project orcat

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research methods

experience

The reason I chose to do a project regarding cycling is because I see myself ending up in that industry. Over summer I offered my services as a bike mechanic to get people out in lockdown. Experiencing the Bike Boom first hand.

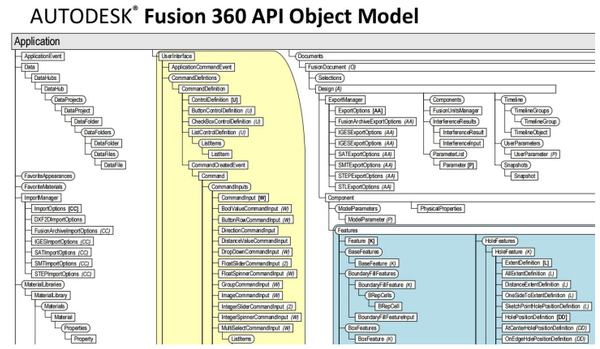
I fixed old rusted bikes and built brand new time trial bikes. I sourced people their first bike, picking out what they needed. I set up and fixed hundreds of differnt bikes over lock down. What did I notice?

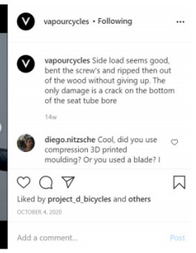
People dont really know what they want, and really dont know what they need.

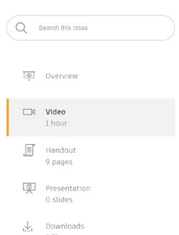
‘experience’

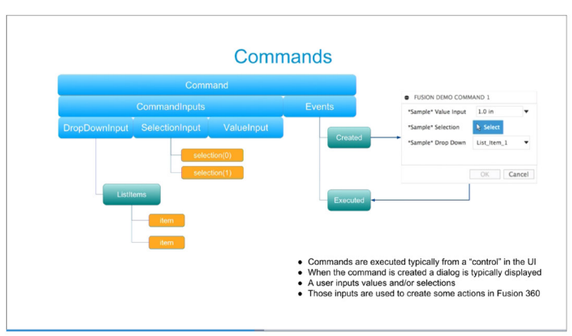
It’s been a year of learning by observing, and learning through other peoples eyes.

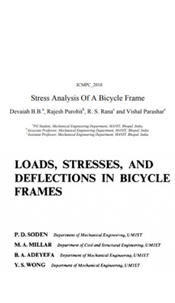
Bike design, frame building, bike fitting, biomechanics, generative design, javascript, manufacturing, modelling. parametric design, fusion API, React and so on. There was a lot of learning curves to overcome this year. Due to the nature of the year the majority of research happened through YouTube, books, research papers and journals, documentaries and the internet.

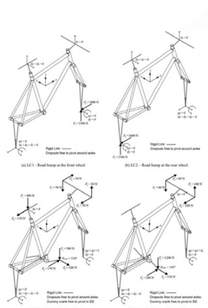


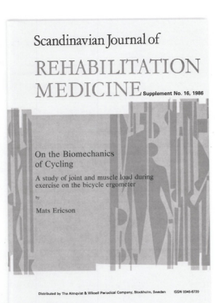












interactions

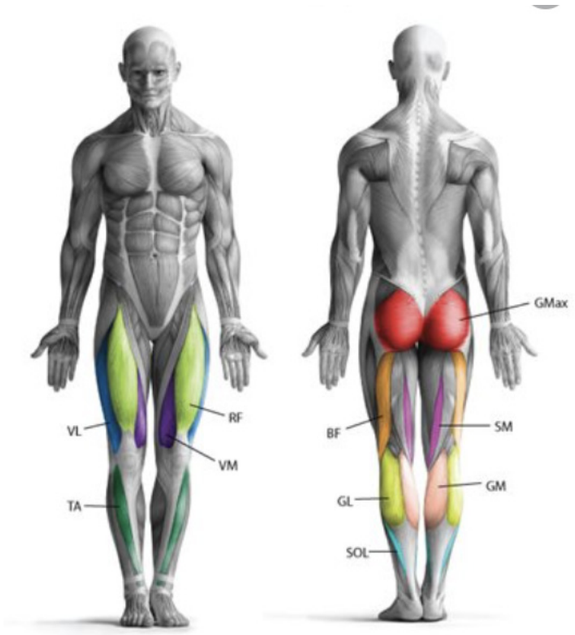
A combination of the three stakeholders lead to the variables that define my project.

