C.A.D evolution of all clubs, including a putter, iron and driver.

***NOTE: Hover mouse over videos and click play to begin the evolution.**

Image removed due to copyright

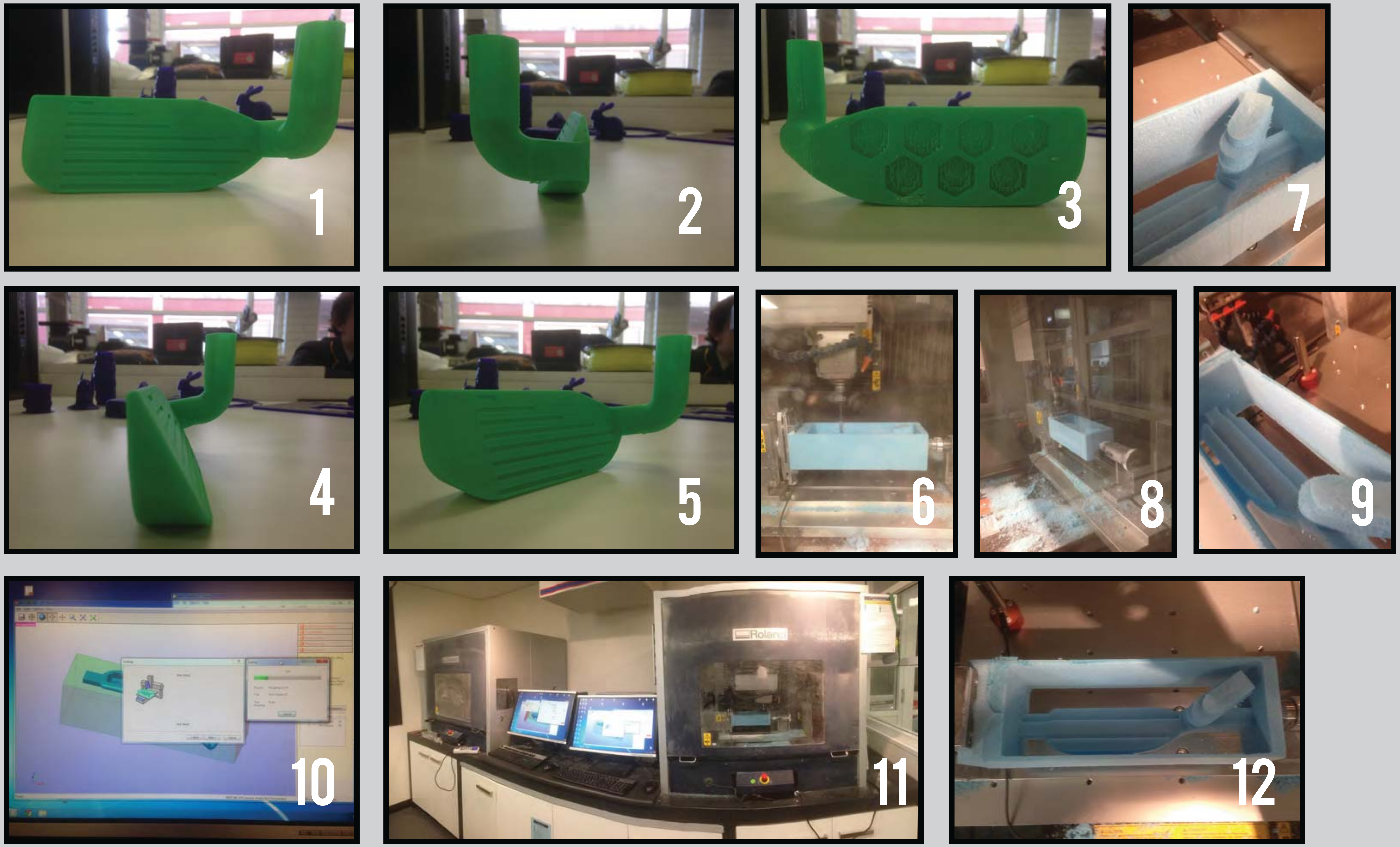






TEST MODELS & MODIFICATIONS

The following pages contain information indicative of purposeful testing, refinement and modification to validate ideas.



1 - 5 ABS Plastic model of an iron.

6 - 12 Styrofoam model of an iron, using a Roland Mill.

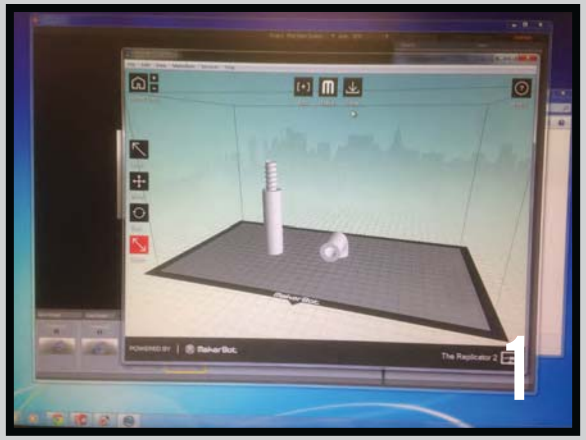
**NOTE: Moving from ABS plastic to Styrofoam as making test models in Styrofoam was more time efficent. The angle of the club connection point was changed, instead of being at 90 degress, it was moved to an angle of 67 degrees, as a golf shaft is attached to the club on this angle to allow the user to use the club in its intended way.*

TEST MODELS & MODIFICATIONS

1 - 10 Styrofoam models (2) of an iron, manufactured in a Roland CNC mill

**NOTE: Another two foam models were produced of the iron, with a cut in the backside of the club to add visual appeal, with fillets to shape the club in a unique way.*

TEST MODELS & MODIFICATIONS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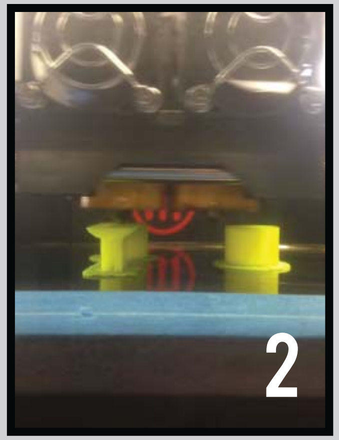
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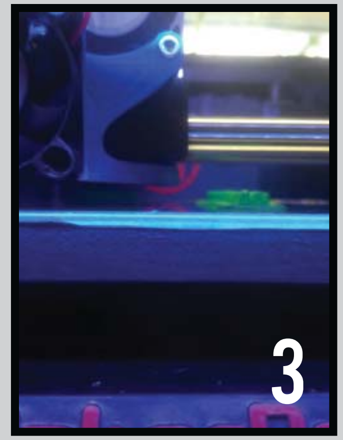
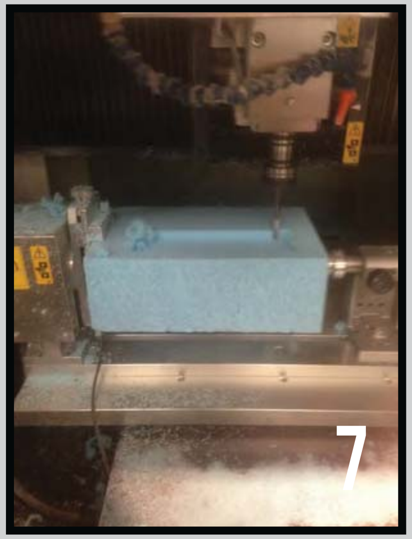

3


4


5


6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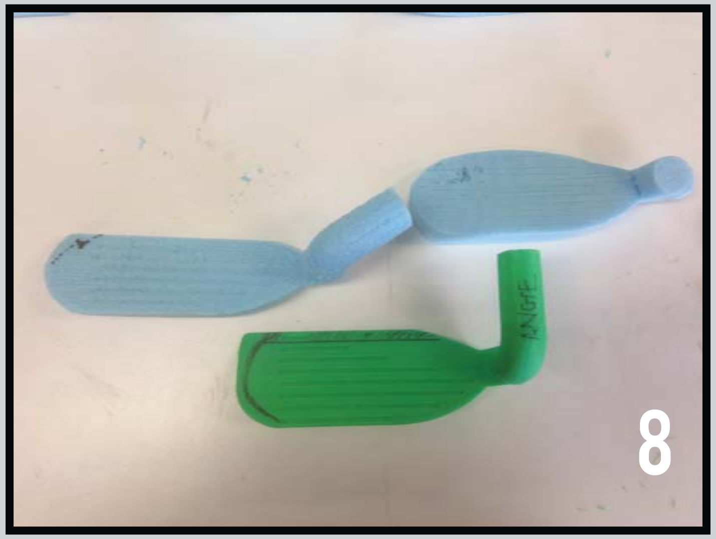
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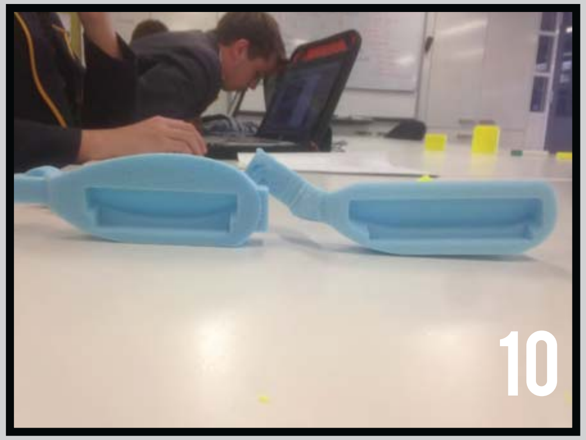
9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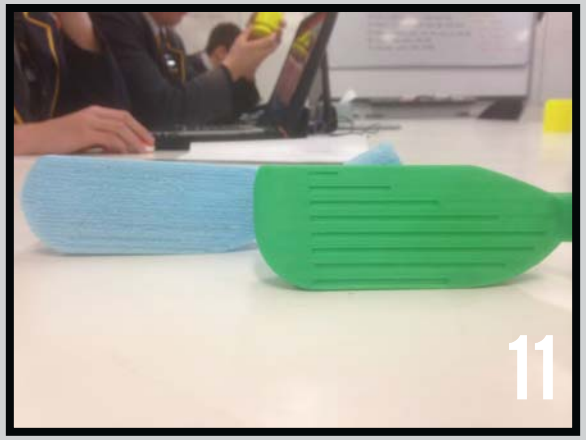

