TREAD: WRIST MULTI-TOOL

Design and Solid Modelling Assignment Report

Details:

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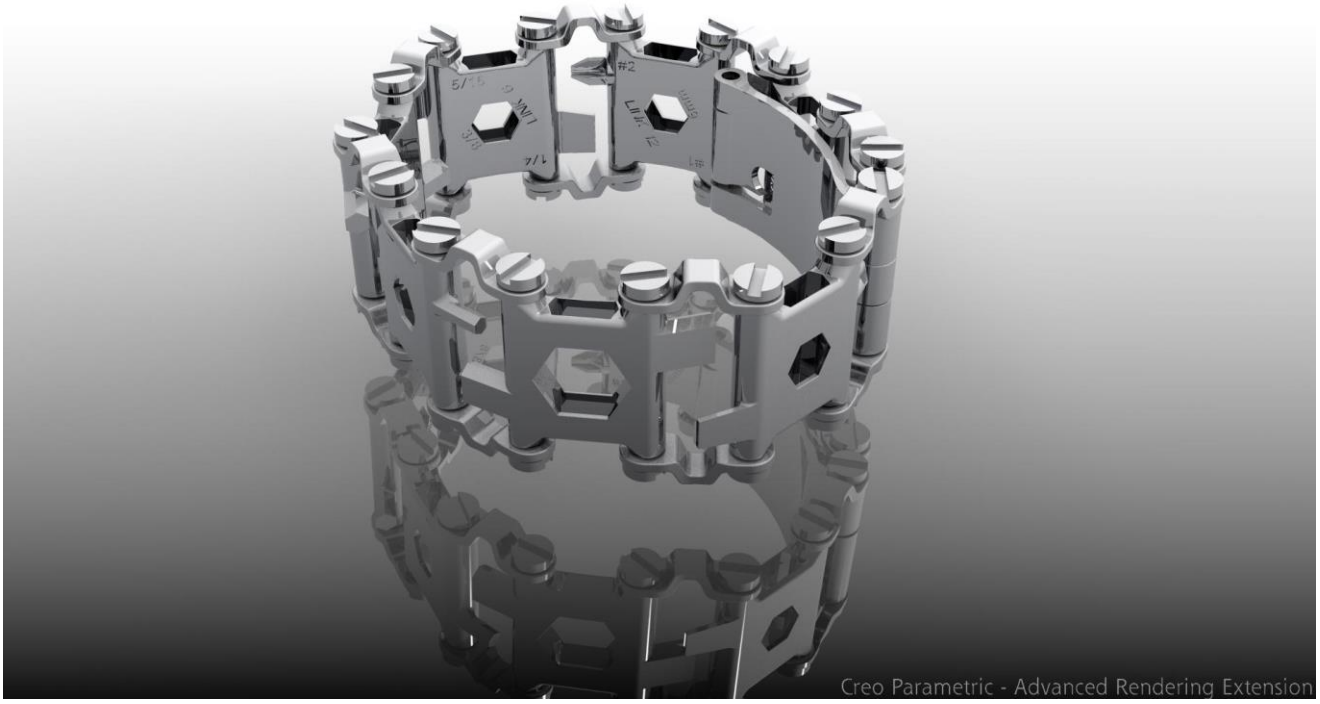
Contents:

Abstract:

This report covers the modelling process of the Tread wrist multi-tool by Leatherman using PTC's 3-D CAD software Creo Parametric. Showing the difficulties faced with the complexity of various components and how they were overcome. Then describing how the various components interact with each other once assembled together into one model. Finally, a set of exported formal drawings of the assembly and orthographic drawings of the three major parts.

Creo Complexity - Planning:

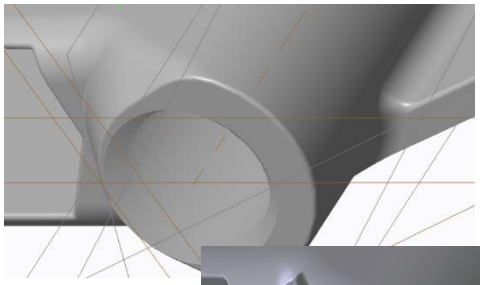
Tread is made up of a series of variable links connected with screws and links, with a clasp to allow for the wristband to be expanded in order to remove. With a lot of repeating parts, I was able to take advantage of duplicating the screws and outer chain links. However, the links in-between posed a serious challenge as each has a unique set of tools accompanying them. Therefore, I had to customise each link individual set to the corresponding specification to every tool. A list of the links can be found online here: https://www.leatherman.com/tread.html