Off-the-shelf items are designed to fit no individual in particular and as many people in *general.*

user input

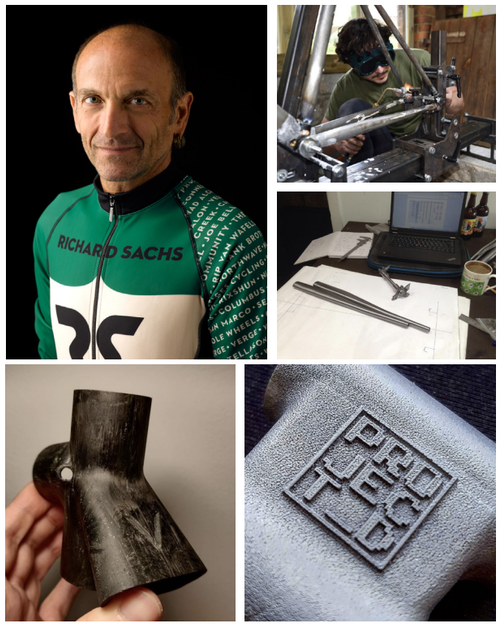
Interacting with previous customers and small lockdown cycle groups, I was able to put together a list of the variables which define cycling for the everyday cyclist. It is much moe than just a sport for people, it is a way of life, a means of travel, an idea of a holiday, a way to stay happy. The bike is bigger than the product.

specialist insight
medical



I spoke and met with physios, masters of biomechanics, kinesiologists and orthopedics all with a background in the sport. I learned of a general skepticism surrounding the validity of some fit processes, and what sort of protocol to adhere to when designing my product. I got an introduction into poor joint motion and how to detect it on and off the bike. Furthermore I learned that almost all injuries caused in cycling are due to bad positioning, posture and an unawarerness of what's poor cycling style.

