

Component analysis: aluminium bike frame



(aluminium bicycle frame - <http://www.practicalmachinist.com/>)

Word count: 1645

1: Purpose

The frame of a bicycle is the main body to which all other components attach.

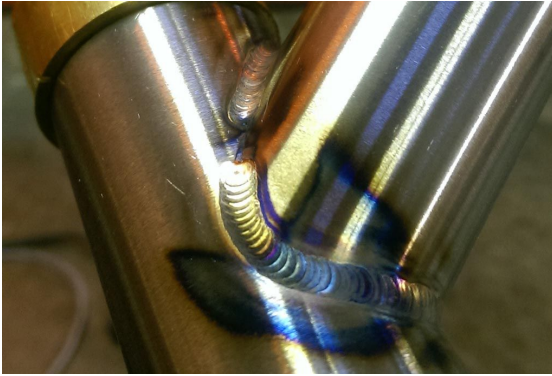


(Above: Santa Cruz bicycles aluminium frame)

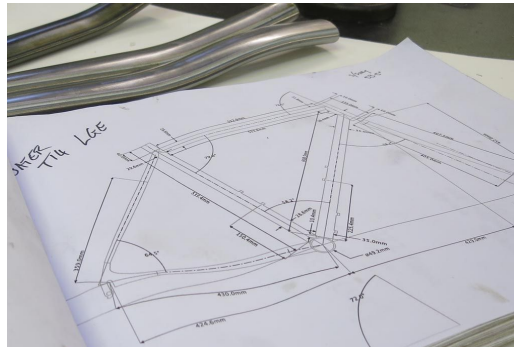
The frame of a bicycle needs to accommodate a number of different features which allow it to work effectively with other parts of the bike. Examples of which you can see in the image above, these include attaching points for other major components such as the rear wheel, handle bars, suspension and pedals. It needs to meet all those criteria and be able to support the weight of the cyclist and any cargo they might be carrying.

2: Manufacturing process

As with all things, the frame has to be made from a load of different parts and base materials. The Bike frame is no different, its manufacturing process can be divided up into several stages.



Left: Fabrication Right: Painting



Above: Design

(Source: shandcycles.com)

2.1: Design stage

The first stage of the frames construction is the design stage. This is where the size, geometry and material required is calculated. Arguably the most important stage of the manufacturing process the planning conducted here makes sure that all other stages are carried out and completed smoothly and accurately.

The primary focus of the design stage, especially when making bespoke pieces, is to calculate the required size of the frame using body measurements and decide the the geometry of the frame to ensure that the load applied by the rider is handled efficiently and has little or no risk of breakage when sudden impact occurs during usage. This is done by using a predetermined catalog of tested frame shapes which have been tested to work effectively in different environments.

2.1.1: Design Considerations



Left: Road bike frame Right: Mountain Bike frame
(Source: evanscycles.com)

Bicycle frame can feature a number of different features, shapes and qualities which change them for different purposes and types of cycling.

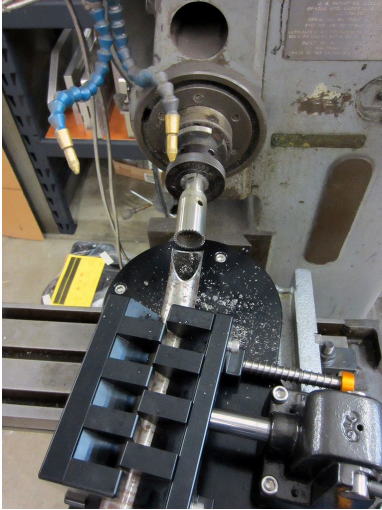
For example, reference the images above. You can see clear differences between road and mountain bike frames.

The mountain bike frame has features which make it distinctive next to other bike types of bike frames. The first clear difference between them is the inboard suspension. This allows the frame to better deal with sudden impact when landing or crashing on or into rocks. It also features a number of other features over the the road frame, notably more modular parts for easier change out when breakage occurs. For example, the pedal mount in this instance is bolt on / riveted to the frame.

On the other hand, the road frame features built in steering components for higher durability and longer life. Also it has fewer moving parts and no suspension for increased stiffness for improved cornering and road feedback. The lack of moving and complex parts makes for easier repair when accidents happen such as chain coming off and bolts coming loose.

2.2: Fabrication Stage

The fabrication of the bike frame is the process of turning raw materials, in this case Aluminium, into a functioning bike frame.