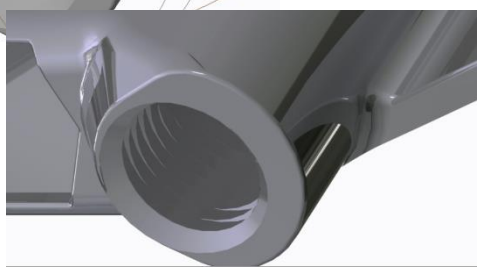


Due to Tread being made to fit around one's wrist it all the parts are designed to follow the curvature of a human arm. Therefore, for every part excluding the screws I had to consider the exact curvature to allow for the object to be assembled correctly. This meant I had to carefully plan the curvature of each part keeping all the links and clasps in sync with each other before undergoing construction of the models.

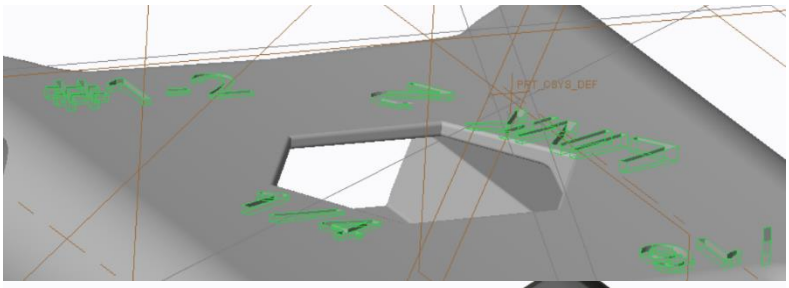
Also, because Tread is compacting a multi-tool down onto a bracelet there is a lot of very confined areas of movement which severely limits the room for error on the design. Therefore, before the modelling of my parts, I carefully set out the dimensions of conflicting areas to ensure that when it came for me to assemble my model the links could move freely past one another.

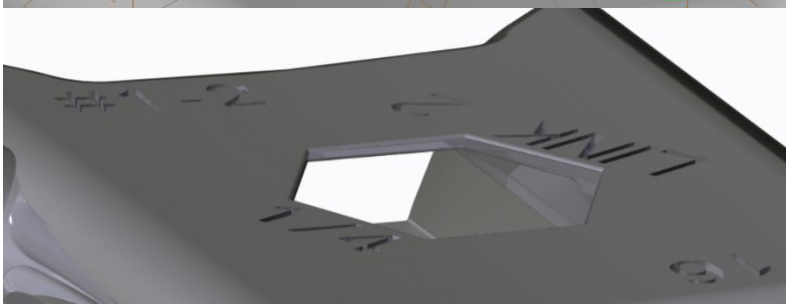
Creo Complexity – Curves and Text:



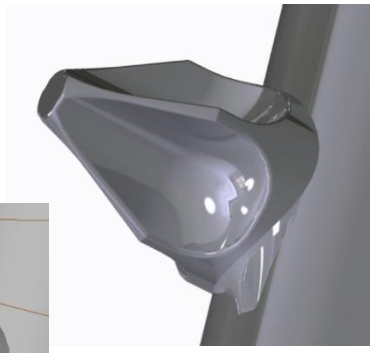


Although once I had planned out my part structures new challenges began to arise. Being a high-quality Leatherman tool, the parts are very intricate containing subtle surface variations in order to improve the visual appeal of the product. Therefore, I face a multitude of difficult slanted and curved faces requiring a large set of offset planes in order to achieve this professional look.

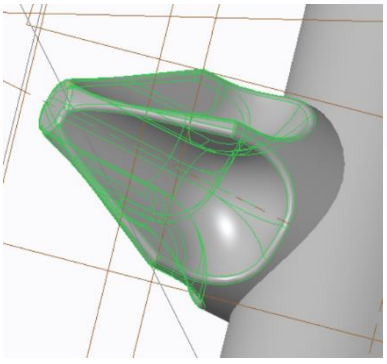


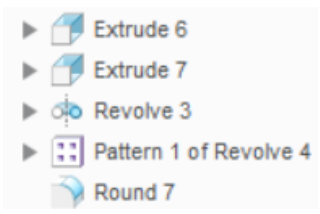


Also, due to the quality of this item text has also been engraved into each link in order to provide information on the various links for each link. In order to achieve this, I had to incorporate the text function in the sketch tool for extrudes on all of the tool bearing links. Which often became a challenge to align and arrange, especially on the curved surfaces of the links.