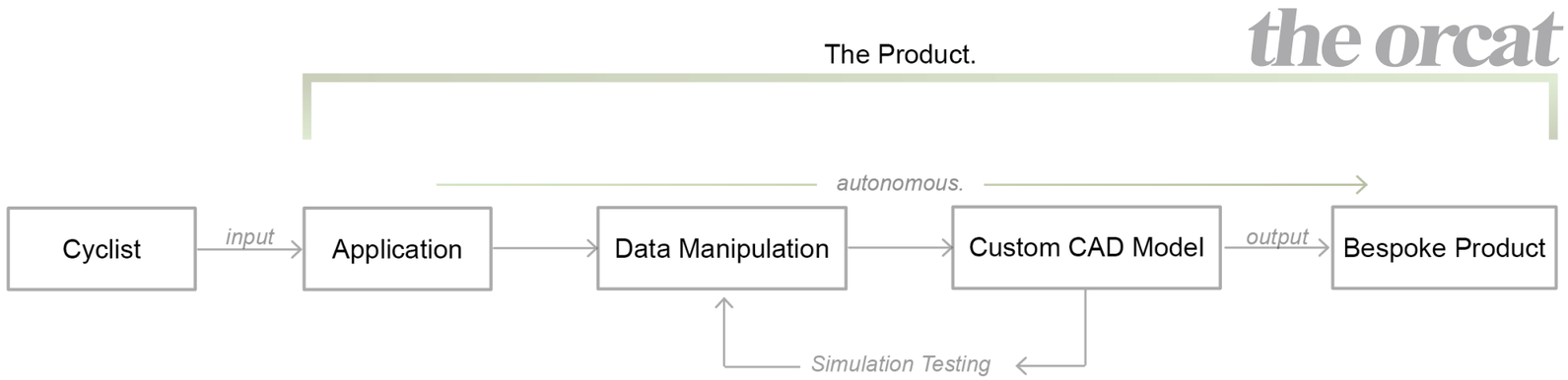
specialist insight
bicycle

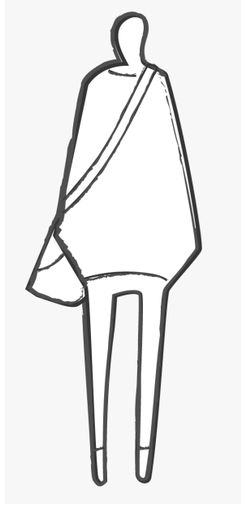


I met with frame builders in Glasgow, spending an afternoon in the workshop watching a product come together, really developing an appreciation for the skill and craftsmanship of custom bike builders. I got in touch with cycling specialist engineers in Hong Kong to hobbyists in Berlin to enigmas in America. I learned of the insides and out of frames from a range of different people in the industry.

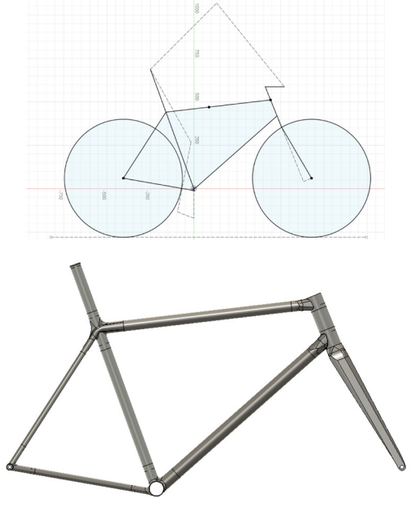
product overview

The Orcat is an end to end process. It starts with a comprehensive assessment of what a cyclist wants and needs from a bike and ends with the output of a bike that has been designed and constructed specifically to match those wants and needs. The Orcat process has four distinct stages, all with differing design requirements.





Order Number	0001	0002	0003	0004	0005
Description	del torigo	wisp	valderama	aletorije	le mula
BottomBracketH	280	300	290	237	276
TopTubeCC	580	590	550	580	555
SeatTubeCC	530	500	520	530	530
ForkRake	50	45	48	39	51
ForkLength	380	380	380	380	380
WheelDiameter	680	680	680	680	680
ChainStayLengt	410	415	412	408	409
SeatTubeAngle	70	71	70.5	69	70
HeadTubeAngle	68	70	69	69	71
TopTubeAngle	0	0	0	0	0
HeadTube	140	160	135	155	140
BottomBracketW	68	68	68	68	68
RearAxle	130	130	130	130	130
FrontAxle	100	100	100	100	100
L	26	26	26	26	26
X	5	5	5	5	5
B	25	25	25	25	25
SaddleTT	120	120	120	120	120
SeatTubeDiamet	30	30	32	30	30
FrontWheelClear	40	40	40	40	40
HeadTubeDiame	45	45	45	45	45
TopTubeDiameta	30	30	32	30	30
DownTubeDiame	30	30	35	30	30
ChainstaDiamete	18	18	18	18	18
SeatStayDiameti	16	16	15	16	16
HTWT	1.2	1.2	1.2	1.2	1.2
DTWT	1	1	1	1	1
TTWT	1	1	1	1	1
STWT	1	1	1	1	1
CSWT	1	1	1	1	1
SSWT	1	1	1	1	1
ForkDiameter	18	18	18	18	18
FWT	1.5	1.5	1.5	1.5	1.5
BottomBracketD	30	30	30	30	30
BBWT	1.5	1.5	1.5	1.5	1.5
Cranic_Length	340	340	350	340	340
ClearToHeel	400	400	400	400	400
SeatTubeCT	575	575	575	575	575
STTopToSaddle	120	120	120	120	120
TyreWidth	28	28	28	28	28
SaddleSetback	10	30	50	1	5
Standover Height	750	720	770	800	698
Stem	110	100	110	130	150
SaddleHeight	766	800	730	777	750
torso	540	540	540	540	540
arm	690	690	690	690	690
femur	480	480	480	480	480
inseam	890	890	890	890	890
ankletoball	120	120	120	120	120