11

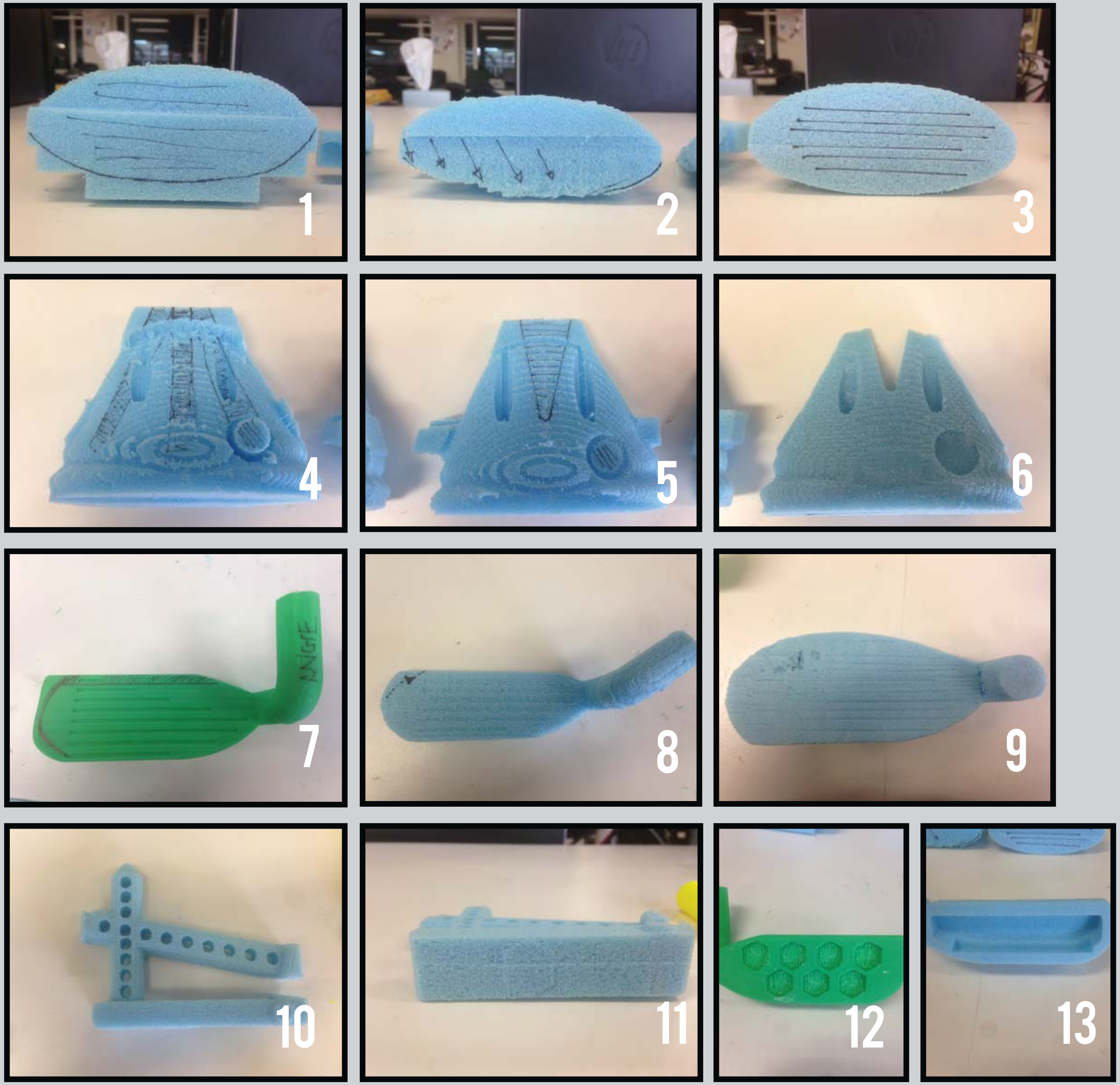
1 - 3 construction of a thread locking system using the MakerBot 2X programmed in Maker-Ware.

4 - 7 Driver models constructed in Styrofoam.

8 - 11 three irons with different modifications, two in Styrofoam and ABS plastic.

**NOTE: Using maker ware a thread locking system was produced to analyse if it would be suitable for the club. A serious of drivers were produced with changes to the clubs structure cutting a 'V' shape to the back to give it an appealing look and remove its bulky look. Picture 8 shows development of the iron with the final shape in the top right hand corner, with the clubs face being extended to allow more surface area to hit the ball.*

TEST MODELS & MODIFICATIONS



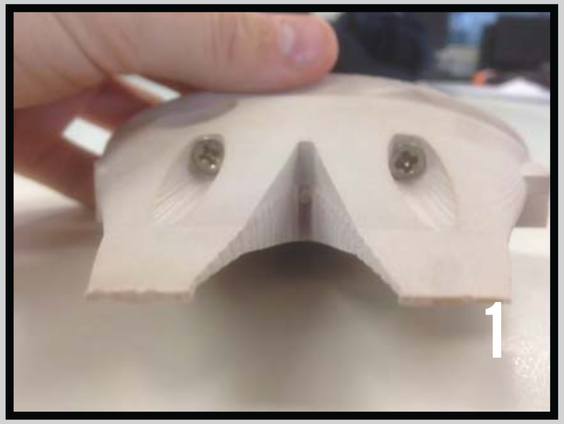
1 - 6 three Styrofoam models of a driver.

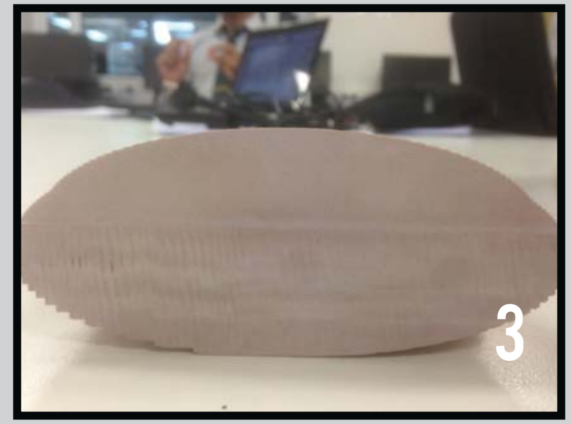
7 - 9 three modifications of the iron club.

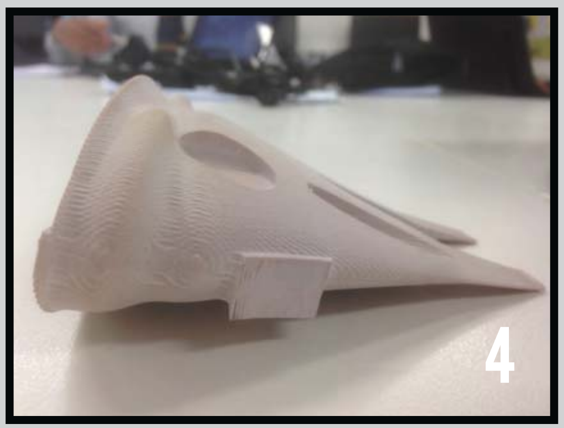
10 - 11 putter constructed in Styrofoam.

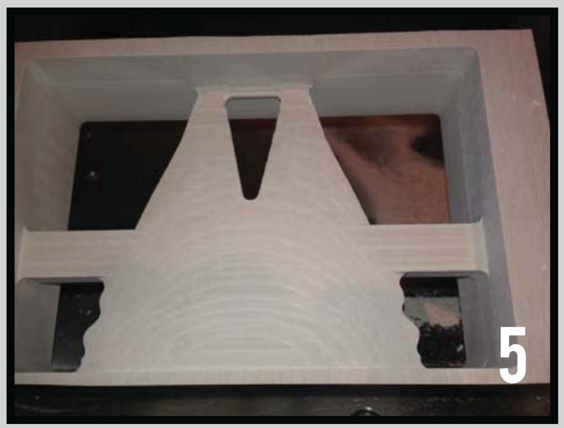
**NOTE: Pictures 1 - 6 highlight driver development minimising the clubs face with fillets to give it a more slick design, with a 'V' shape cut out to add visual appeal. Minor changes to the putter, with a small octagon shape placed on the center of the face to indicate where the center of the club is.*