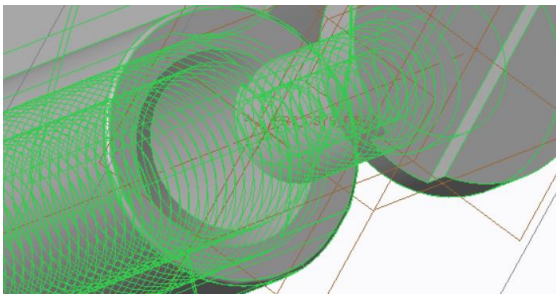
Next, I had to face the challenge of forming the wide variety of tools that come with the Leatherman Tread which each brought their own difficulty. However, I found the Phillips drives to be especially challenging. Where I had to involve a series of revolves that first cut the model down then a patterned revolve to produce the 4 edges followed by some very frustrating rounding to give it the perfect finish.

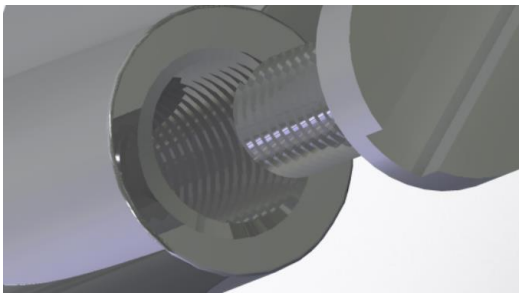




Creo Complexity – Threading and Assembly:

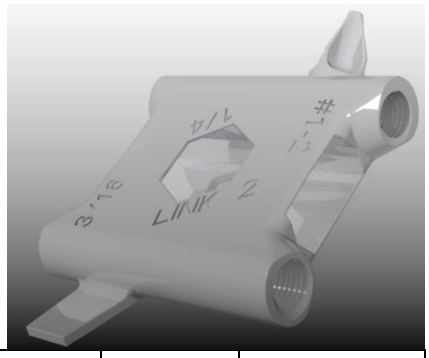
Then in order to complete my parts I had to produce matching threads within each link and screw finishing the finer details within each part. This was done using the helical sweep tool allowing to pass a sketch through a specified spiral at the desired pitch. Ensuring that I had matching threads between each link and screw.





Finally, due to the nature of the object all the linking parts (excludes the screws) contains a variable moving axis on each end. Therefore, during the assembly of Tread, I had to form a very large amount of pin constraints “59” (One for every part). Which became very time consuming to get right, however, it resulted in the model to be easily opened and closed around the constraints. I also limited the angle of rotation for the clasp so the movement of the hinge stops when Tread is completely closed.

Object Design and Operation:



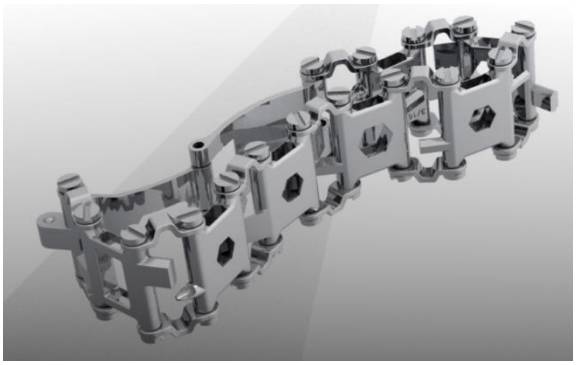
Links:

Making up the majority of the Tread are the variety of links which hold onto most of the tools. They are able to be pivoted alongside each other allowing them to be moved and held in a position where they the tools can be operated. Below I have listed the individual tools on each link.

Link Number	2	6	7	8	9	10	12
Upper Tool	#1-2 Phillips Screwdriver	5/16” Screwdriver	3/32” Hex Drive	1/4” Hex Drive	5mm Hex Drive	3mm Hex Drive	#1 Phillips Screwdriver
Centre Tool	1/4" Box Wrench	3/8” Box Wrench	3/16” Box Wrench	Oxygen Tank Wrench	10mm Box Wrench	8mm Box Wrench	6mm Box Wrench
Lower Tool	3/16” Screwdriver	1/4" Screwdriver	1/8” Hex Drive	3/16” Hex Drive	6mm Hex Drive	4mm Hex Drive	#2 Phillips Screwdriver

Clasp Connector:

This is half of the clasp mechanism that acts as the clipping slot where the ball-bearing spring lock clips into, holding the bracelet on and in place. It also contains a #2 square drive the can be accessed by folding and flattening the Tread down.