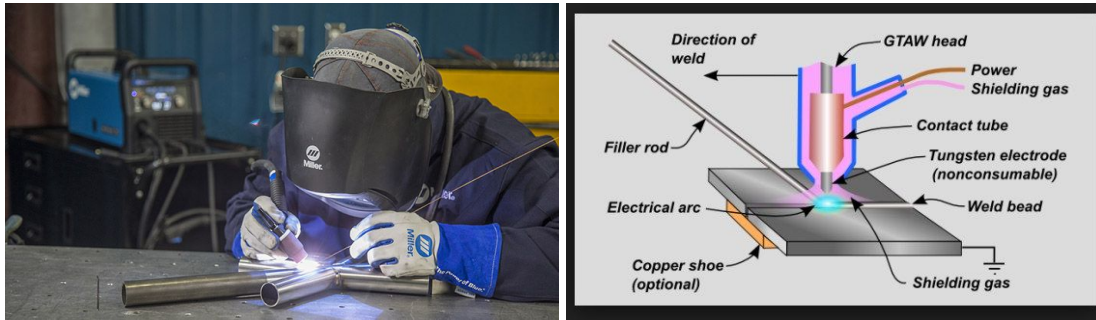


Left: Cutting tubes to allow effective construction of the frame
(source:anvilbikes.com)

Right: bending allows for improved aesthetic qualities (source: bikerumor.com)

The first thing done in the fabrication stage is creation of the correct components according to the design. This is done by cutting, bending and mitering tubes of aluminium ready for welding. All components are determined by the design while being planned and prepared for welding by the fabricators.

2.2.1: TIG welding



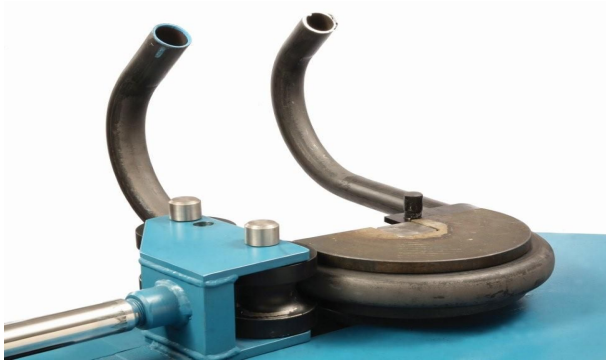
Left: Tig welding in progress (Source:millerwelds.com)

Right: Diagram of a tig welder in use (weldingis.com)

Tig welding is a fairly difficult process which requires being done by experienced professionals in the case of the fabrication of high quality aluminium bike frames, more so than other types of welding like Mig welding which isn't necessarily possible with thin gauge aluminium components such as the pipes used in bike frames.

This welding process is characteristically different to most mig welding types due to the manually fed filler metal, mig being automatically fed through the welding gun. This is why it tends to be more difficult for most users who might not be as dextrous or are only used to using mig welders which only requires holding the welding gun. Tig requires an electrode to conduct the electrical arc which makes the conditions possible for welding and also needs a slightly different mixture of gases to protect the weld in progress from air contaminants.

2.2.2: Pipe bending



Left: Example of tube bending apparatus (source: omp.net.au)



Right: Example Pinarello design which requires pipe bending in the manufacturing process (source:www.racycles.com)

Pipe bending is a pretty self-explanatory process. It involves the securing of one end of a pipe using a clamp and force being applied to the opposite end which rotates it around a jig or point which results in a bend being put in the tube. This process is possible given the relative manuability of the metals used, aluminium in the case of bike frames.

However, there are certain trade-offs with bending tubes. Most notably wrinkles and necking caused by the different forces applied during the bend.

Stretching: results in thinning of the wall and in extreme cases tearing may occur