product breakdown

application

An application has been developed using Javascript code and React software to capture a broad range of user inputs that provide the raw ingredients for designing the right bike. Feedback from interviews and discussions with bespoke frame builders and physiotherapists helped shape and design the span of data fields required. The final version of the App segments data input fields by Profile, Metrics, Variables, and Fine Tuning. With the help of a software engineer, the app could be fully automated by linking in available, but expensive, bike geometry databases and coding the variables. For the purpose of this project, only the profile and metric inputs are coded. The variables and fine tuning require to be manually fed.

manipulation

React feeds the data into a manipulation model on Google Sheets that takes the raw data and creates the geometry required for a frame and a specification list of the parts needed.

custom CAD

The output from the manipulation model feeds into Autodesk's Fusion 360 software, through an API script command, adjusting the parameters used to design and define the frame. At this stage, simulation testing is manually carried out to test standard & regulatory compliance and a feedback loop puts the outcome back into the manipulation model to revise and update.

bespoke product

The final stage of the process takes the CAD model and uses generative design to produce bespoke bike lugs that can be 3D printed. Bike lugs control and define a bikes geometry and absorb the forces produced by the cyclists. The bespoke lugs are compliant to cycling safety standards and critically, designed specifically for each user specification.

goals

current problem

It may sound very basic but for all cyclists, including new participants, getting a bike that fits your wants and needs as a cyclist will be beneficial in a number of ways.

- In the long run, it will save money and waste. There will be no need to adjust, amend and upgrade components to try and retro fit a bike that has already been purchased.
- It will reduce health and discomfort issues that stem from cycling the wrong type or size of bike and in doing so, it will enhance the enjoyment of the activity and personal
- wellbeing.
  For cyclists at the elite or competitive end of the spectrum, it will offer the small marginal gains that can make all the difference between winning and losing.

Greater participation in cycling is a good thing. Good for physical and mental wellbeing. Good for the environment. A well fitted bike is a positive step to encouraging more miles travelled on two wheels. But at this point in time, a good bike fit is limited by construction methodologies and commercial considerations on the supply side. Mass market production means sizing must work from demographic averages and all the shortcomings that go with that. And the nature of retail is to create new type classifications to market and sell (Road, Touring, Gravel, Mountain Bike, Hybrid, Commuter etc). These type classifications create 'silos' for component specifications. What a good bike fit and bike design should mean is finding the right geometry and choosing the right components without restriction by type classification or industry averages. Bike fitting, design and construction does not offer this at the moment.

emerging gap

Recently, high end bike frame builders have begun experimenting with construction methodologies that are relatively new to cycling. The first 3D printed prototype/ concept frames are being tested. Some of the best-known frame builders in the world of cycling have already publicly acknowledged that 3D printing is the future. Dimitris Katsanis, one of the worlds leading top end carbon frame designers, has only recently, switched his entire focus to 3D printed Titanium.