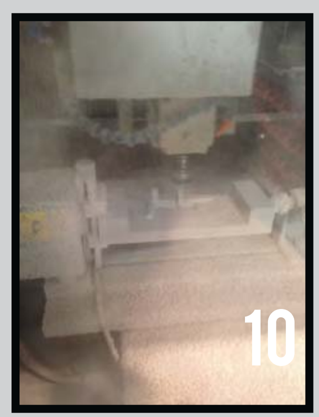
TEST MODELS & MODIFICATIONS

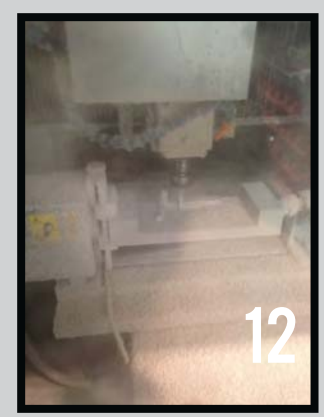










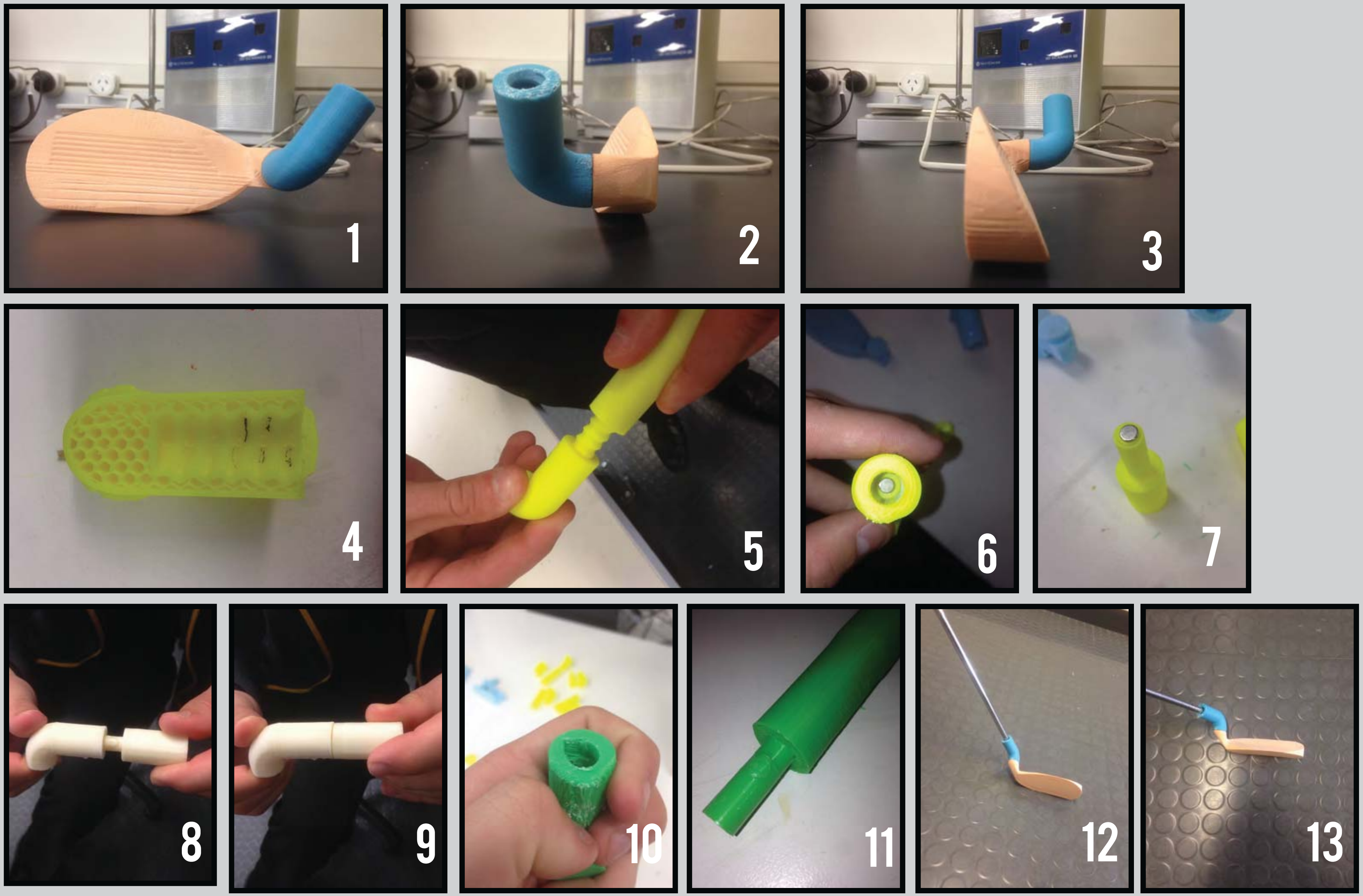


1 - 12 driver club being made in Medium density chemical wood, using the Roland Mill.

**NOTE: Material change into chemical wood as a final design was completed. Two screws were inserted into the back slots, this was to provide extra strength when hitting the bill, and be visually appealing.*

TEST MODELS & MODIFICATIONS

The following pages contain information indicative of purposeful testing, refinement and modification to validate ideas.

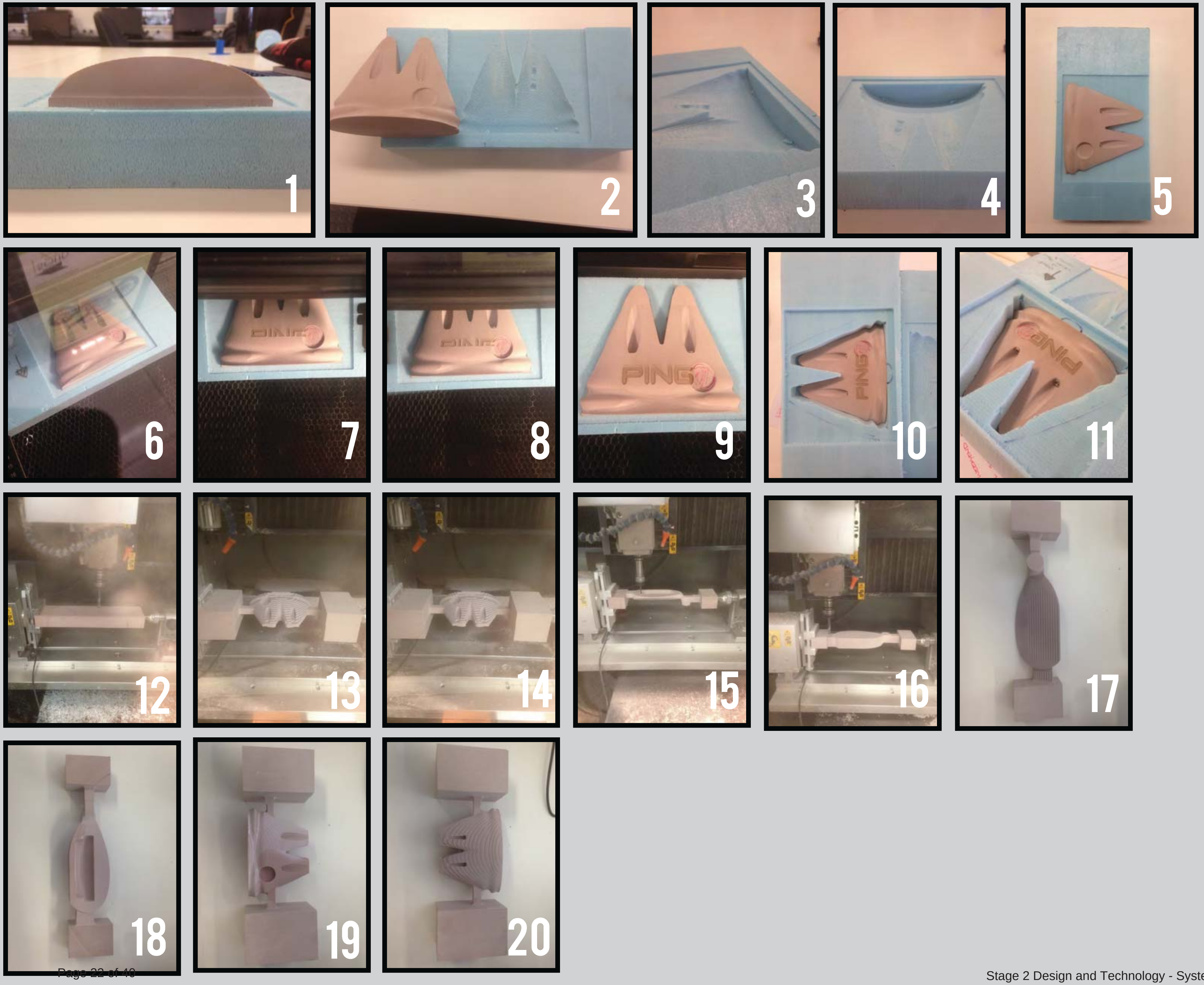


1 - 3 iron made in low density chemical wood connected with a thread locking system.

4 - 11 testing different locking systems, magnet, thread, twist and lock with each locking system in different ABS plastic.

**NOTE: Iron was milled in low density chemical wood to see if it would be a more suitable material. Different locking systems were tested, producing 4 different methods in ABS plastic to decide which method was the strongest. The green plastic is the twist and lock method, and the white plastic is a development of this changing the shape of the ball that twists into place to lock the mechanism. The ball was made larger to tightly fit between the canal*

TEST MODELS & MODIFICATIONS

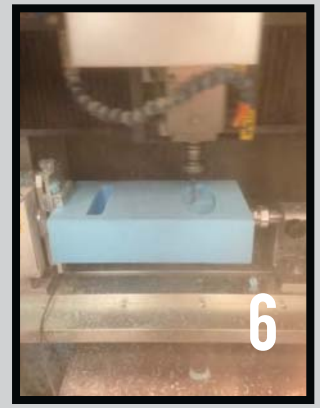


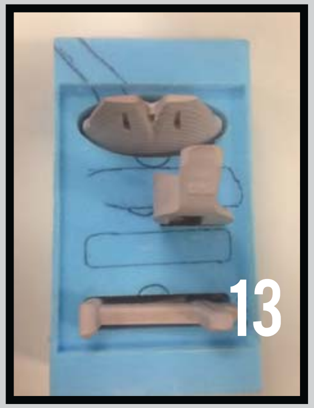
1 - 11 testing a mould for the driver in chemical wood, using a lazer cutting to cut in a 'PING' logo to the top face of the club.

12- 20 iron and driver being milled in the Roland, connected by tabs to the original blocks holding the piece stable whilst the drill pierce moves in a programmed path.

**NOTE: Moulds were made to test how the club would fit into the carry case. Originally the club was only 50% into the mould, developing into it being almost fully in to ensure the club would stay in place when carried. Finger holds were placed in the front to easily remove the club from the mould. A logo was lazer cut into the top sruface to give the club some brand identity.*

TEST MODELS & MODIFICATIONS



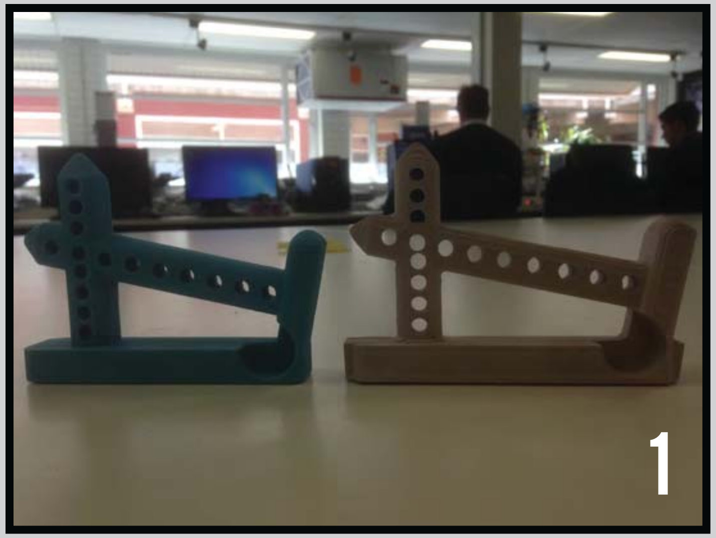


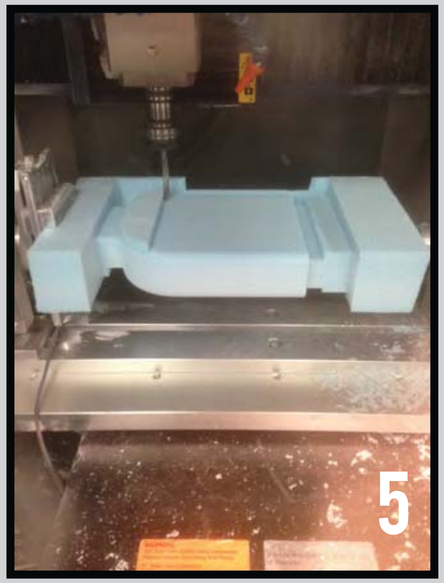
1 - 13 test moulds being milled and chemical wood clubs testing different methods in how they will fit.