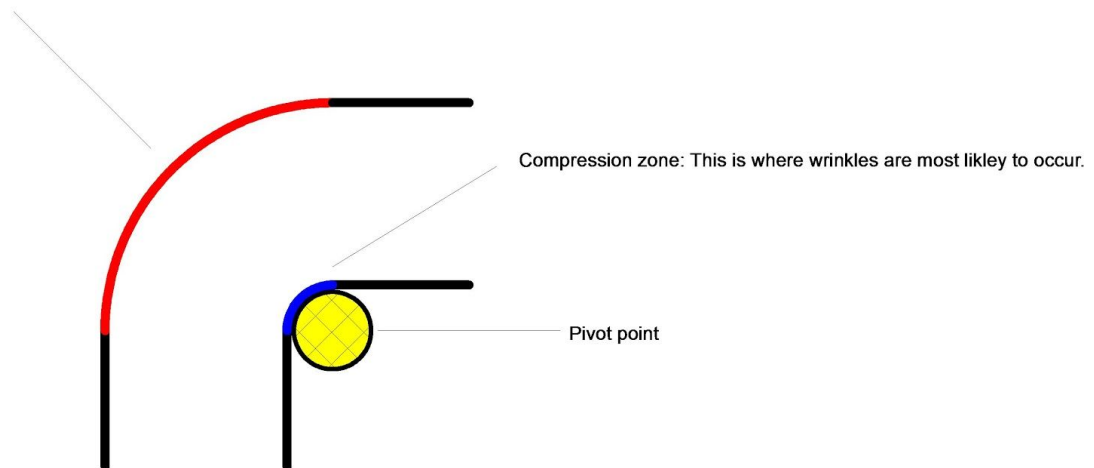


Diagram: Demonstrates where the strains are applied during bending (own content)

The negative effects that the bending process induces is the reason why its very rare to see it used in high performance designs such as road race bikes. Instead, you see it far more often in designs that are intended to be more aesthetically pleasing or if the designs have some special feature which means that normal straight bars are not appropriate.



Left: Dahon Vigor P9 (independent.co.uk)

Right: MILAN Citizen Bike (citizenbike.com)

The foldable bicycle design is the most prominent type of frame which incorporates the tube bending technique.

2.3: Finishing

Aluminium bicycle frames are treated in much the same way as car bodies and any other sort of metallic vehicle body. There is a series of priming and preparation required before painting and finishing.

2.3.1: Sandblasting



Left: Sandblasting being used in industry (dynamicco.com)

Right: Bicycle frame post treatment (thermalspraysolutions.com)

Sandblasting is an abrasive process which involves a mixture of water and diamond, sand or metallic compounds are propelled through a hose at very high velocity and pressure. When the apparatus is used upon rusty or degrading metals it removes surface imperfections and residual unwanted oxides. This leaves an ideal surface on which to apply primer.

2.3.2: Priming



Left: example of metal primer product (source: amazon.com)

Right: Example of bike frame with primer applied

Priming is the process of sealing and protecting the material ready for the application of paint. The primary function of primer is to provide a smoother surface to which paint can be applied and to provide protection for the material against corrosion.

The primer can be applied in the same ways as paint, usually through a sprayer or by hand. Once applied, the surface which it is applied to will need to be sanded using a sanding block or just by hand depending on the detail in the surface.

2.3.3: Painting



Left: Example of professional spray gun (Source: airtoolsswa.com.au)

Right: Painting in progress (Source: youtube.com)

Painting is a popular method of decorating anything. The process of painting differs depending on the subject, in this case its a bike frame. Given the large surface area of the component the use of a spray gun or spray can is necessary.

The spray gun works by passing compressed air through a nozzle to which a paint reservoir is connected. The moving air will draw the paint out of the reservoir as it causes an area of low air pressure as it leaves the barrel essentially sucking the paint out of the nozzle and onto the subject.

2.3.4: Other finishes

Although painting is by a reasonable margin the most popular type of finish used on bike frames, there are plenty more that are considered for different effects and benefits which are either difficult to achieve with paint or cant be at all.

2.3.4.1: Wrapping



(source:forums.mtbr.com)

Wrapping is a popular type of decoration carried over from automotive customisation. Wrapping allows for very detailed and intricate patterns to be laid onto the frame. Although extremely popular in cars, it's not so popular on bike frames. The large number of tight corners where pipes have been welded together makes it difficult, especially for amateurs, to lay it down neatly as to not cause any wrinkles or bubbles in the plastic.

2.3.4.2: Powder coat



Right: Black powder coating (Source: powderkegcoating.com)

Left: Matte Blue coating (source: missionbicycle.com)

Powder coating is a process that involves the melting of plastic powder onto the surface of the metal. To achieve the desired effect the plastic powder will be dispersed evenly over the subject and then placed into a heater where the powder liquifies and bonds with the material. Types of texture that the plastic coating has can be determined by the temperature its baked at. Lower temperatures will lead to a more coarse, matte texture while higher ones will lead to a smoother texture, extremes of either will affect the quality by either thinning the layer so that it won't stick to the material properly and would lead to it crumbling off with time.

3: Conclusion

In this essay I have discussed the production of aluminium Bike frames. I looked at the design process and what the designers need to consider when attempting to design a frame. I have also looked at the manufacturing of the frame looking at the material used and how it is manipulated to achieve the desired shape and discussed the implications of different processes. Finally, I looked at the types of decoration which is used to make the frame more attractive and how the frame needs to be prepared to be suitable for these processes.

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