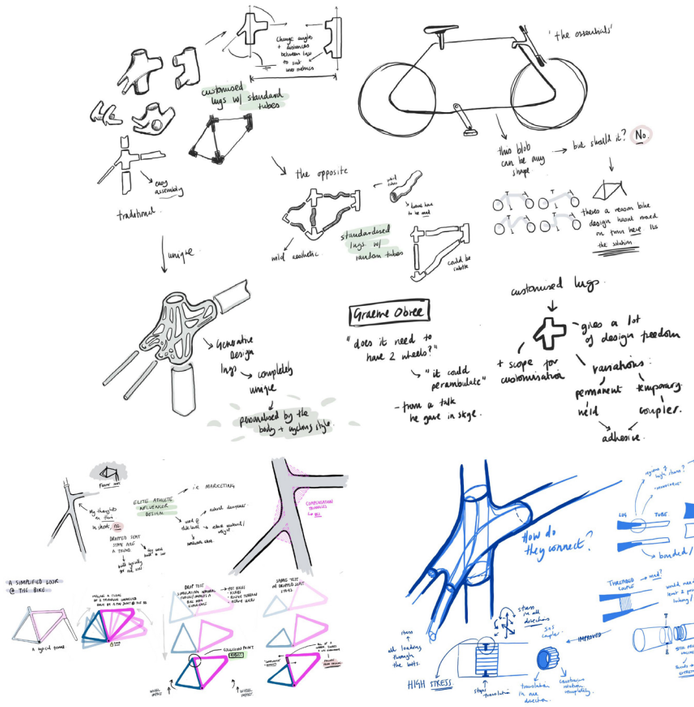
As the manufacturing process is developed out, the capability of tailoring individual bikes to fit the unique requirements of every cyclist will be created. No longer will the choice be between the extremes of an off the shelf mass produced bike that is sized to global averages or a manually built frame that relies on the experience and skill of the builder to deliver an end product that will live up to its price tag. A middle ground is emerging where bike frames will be tailored to suit each individual but constructed using sophisticated methodologies and mixed materials. The gap will be the process of collating, analysing, and using the right input data to feed into and extract the most out of the new construction process. My project anticipates this gap and provides a ready-made solution.

future opportunity

Cycling in the UK is in a sustained phase of growth. COVID-19 in 2020 provided a step change in cycling participation and as towns and communities plan for a greener future, the boom is set to continue. Right now, the cycling market in the UK has plenty of room for expansion through increased numbers of participants. As markets stop attracting new volume, innovation, differentiation and premiumisation become key to growth in value. Technology has a huge role to play in that. Looking across at the 'adjacent' market of golf which is more mature in the UK and to an extent saturated, we begin to get an idea of how the market for new bikes will continue to develop. Golf has demonstrated that custom fitted, bespoke design can successfully capitalise on the desire of participants who want something to talk about with their peers or perhaps more importantly, give them the edge when it comes to performance. As the market for bike frame design follows this trajectory, my project will provide the right type of platform for businesses to take advantage of the commercial opportunity. There will be no reason why high end off the shelf bike brand owners cannot begin to offer bespoke bike fit, design and construction to their range. It won't be cheap, but other adjacent markets such as golf demonstrate that there will be demand.

concept development

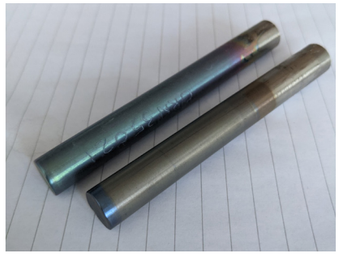
2D



A range of different solutions were conceptualised with the focus on how to address the current problem, meet an emerging gap and design for a future opportunity. In the end a fully fledged system was created. A desire to have some proof of concept, led to prototyping ways of doing DIY manufacturing processes from home. A part was produced using braided carbon fibre tubes which were vacuum bagged to a ‘generative design’ lug section. The part was ~10% lighter and was able to support 70kg of body weight without deflection. A success!

3D

Processes



DIY load testing, annodising and vacuum bagging techniques.

defined by the user

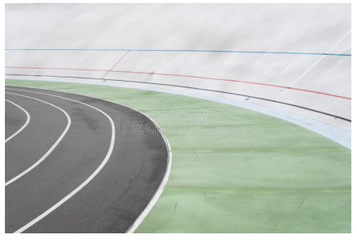
everyone is different.
every *one* is different.