Bottle Opener:

The second part of the clasping unit which houses the ball bearing and spring system which locks into the clasp connector to close the bracelet and acts as a 1/4” socket adapter. This allows the tread to be used with a 1/4" socket set dramatically increasing the variety of tools this compact object holds. Shown to the left is the object manipulated into a position where the bottle opener would be used.

Spring pin:

A spring loaded pin that is inserted between the Clasp Connector and Bottle opener to act as a more minimalistic hinge at the clasp.

Spring:

Helically swept, tiny 2mm spring that sits behind the ball bearing which allows the bearing to spring inwards and then locks back when in place.

Object Design and Mechanisms:

Ball Bearing:

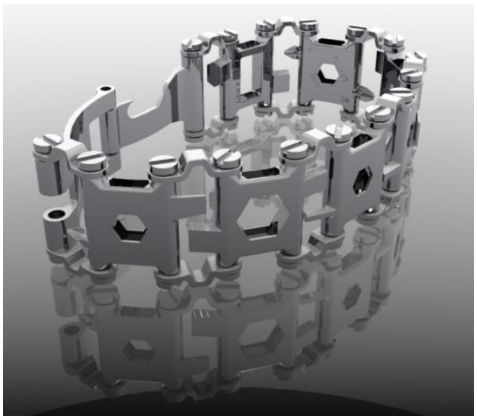
Acts as the surface in the spring-bearing lock mechanism. Moving inwards as the Clasp Connector slides over the lock and then springs back to lock.

Outer chain link:

Connects the linking components together by branching between screws set into the ends.

Screw:

Secures into the various components holding the Outer chain link in place while also allowing a small amount of room for movement between the parts with a slight counter sink.



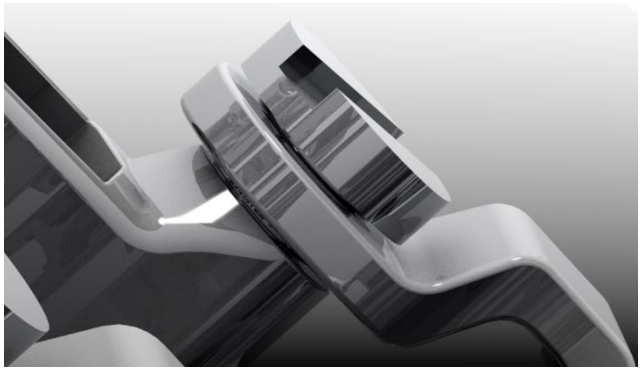
Ball Bearing-Spring Lock:

Clasp Mechanism:

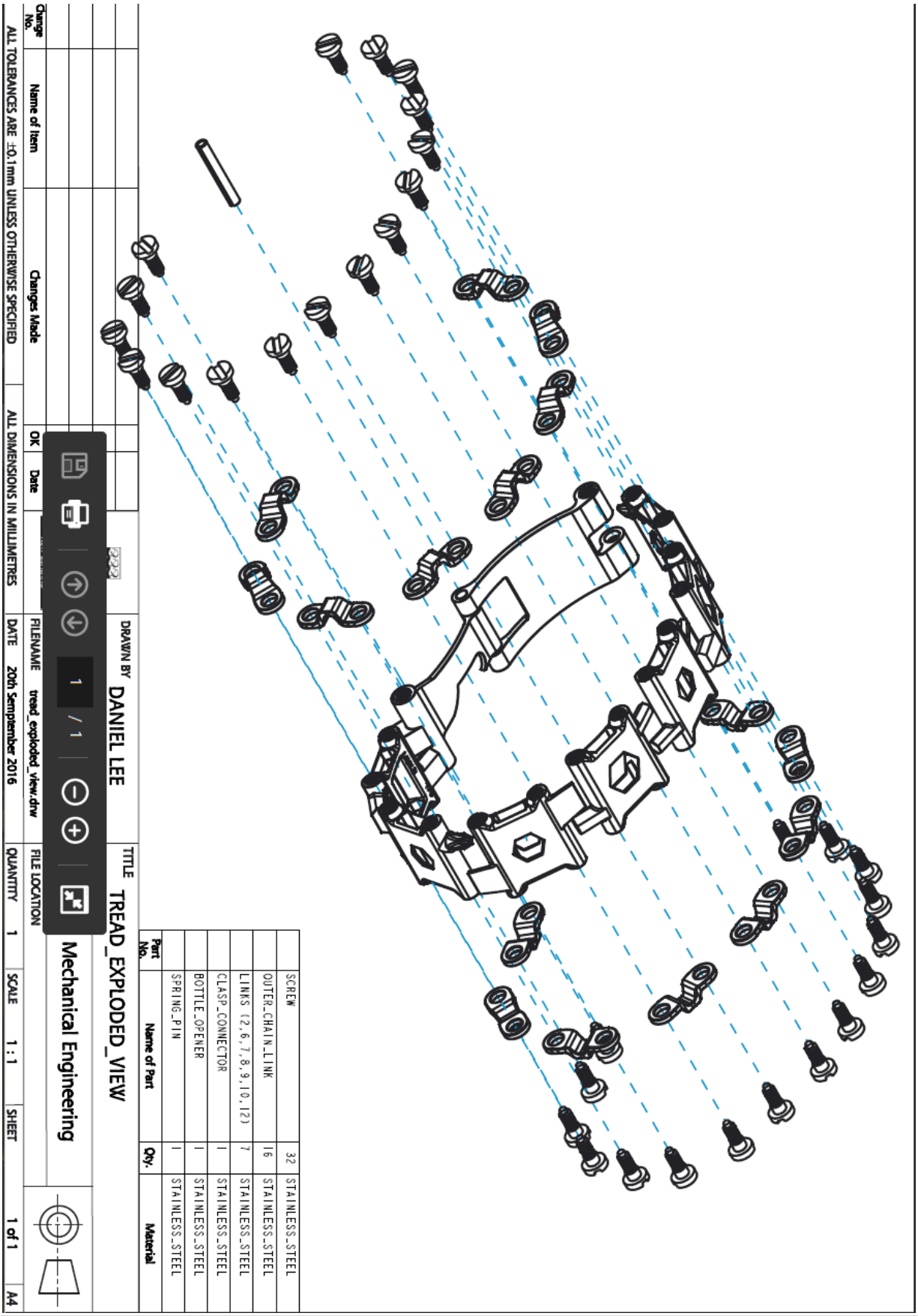
The aim of this piece is to allow for the user to expand and retract the diameter of the wristband in order to allow Tread to be taken off and on respectively. This is achieved by a hinge system between the two halves of the clasp (Bottle Opener and Clasp Connector) secured by an inserted spring pin. This allows for movement between the two pieces, letting the user open and close the bracelet.

To allow for the user to keep the clasp held in place when they have Tread locked around their wrist. This is done by enforcing a Ball Bearing into a socket within the Clasp Connector with the Spring hidden behind it. A force is required to be applied to this system in order to overcome the Spring and move the Ball Bearing back into the housing and allow the Bottle Opener to slide out of the connection position.

Oscillating Screw Pin:



At the ends of every linking component (Links, Clasp Connector and Bottle Opener) are Screws and Outer Chain Links that join the individual components together. Each is threaded to match every corresponding part allowing them to be placed within one another. Although, the important aspect is the slight amount of space positioned between the head of the screw and the threading which allows for the movement between links. This gives a loose pin connection at the ends of each linking component. Which allows for the entire bracelet to bend and fold over on itself allowing for the use of any of the tools.



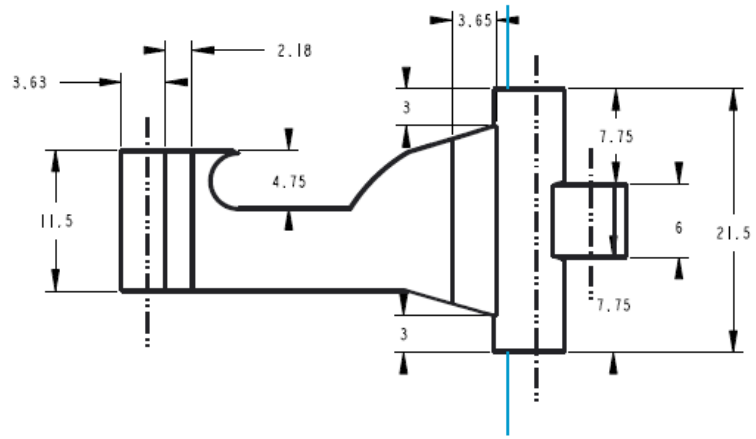
Part No.	Name of Part	Qty.	Material
	SCREW	32	STAINLESS_STEEL
	OUTER_CHAIN_LINK	16	STAINLESS_STEEL
	LINKS (2,6,7,8,9,10,12)	7	STAINLESS_STEEL
	CLASP_CONNECTOR	1	STAINLESS_STEEL
	BOTTLE_OPENER	1	STAINLESS_STEEL
	SPRING_PIN	1	STAINLESS_STEEL