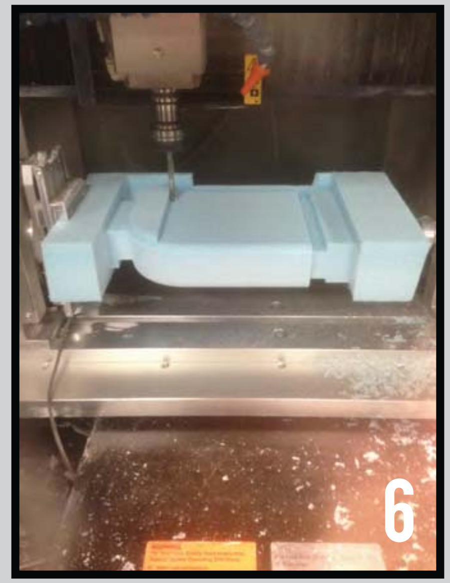
14 - 18 locking systems for clubs and golf shaft, constructed in yellow and blue ABS plastic.

**NOTE: Each club was tested to see which way they would be placed into the mould, weather it be vertical, horizontal or on an angle. This was to see which method would be the best suitable when all three clubs are enclosed in the carry case. Connecters for each club were printed at different angles as each club has its own specific angle in which the shaft connects.*

TEST MODELS & MODIFICATIONS





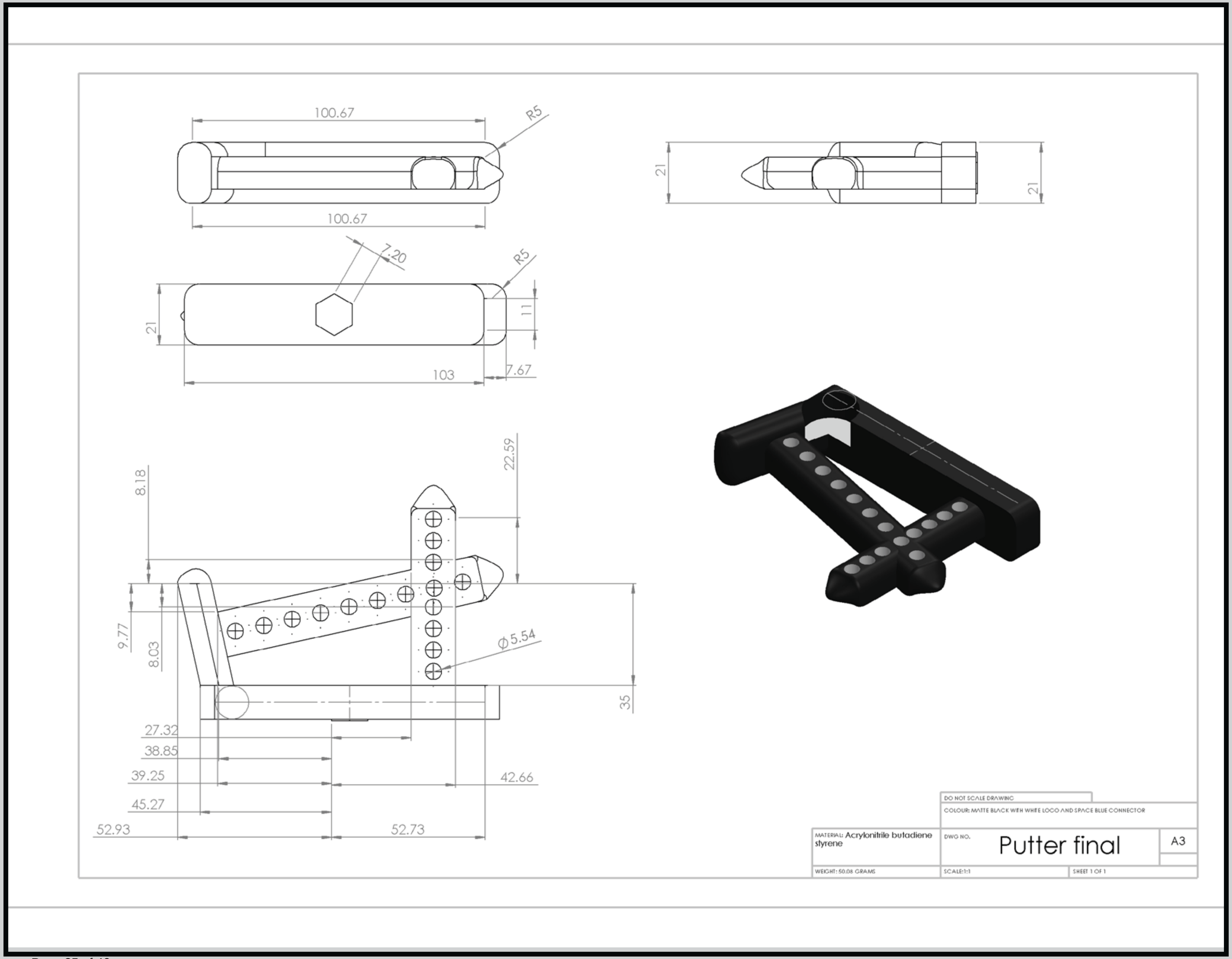


1 - 2 putter constrcuted in ABS plastic and chemical wood, a decision was made to use the ABS plastic model as the finish was better.
3- 9 carry case milled in Styrofoam and then the final in medium density chemical wood.

**NOTE: Putter was made in ABS plastic and chemical wood to see what provided a better finish. A carry case first manufactured in Styrofoam to see if each club would fit in its desired position and if the clubs, whilst walking would stay. A final chemical wood model was then produced with all clubs successfully fitting in their positions.*

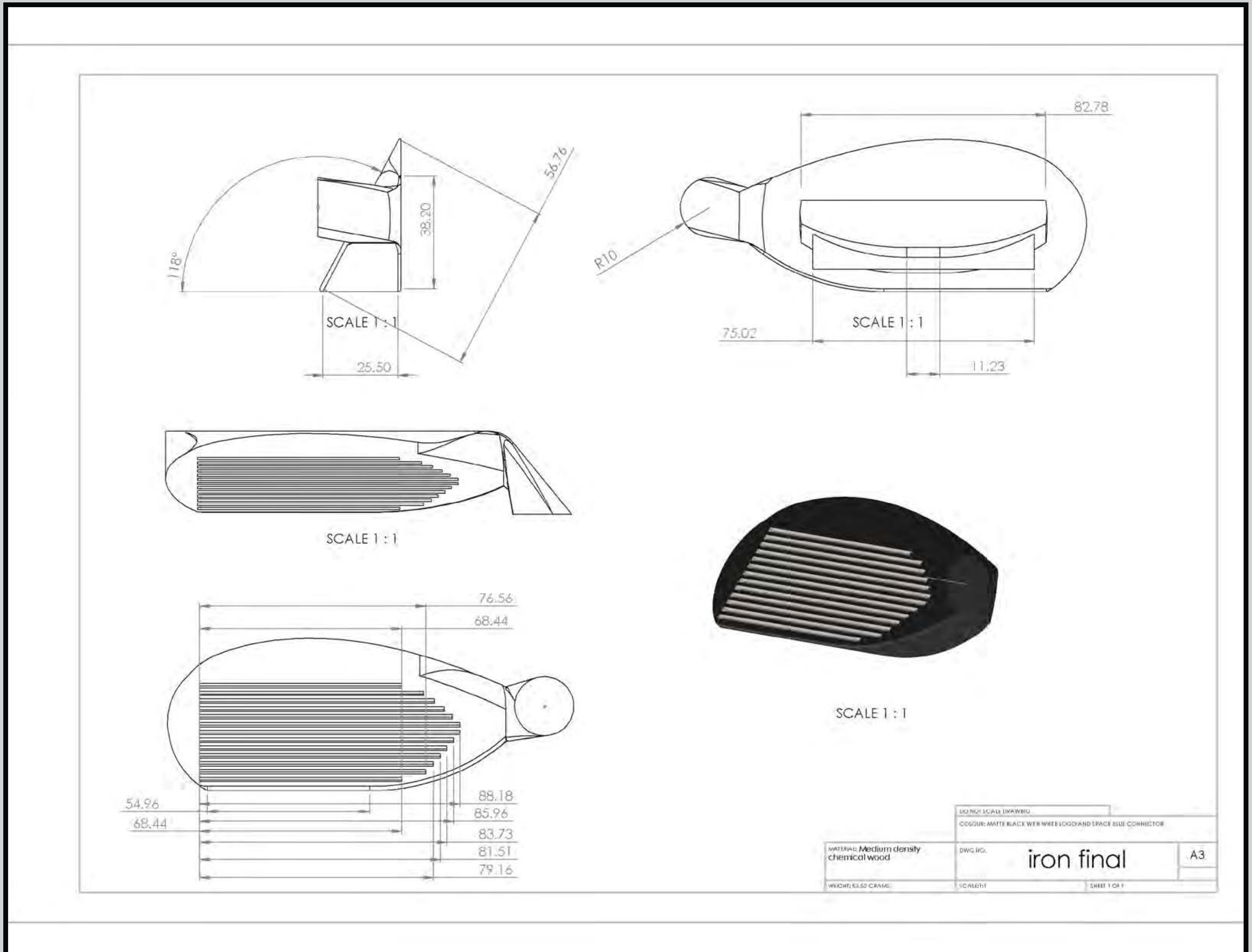
ENGINEERING DRAWINGS

The use of leading technical processes has enabled the student to demonstrate accomplished communication of the product ideas in the following drawings.