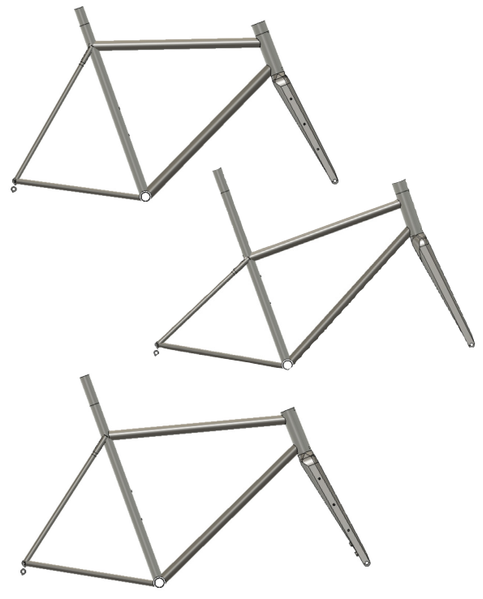
It doesn’t matter what shape, size, height, ability or ambition the user has. The bike is defined by their biometric data, what they want to do and where they want to go.







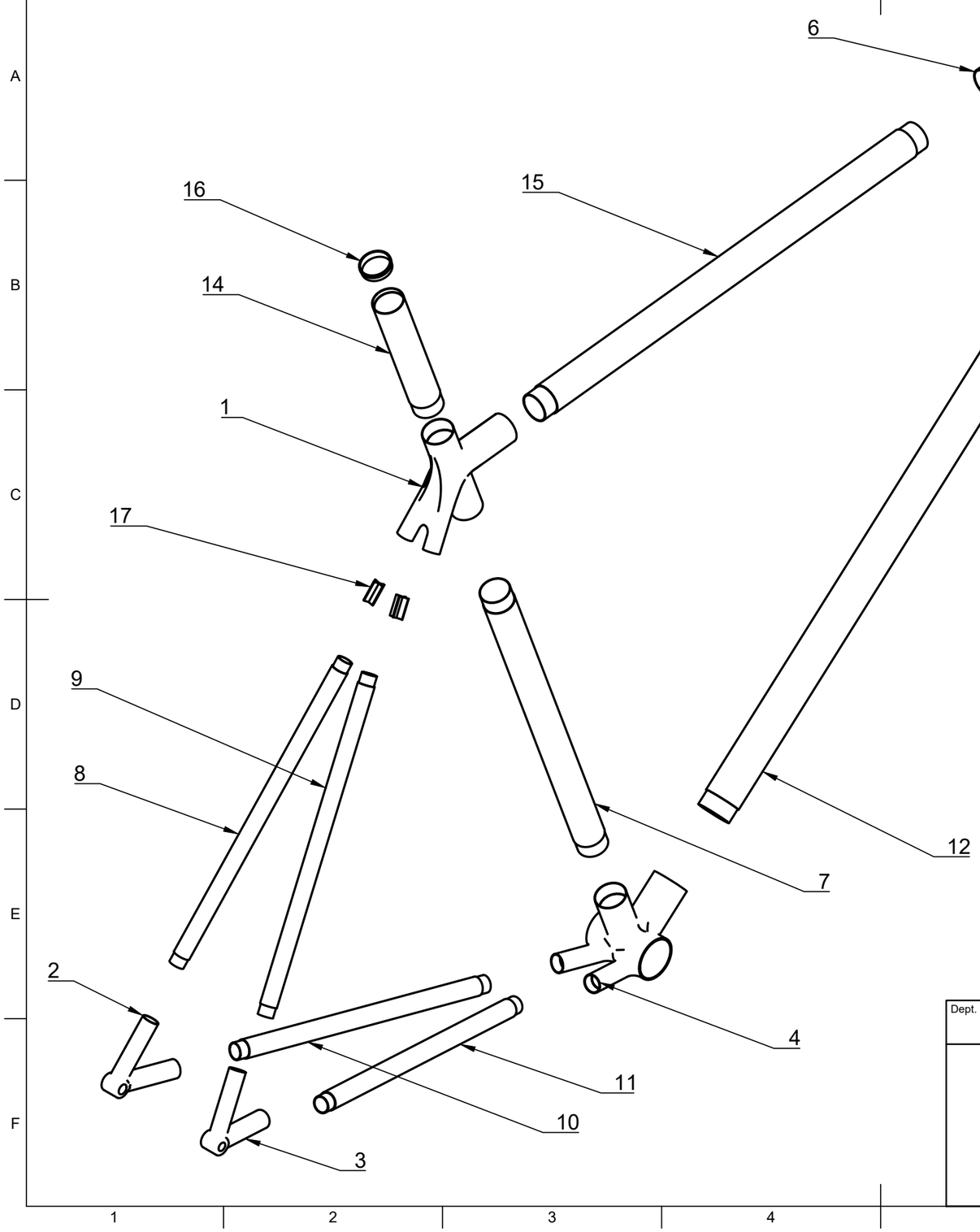





Creating a mathematical model which positions users based off angles defined by style of cycling, adjustments and manipulation of the frame could then be carried out to accomodate for pre existing conditions, for any limitation in the users range of movement, and for any weakness or impairment of the users muscles and ligaments.

The product consists of 3D printed Titanium 6/4 lugs and carbon fibre tubes. The reason for this choice being the infinite potential for customisation it offers. Differing the layup orientation can produce different stiffnesses of tubes which can be formed round a number of different shaped mandrels.