Change No.	Name of Item	Changes Made	OK	Date

ALL TOLERANCES ARE ±0.1mm UNLESS OTHERWISE SPECIFIED | ALL DIMENSIONS IN MILLIMETRES | DRAWN BY DANIEL LEE | TITLE TREAD_EXPLODED_VIEW

DATE 20th Semptember 2016 | FILENAME tread_exploded_view.drw | FILE LOCATION | QUANTITY 1 | SCALE 1 : 1 | SHEET 1 of 1 | A4

Mechanical Engineering



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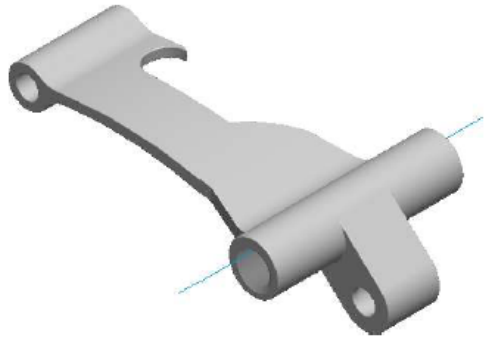

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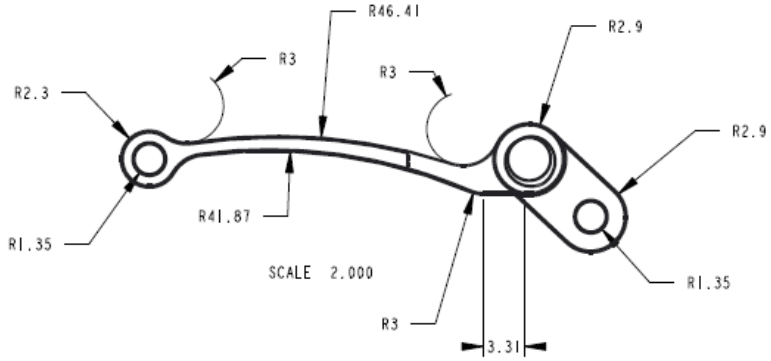