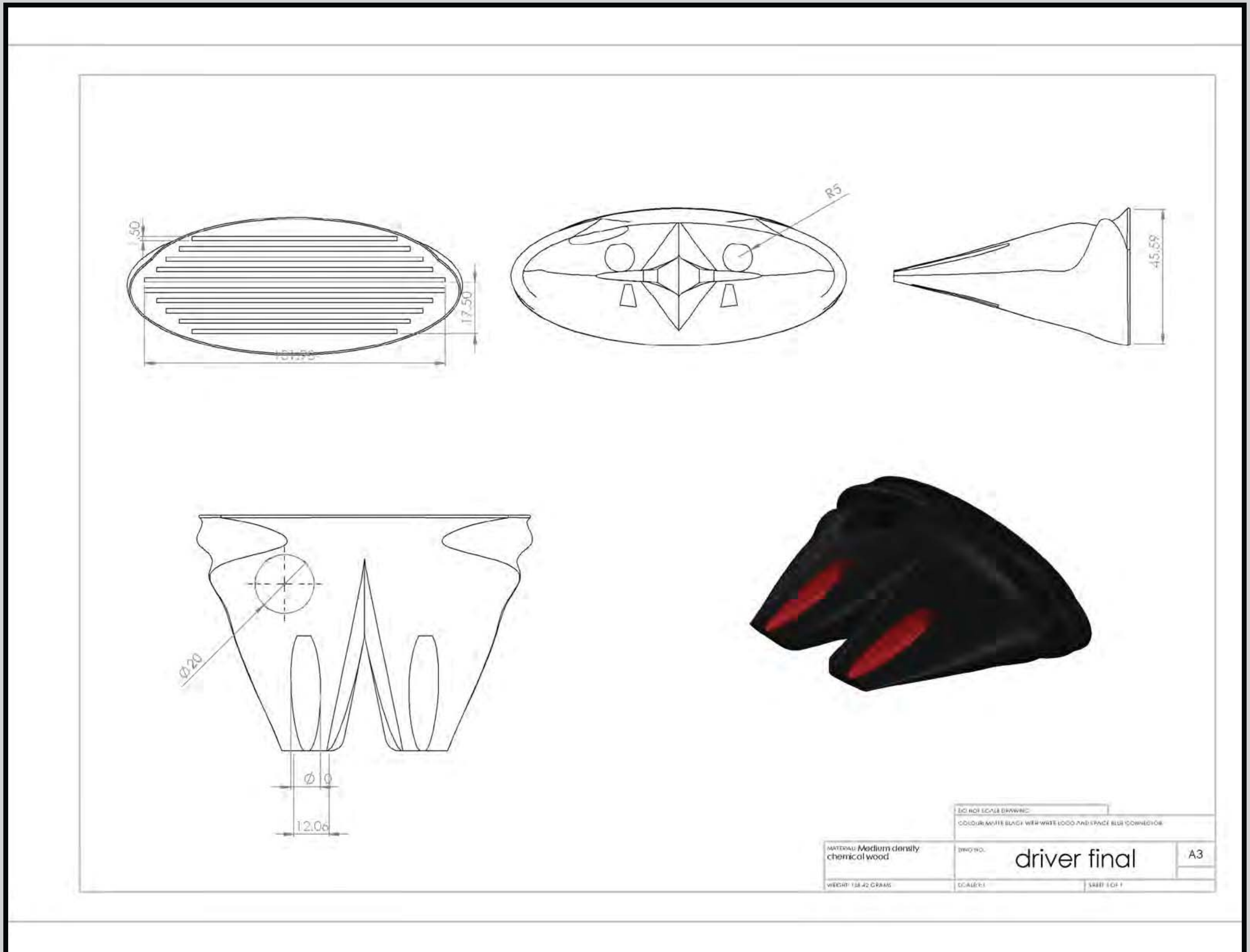
PUTTER

ENGINEERING DRAWINGS



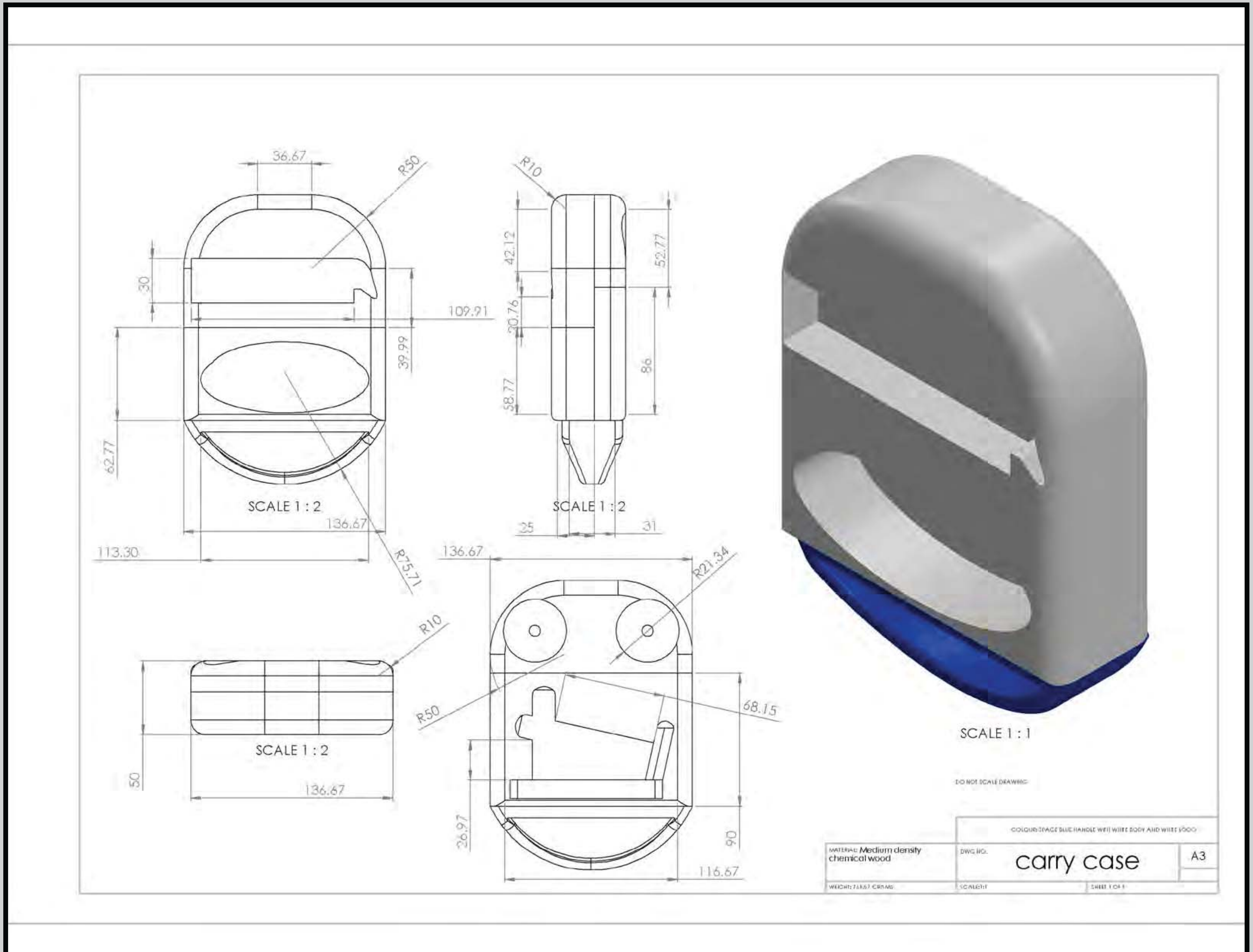
IRON

ENGINEERING DRAWINGS



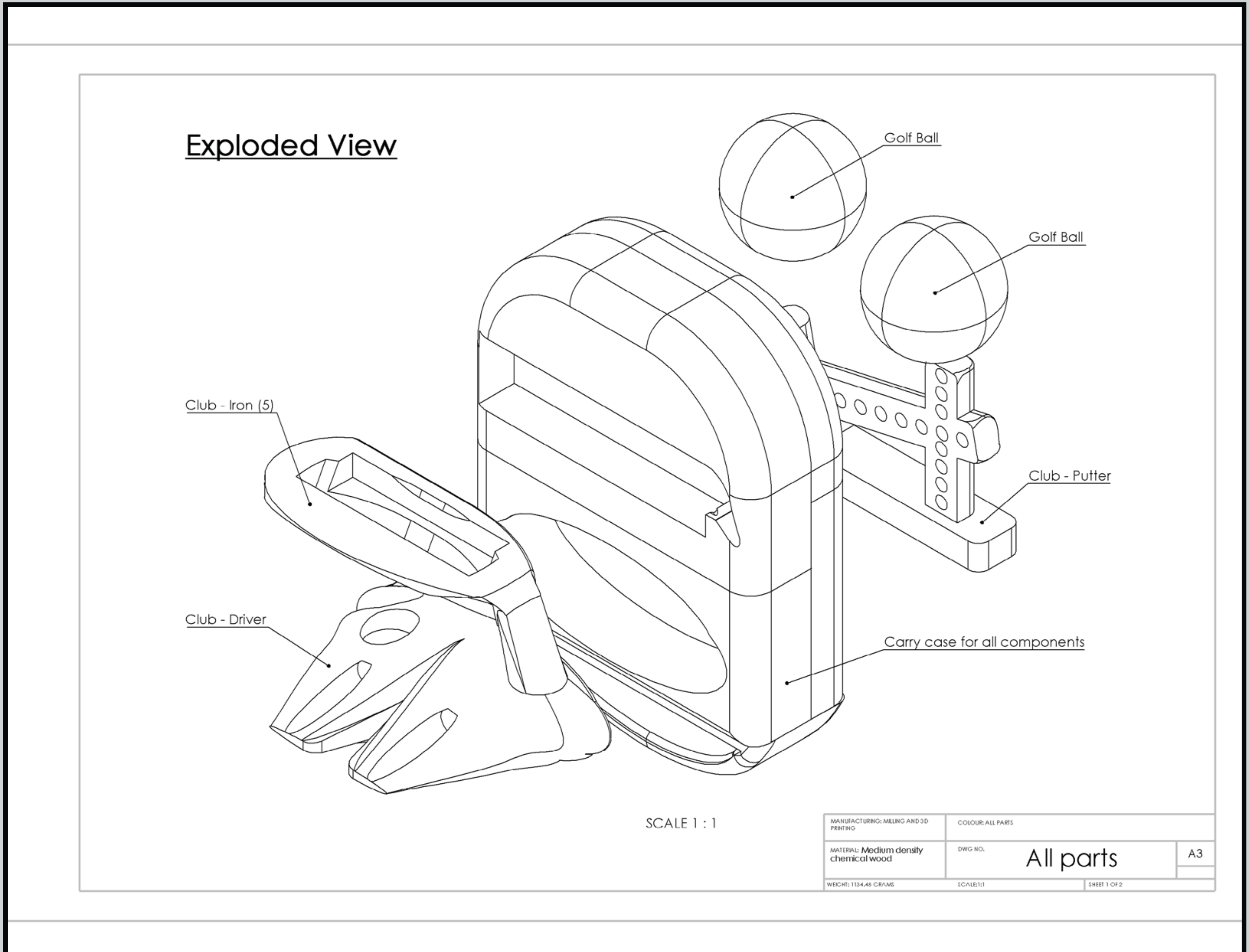
DRIVER

ENGINEERING DRAWINGS



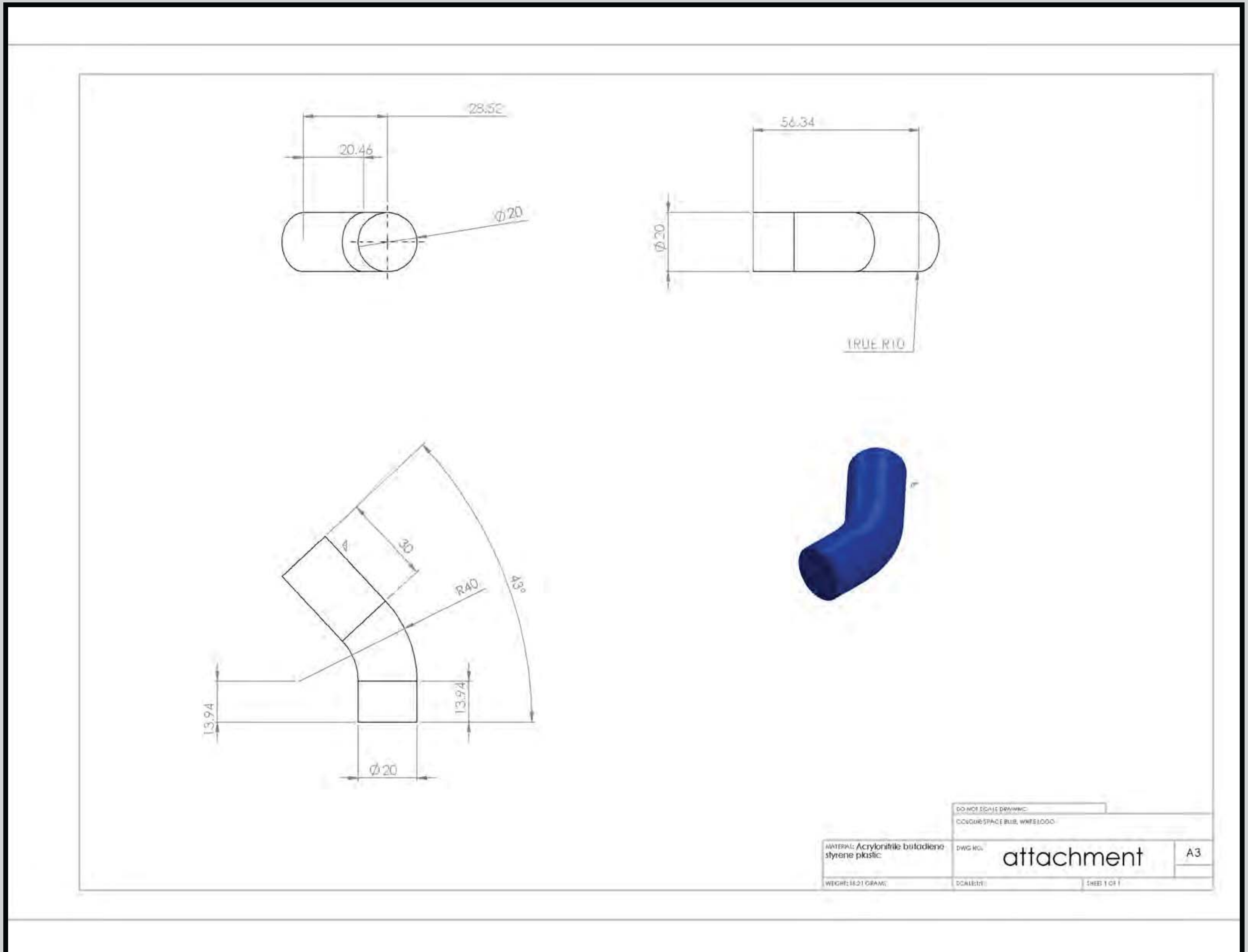
CARRY CASE

ENGINEERING DRAWINGS



CARRY CASE & CLUB HEADS
EXPLODED VIEW

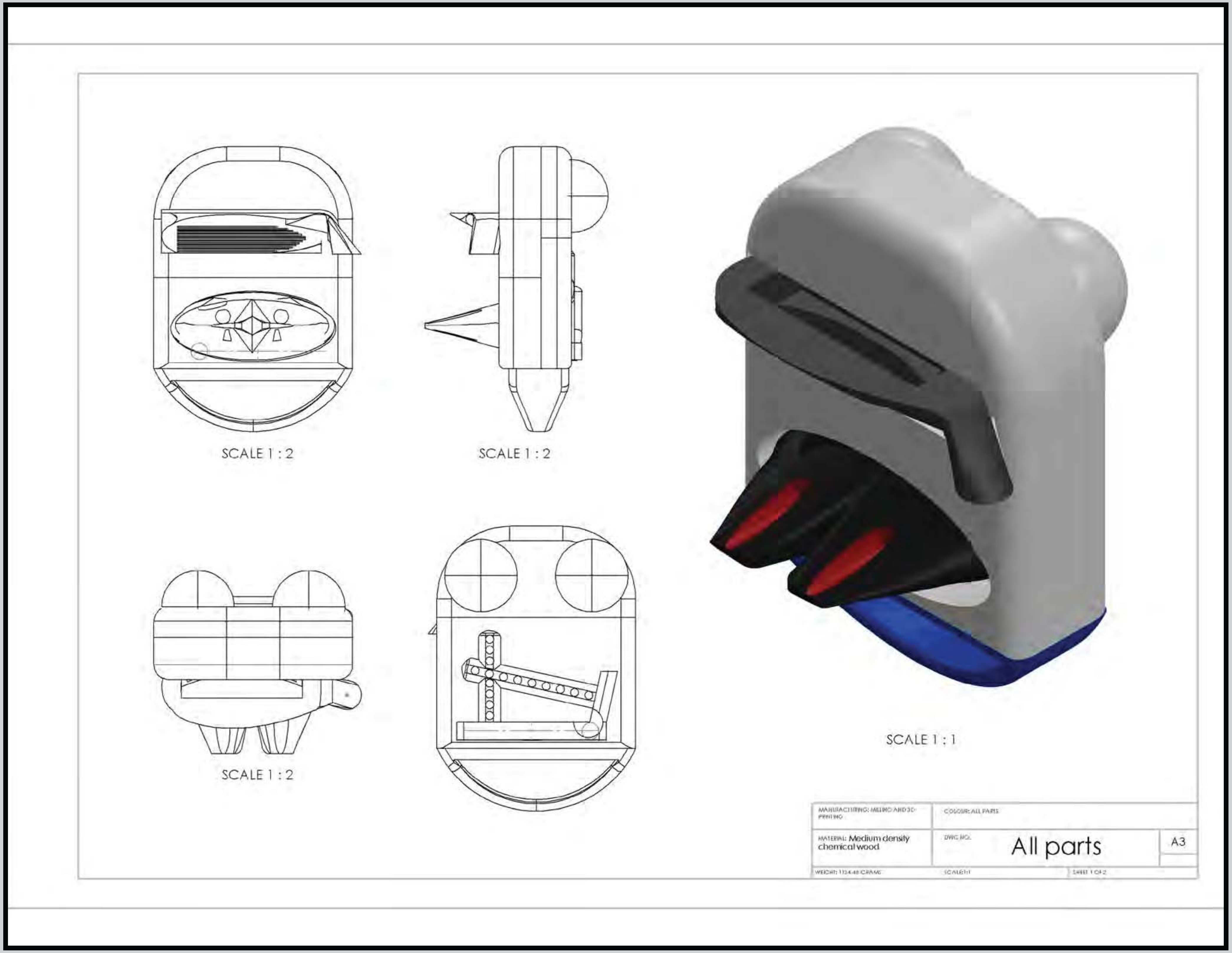
ENGINEERING DRAWINGS



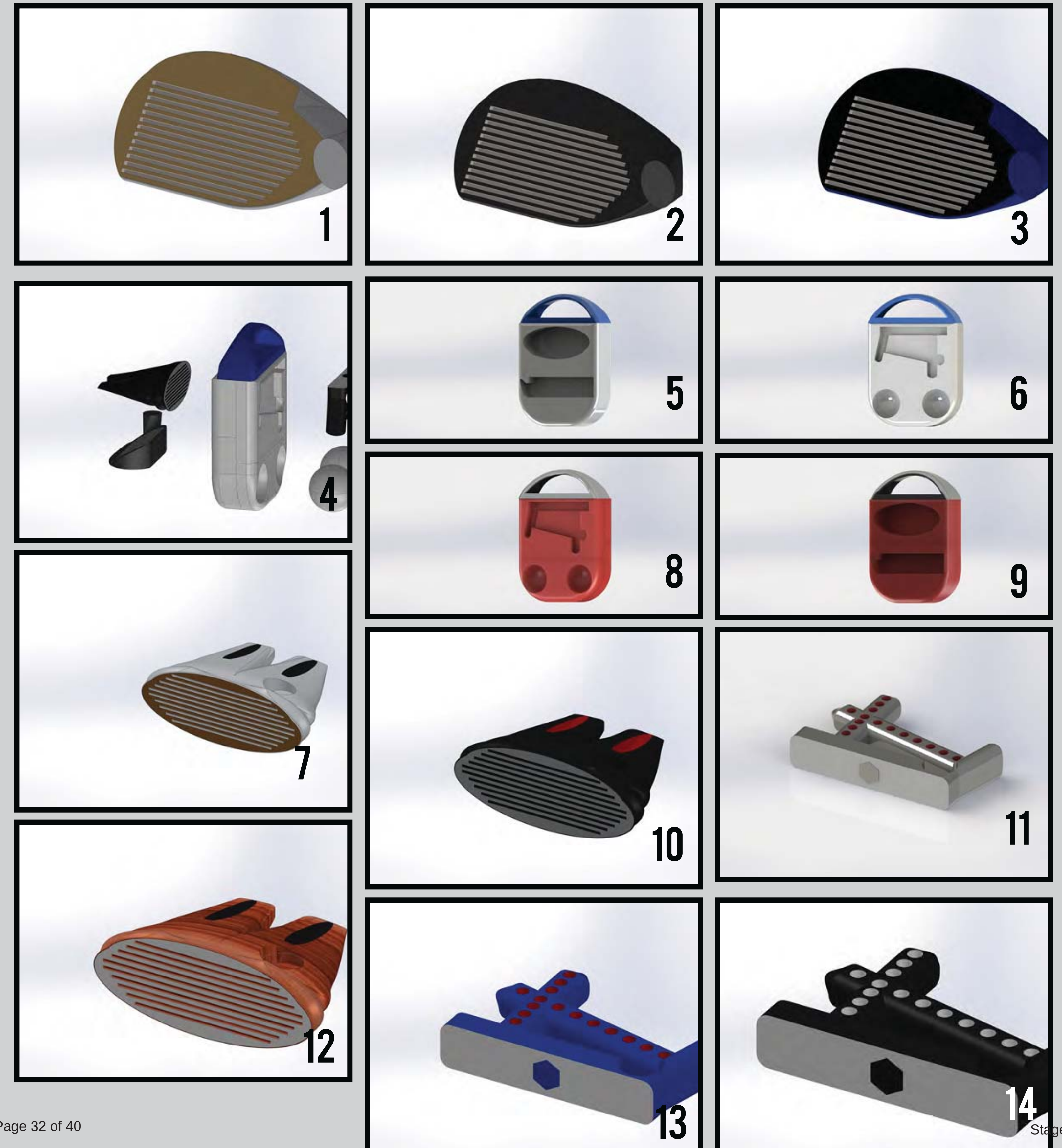
THREADED ATTACHMENT

ENGINEERING DRAWINGS