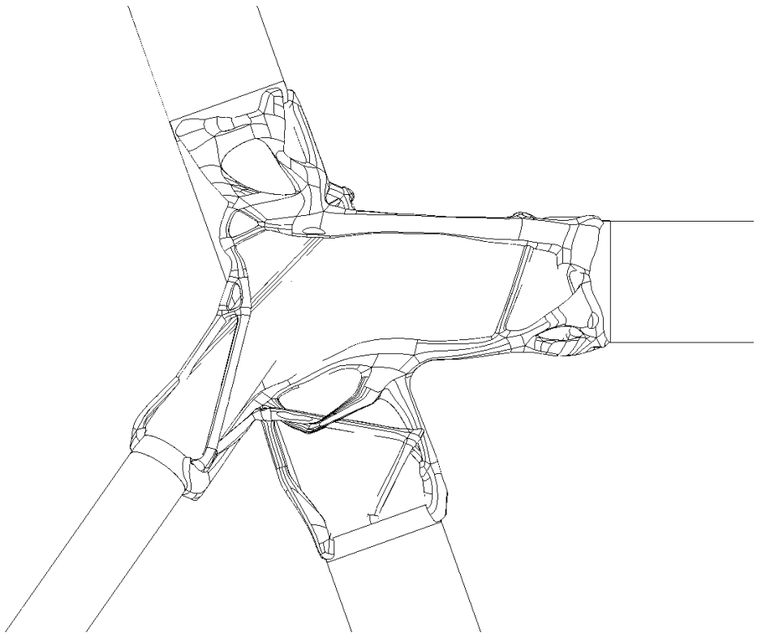
The lugs are where stress concentrations build. Ti 6/4 is easily printable and therefore very tunable to take account of the different stresses. Ti is also superior to CF when it comes to durability, absorption and comfort. An incidental benefit of using a mix of Ti lugs & CF tubes is that a fracture in the tubing becomes a replaceable part. In an all CF frame, a fracture means a new frame.



BOM			
Item	Qty	Part	Material
1	1	Seat Tube Lug	Ti-6Al-4V
2	1	Drop Out L	Ti-6Al-4V
3	1	Drop Out R	Ti-6Al-4V
4	1	Bottom Bracket Lug	Ti-6Al-4V
5	1	Lower Head Tube Lug	Ti-6Al-4V
6	1	Upper Head Tube Lug	Ti-6Al-4V
7	1	Seat Tube	CFRP
8	1	Seat Stay L	CFRP
9	1	Seat Stay R	CFRP
10	1	Chain Stay L	CFRP
11	1	Chain Stay R	CFRP
12	1	Down Tube	CFRP
13	1	Head Tube	CFRP
14	1	Seat Post	CFRP
15	1	Top Tube	CFRP
16	1	ISP Flat Mount	Ti-6Al-4V
17	2	Carbon Insert	CFRP