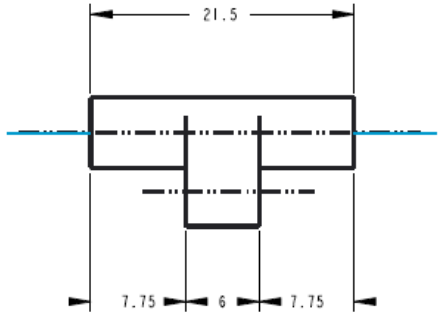

Change No.	Name of Item	Changes Made	OK	Date

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

DRAWN BY	DANIEL LEE
TUTOR	RICHARD LIN
GROUP No.	-
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DEPARTMENT	Mechanical Engineering
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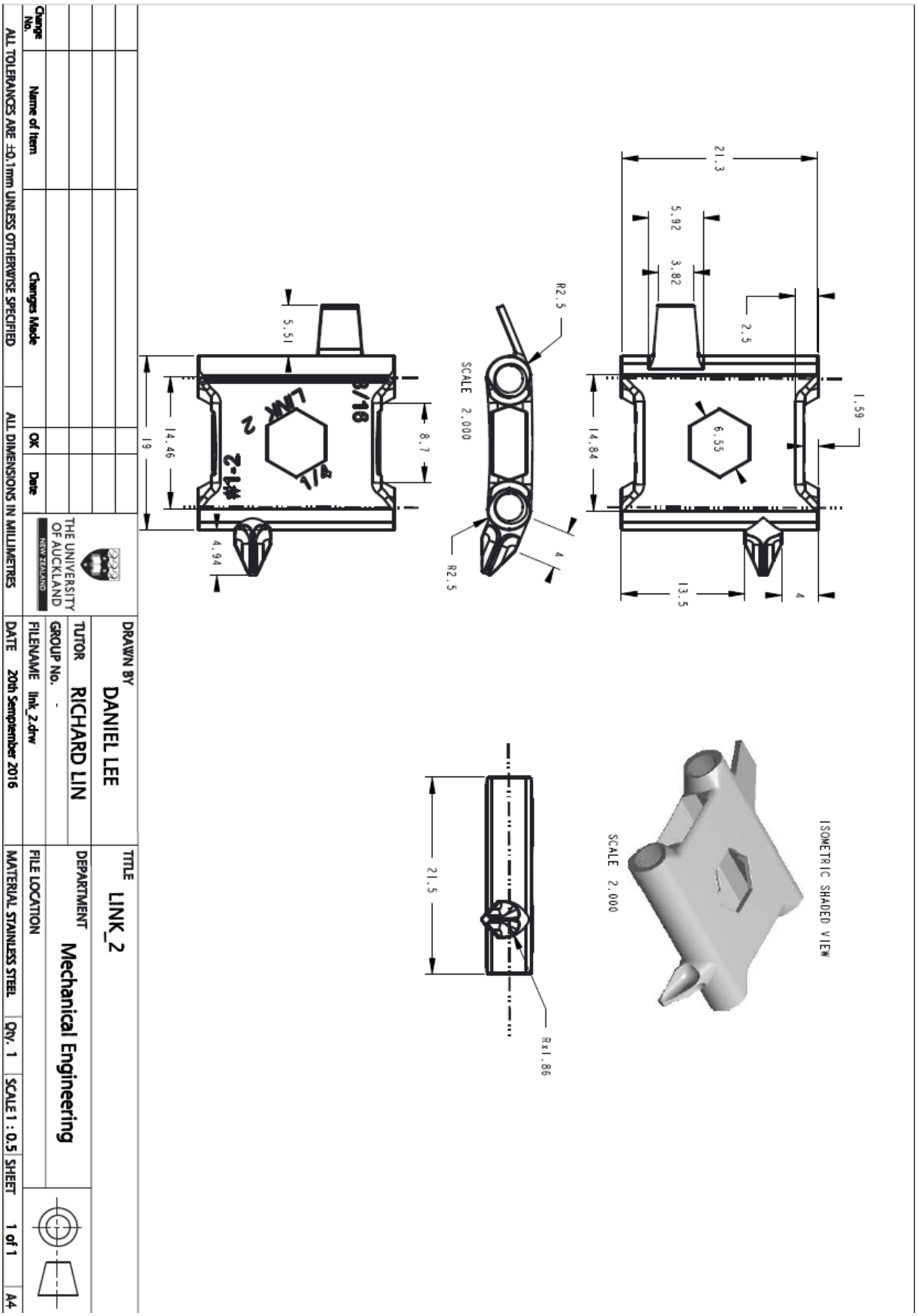
SHEET	1 of 1
	A4