FINAL ASSEMBLY

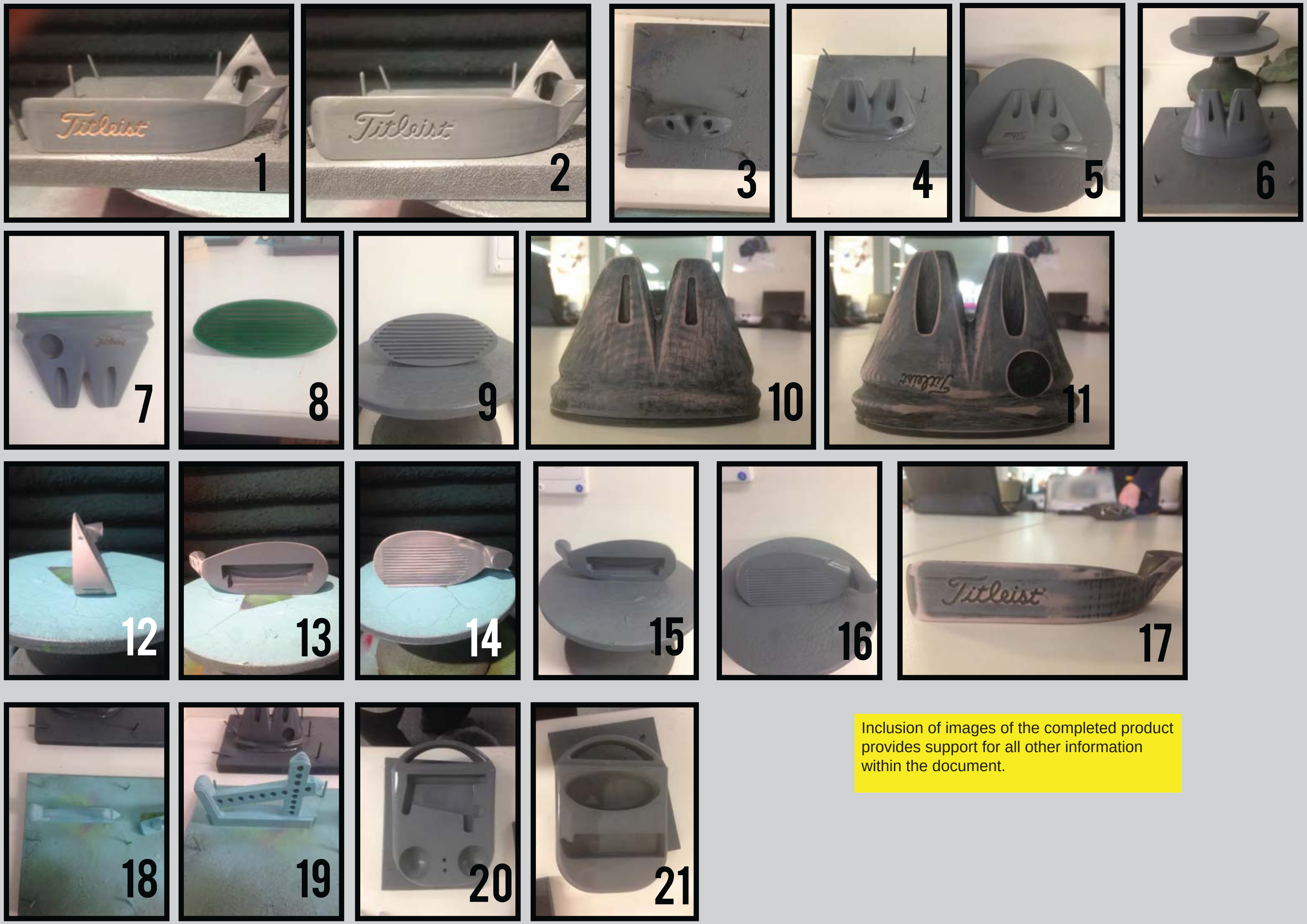


RENDERS



Renders 2, 10 and 14 were my favourite colour combinations and were mirrored in the production of my final product.

CREATING THE FINAL CONCEPT MOD-



Inclusion of images of the completed product provides support for all other information within the document.

1 - 2 iron club engraved with a logo on the bottom face and primed with paint.