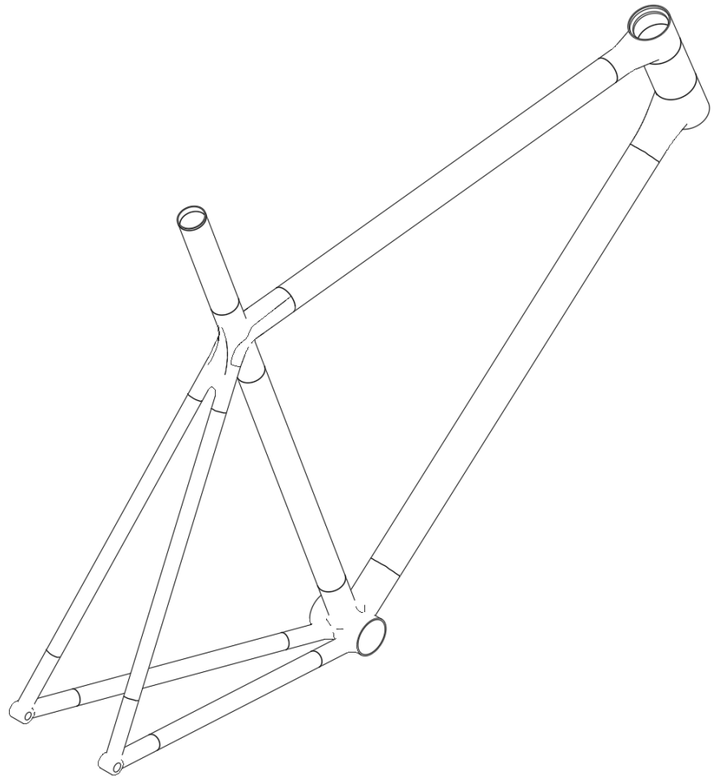
Dept.	Technical reference	Created by Patrick Neison 04/2021	Approved by
		Document type	Document status
		Title: Bike 000 General Assembly w/ BOM	DWG No.
			Rev. / Date of issue / Sheet 1/1

the future

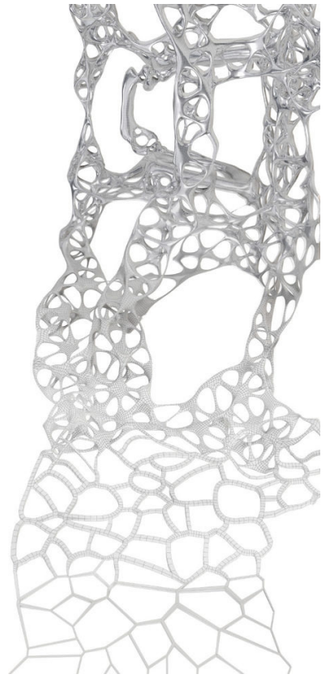


Due to complications surrounding this year, the generative lugs progress was halted early on due to restricted access to computational power. However in the future the bikes would feature generatively designed lugs integrated into the frame. Adding these unique components to the frame that have been programmed by your body to create that truly one-of-one product.

Given time, the transmission of the carbon tubing into the titanium lug would be seamless and flush, with the striking natural form of the lugs being a stand out



Further refinement of the data input section of the system. For the user, an interactive model which can then be customised from a cosmetic view, completing the customised bike. Within the mathematical model a more extensive consideration into one less quantifiable variable: medical conditions. Opening up the sport to people who otherwise wouldnt have the chance by having more elements of customisation, moving beyond conventional shaped frames.



Whilst the potential of Fusion 360s generative design is infinite, the current capabilites have limitations. Optimisation of the solver itself could see a more refined and efficient workflow. Constraints based on material thickness, minimum/maximum radius and void area would prove more efficient in creating acceptable iterations. Furthermore, a defeaturing tool to reduce surface complexity and thus, processing power, would be beneficial for post processing.