ALL TOLERANCES ARE ±0.1mm UNLESS OTHERWISE SPECIFIED

ALL DIMENSIONS IN MILLIMETRES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19
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LINK 2
2-1/4
1/4
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Name of Item
Changes Made
OK
Date
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THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
DRAWN BY DANIEL LEE
TUTOR RICHARD LIN
GROUP No. -
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DATE 20th Semptember 2016
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DEPARTMENT Mechanical Engineering
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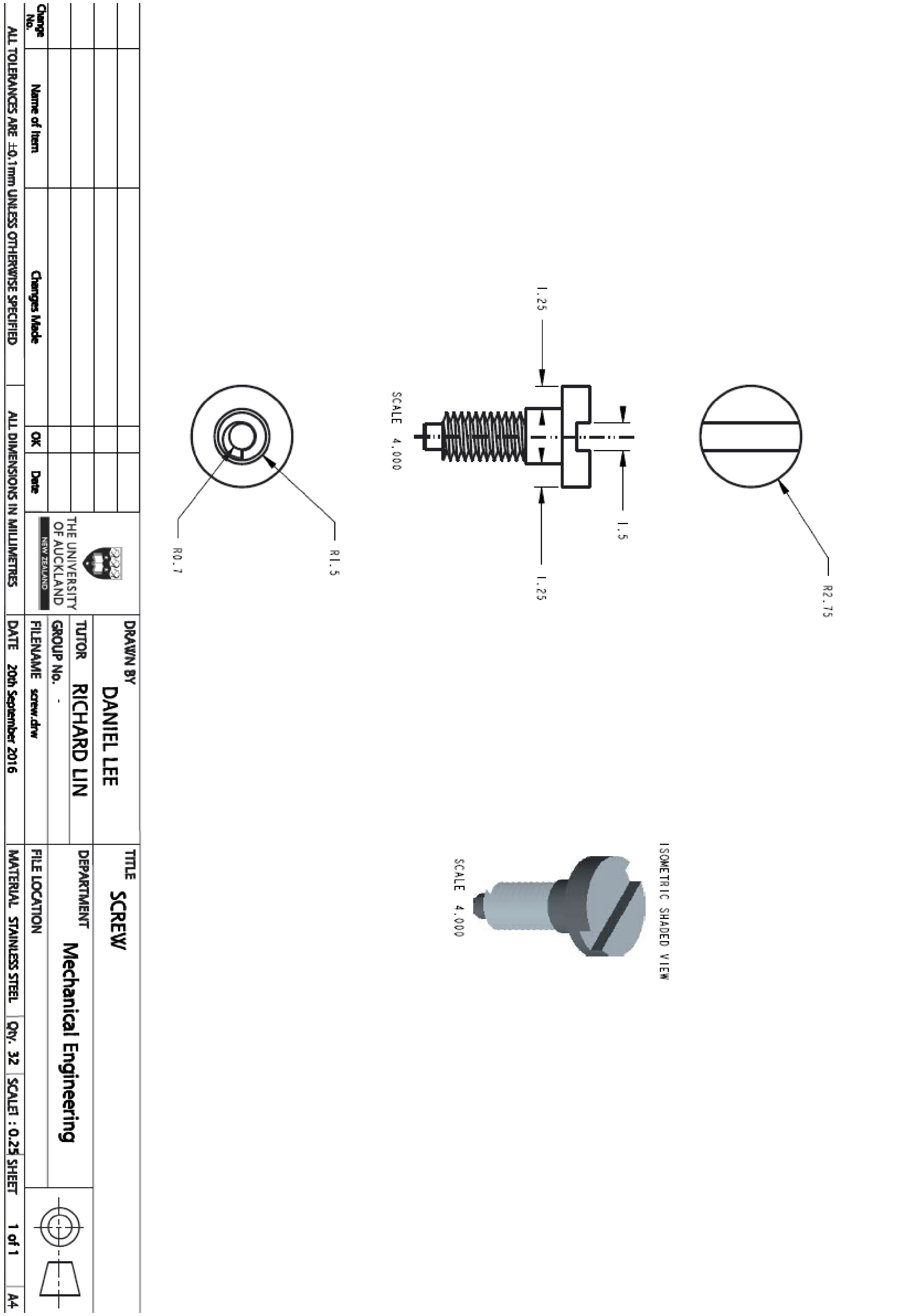
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Changes Made
OK
Date
ALL TOLERANCES ARE ±0.1mm UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS IN MILLIMETRES
THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
DRAWN BY
DANIEL LEE
TUTOR RICHARD LIN
GROUP No. -
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DATE 20th September 2016
TITLE
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DEPARTMENT
Mechanical Engineering
FILE LOCATION
MATERIAL STAINLESS STEEL
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SHEET 1 of 1
A4

Product Design Specification

Environment:

- The Tread wristband should be able to withstand tough conditions. As the tools is inspired to be taken everywhere the user goes. Including, outdoors, around water and around machinery. Each posing major threats to the life time of the product like rust, corrosion and physical permanent deformation.
- Although it needs to be ergonomically suitable for the user to comfortably wear on their wrist. Making it a tough balance for the design of the tool.

Aesthetics/Materials:

- The stainless steel used in the manufacturing of the parts needs to be hard enough to prevent visible deformation from everyday use. Although tough enough to withstand fractures from sudden impacts.

Function:

- The screws must allow for enough room for the outer chain link to move freely, allowing for the user to manipulate the orientation of each link.
- Linking components must have enough room between corresponding parts to avoid collisions between one another.
- The spring in the ball bearing-spring locking mechanism must have a spring co-efficient strong enough to hold the bracelet in place when the user is wearing Tread. Although, forgiving enough to allow the user to remove the bracelet with a reasonable amount of effort.
- Secured screws must be able to be removed by the user, in order to allow them to customise their components. As for them to be able to remove and substitute out various links, screws need to be removed.