3 - 11 driver club primed with paint and glued with an acrylic face, which was primed over and club wet rubbed to improve finish.

12 - 17 iron club in painting both ready to be primed and wet rubbed to improve finish.

18 - 19 putter is painted with spray putty filling any unwanted defects.

20 -21 carry case primed front and back.

CREATING THE FINAL CONCEPT MOD-

1-5 iron club painted with a matte black.

6 -7 driver club painted with matte black.

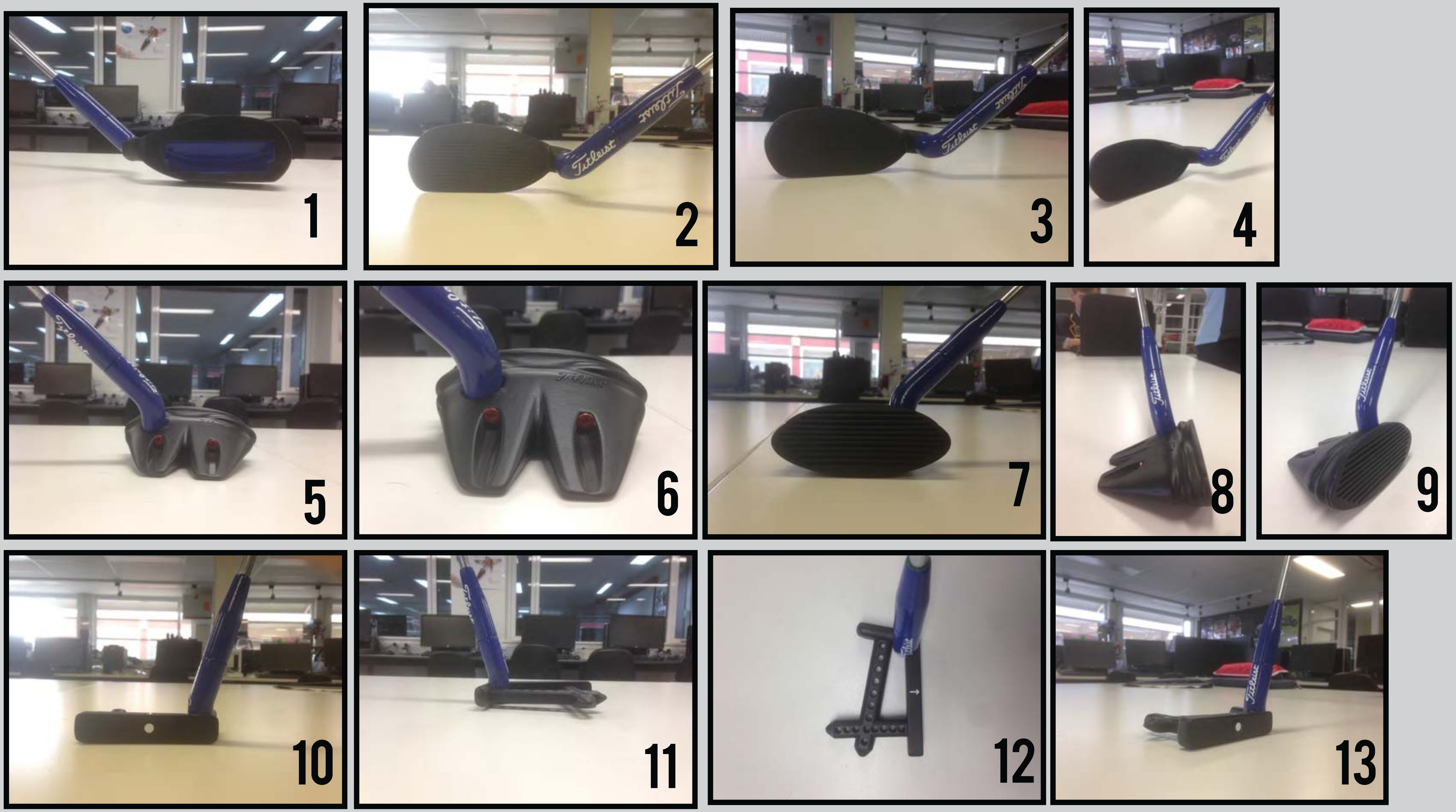
8 putter painted with a matte black.

9 -13 locking system painted with a space blue contrasting nicely with matte black.

15 - 21 carry case with all clubs placed in positions with the case primed and painted with a space blue complementing the locking system.

22 - 28 all painted used shown (22) with all clubs almost finished with matte black and space blue complemented with white stickers.

CREATING THE FINAL CONCEPT MOD-



1 - 13 all clubs connected with shaft photo-graphed from different angles to highlight all features.

FINALS (DRIVER, IRON, PUTTER & CARRY CASE)

EVALUATION

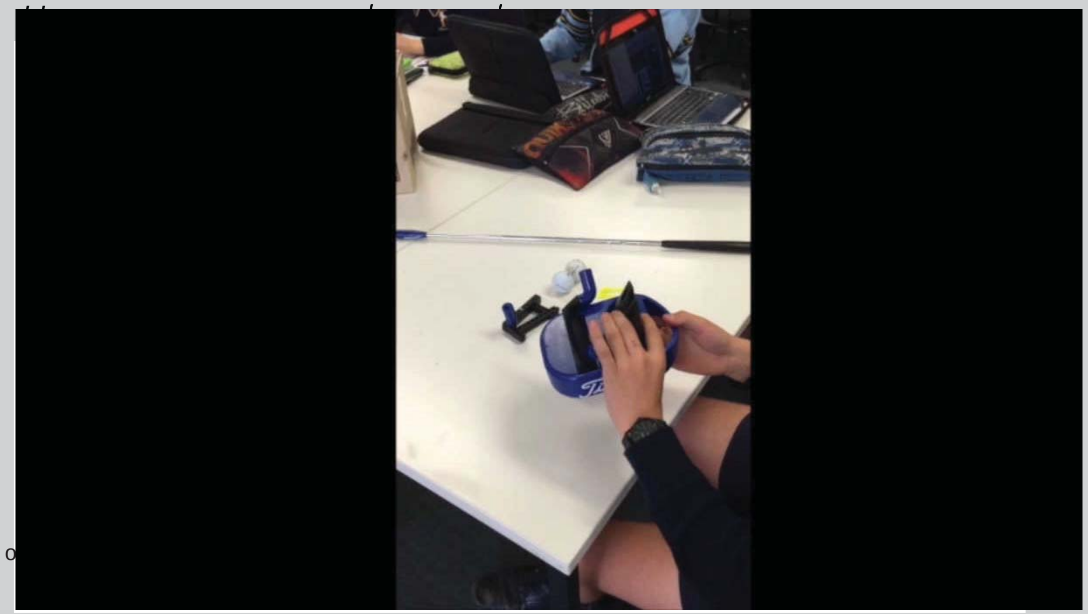
The discussion demonstrates an insightful and well-considered evaluation of the design process and the product outcome against the design brief requirements.

Analyzing the final product identified that it successfully fulfills all brief requirements to a high standard (as highlighted in the table 6).

The final product is an effective solution to the problem as it enables 3 different golf clubs to securely connect to one shaft through a simple thread locking system, accompanied by an aesthetically pleasing carry case. *View video below for a demonstration of the solution.*

The next evolution of this product would be to mass-produce in a stronger material such as aluminum with an improved locking system ensuring 100% functionality & safety. A casting process would be the best manufacturing medium (common in mass production) and is efficient with time and costs. This would allow the clubs to be a working model, while being sturdy increasing lifespan and durability, therefore dramatically reducing environmental impact. However metal casting could be damaging towards the environment as it lets of hazardous air pollutants, such as gases. In addition, the product has positive effects on society as it provides the golfing individual with a greater happiness when playing a round of golf because all three clubs fitting on the one shaft, therefore minimizing wight, cost and the strain on the player.

Many test models and modifications were made throughout the entire project using CNC milling and 3D printing. Styrofoam, chemical wood and ABS plastic were the common materials used, with Styrofoam being the ideal material, as it is the most time and cost efficent. Using these materials and processes aided in creating a successful design of the final product. If the project was to be started again, many different club designs would have been explored to produce a more exhilarating design of all golf clubs. A entire set of clubs would have been manufactured and a telescopic shaft, minimizing size.



Comments above are indicative of refined reflection of material selection and procedures with sophisticated recommendations. Reference is also made to the product impact.

Table 6 - Brief requirements completed

TASK(S)	COMPLETED (✓)
Will not be a working model, but will be to scale and finished as per the design intent.	✓ A 1:1 scale model was completed after many test models and modifications to make a visually appealing and functional club.
Will use 'functional' locking mechanism(s)	✓ A simple locking mechanism was installed on both the club and the shaft, making it user friendly.
Will make only 3 clubs (driver, putter, iron)	✓ A driver, putter and iron were manufactured in chemical wood and ABS plastic all incorperating a simple locking system.
Carry case will hold all three clubs, including two golf balls and tee's	✓ An aesthetically pleasing case was manufactured in chemical wood, holding all items intended.
Magnetic connections between clubs and case	✓ A magnetic connection has been installed on all clubs, successfully holding them in place whilst carrying.
Producing a serious of test models (styrofoam, chemical wood, ABS + PLA plastic)	✓ Many test models were manufactured in Styrofoam, chemical wood and ABS plastic, as shown in the test models & modifications section on pages 16-24.
Budget of $200	✓ The cost of my project totalled $191.64, successfully managing my budget saving $8.36.

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Performance Standards for Stage 2 Design and Technology

	Investigating	Planning	Producing	Evaluating
A	Clear, comprehensive, and well-considered identification of a need, problem, or challenge. Thorough and insightful creation and validation of initial design brief based on needs analysis and task identification. Purposeful investigation and critical analysis of the characteristics of a broad variety of existing products, processes, systems, and/or production techniques. In-depth investigation into product material options and focused and thorough critical analysis for product use. Focused and perceptive investigation into the impact of products or systems on individuals, society, and/or the environment.	In-depth analysis of information to develop imaginative, innovative, and enterprising solutions to an identified design brief. Accomplished communication of a variety of refined product design ideas, consistently using relevant technical language. Purposeful testing and refined modification and validation of ideas or procedures.	Sophisticated application of appropriate skills, processes, procedures, and techniques to create a product or system to a precise or polished standard and specification. Accomplished use of resources, equipment, and materials to create a product or system safely and accurately. Accomplished and resourceful development of solutions to technical problems that may arise during product or system realisation.	Insightful and well-considered evaluation of product success against design brief requirements. Insightful and detailed evaluation of the effectiveness of the product or system realisation process. Refined and well-considered reflection on materials, ideas, and procedures, with sophisticated recommendations. Resourceful and well-informed analysis of the impact of the product or system on individuals, society, and/or the environment.
B	Well-considered identification of a need, problem, or challenge. Well-considered creation and validation of an initial design brief based on needs analysis and task identification. Thoughtful investigation and analysis of the characteristics of a variety of existing products, processes, systems, and/or production techniques. Detailed investigation into product material options and thorough analysis for product use. Some depth of investigation into the impact of products or systems on individuals, society, and/or the environment.	Thoughtful analysis of information to develop enterprising solutions to an identified design brief. Capable communication of different quality product design ideas using relevant technical language. Thoughtful testing, modification, and validation of ideas or procedures.	Capable application of appropriate skills, processes, procedures, and techniques to create a product or system to a mostly precise or polished standard and specification. Capable use of resources, equipment, and materials to create a product or system safely and mostly accurately. Thoughtful development of solutions to technical problems that may arise during product or system realisation.	Well-considered evaluation of product success against design brief requirements. Well-considered and detailed evaluation of the effectiveness of the product or system realisation process. Well-considered reflection on materials, ideas, and procedures, with thoughtful recommendations. Well-informed analysis of the impact of the product or system on individuals, society, and/or the environment.
C	Considered identification of a need, problem, or challenge. Considered creation and validation of an initial design brief based on needs analysis and task identification. Competent investigation of the characteristics of some existing products, processes, systems, and/or production techniques. Competent investigation into product material options and analysis for product use. Generally thoughtful investigation into the impact of products or systems on individuals, society, and/or the environment.	Analysis of information to develop appropriate solutions to an identified design brief. Competent communication of product design ideas using appropriate technical language. Competent testing, modification, and validation of ideas or procedures.	Competent application of skills, processes, procedures, and techniques to create a product or system to an appropriate standard and specification. Competent use of resources, equipment, and materials to create a product or system safely and generally accurately. Development of appropriate solutions to technical problems that may arise during product or system realisation.	Considered evaluation of product success against design brief requirements. Considered evaluation of the effectiveness of the product or system realisation process. Considered reflection on materials, ideas, and procedures, with appropriate recommendations. Informed analysis of the impact of the product or system on individuals, society, and/or the environment.
D	Identification of a basic need, problem, or challenge. Creation of a basic initial design brief with some consideration of a needs analysis. Identification of the characteristics of some existing products, processes, systems, or production techniques. Some basic description of material options. Some description of the impact of products or systems on individuals, society, or the environment.	Some identification of information to attempt basic solutions to an identified design brief. Basic communication of some product design ideas with some use of appropriate technical language. Partial testing and some modification of ideas or procedures.	Partial application of skills, processes, procedures, and techniques to make one or more articles to a limited standard and specification. Some use of basic resources, equipment, or materials to create a product or system, with some consideration of safety aspects. Partial development of some basic solutions to technical problems that may arise during product or system realisation.	Description of product progress, with elements of basic testing against design brief requirements. Some description of the effectiveness of the product or system realisation process. Superficial reflection on or description of materials, ideas, or procedures, with basic recommendations. Some consideration of the impact of the product on individuals, society, or the environment.
E	Limited identification of a need, problem, or challenge. Creation of a very basic initial design brief, with support. Statement of one or more characteristics of an existing product, process, system, or production technique. Limited description of one or more product material options. Identification of one impact of a product or system on individuals, society, or the environment.	Attempted identification of some information to develop limited solutions to an identified design brief. Limited communication of one or more product design ideas. Some attempt at testing and limited modification of an idea or procedure.	Attempted application of one or more skills, to follow an appropriate process, procedure, or technique. Attempted use of resources, equipment, or materials, with emerging awareness of safety issues. Some attempted description of problems that may arise during product or system realisation.	Identification of some product progress, with limited testing. Identification of some aspects of the effectiveness of the product or system realisation process. Identification rather than description of materials, ideas, or procedures, with one or more recommendations. Emerging recognition of one or more of the impacts of the product on individuals, society, or the environment.