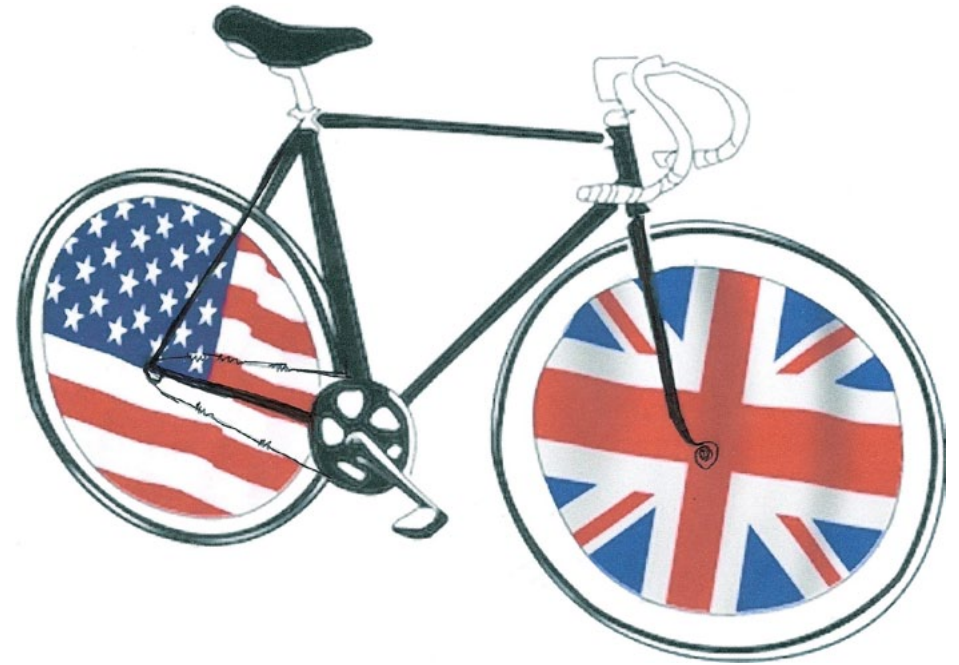


# Bicycle Frame Building in the USA



**Matt Wilkinson**  
Winston Churchill Travelling Fellow, 2011

## TABLE OF CONTENTS

2	Acknowledgments
3	Introduction
4	Historical context
5	Present day
6	Viability for the UK
7	Bicycle types
7	Materials
8	Practical skills
8	The different methods of frame building
9	Routes to learning to build frames
10-11	Equipment
12	Business skills: Developing a brand and marketing skills
13-39	Frame building tour of America
14-16	Owen Lloyd
17	Richard Sachs
18	GeekHouse Bikes
19	SquareBuilt Cycles
20-21	Peter Weigle
22-25	Engin
26	Sputnik Tools
27-28	Bilenky
29-31	United Bicycle Institute
32-39	Doug Fattic's frame building course
40-42	US frame builders survey
43	Conclusions
44	Bibliography

## ACKNOWLEDGMENTS

The generous sponsor of my travels and of this report was the Winston Churchill Memorial Trust.

The Trust has an annual programme of grant giving for travelling fellowships, the aim being for participants to bring back learning that can be applied for the benefit of the UK community. As well as details for applying for a fellowship, reports of past fellows are available on the website and I would encourage you to visit. See [www.wcmt.org.uk](http://www.wcmt.org.uk).

Of course, great thanks must go to all of those that welcomed me with such openness and generosity of time and ideas including Owen Lloyd, Michael Catano, Doug Fattic, Herbie Helm, Lance Mercado, Johnny Coast, Greg and Fence, Thomas Callahan, Simon Firth, Stephen Bilenky, Joel at Via Bicycle, Drew Guldalian, Marty Walsh and all at Geekhouse, Mike Flanigan, Jeff Bucholz, Richard Sachs, Peter Weigle, Andy Newlands, Rob Tsunehiro, Dave Levy and Mitch Prior.

I will continue to blog at [www.wilkinsoncycles.com](http://www.wilkinsoncycles.com)

If you would like to contact me my email address is [mwilkinsoncycles@gmail.com](mailto:mwilkinsoncycles@gmail.com)



## INTRODUCTION

The report is based on the findings of my 5-week trip to the USA in 2011, when I visited bicycle frame builders in several states. I hope this report promotes an appreciation of quality hand built bike frames in the UK and an understanding of the processes involved in their fabrication. I hope also to encourage and inspire others to become involved in bicycle frame building.



### MY STORY

Having decided that I wanted to become a professional bicycle frame builder in early 2008, I contacted most of the surviving established builders in the UK to ask if they could offer me some kind of training, but to no avail. It seemed that there was no conventional way into the trade through apprenticeships, and British frame builders were probably wary of competition and giving away their trade secrets.

Instead I became a cycle courier in London to immerse myself in cycling culture and learn as much as I could about bikes and the people who ride them, whilst doing as much research as possible using books on the subject and by joining internet forums for frame building, where I found lots of useful advice. I gradually bought tools as and when I could afford them, and also built some jigs and fixtures based on designs I had seen in a frame building manual. In 2009 I finally finished my first bike frame, on which I have since ridden many thousands of miles.

**Matt Wilkinson**

The Winston Churchill Memorial Trust Travelling Fellowship 2011

After I'd built another frame for a friend and done some repairs to other peoples' frames, I realised that I needed to speak to other frame builders in order to improve my skills and become more professional, and that the best place to find these frame builders was in the US.

There are many more bicycle frame builders in America than in the UK, and my experience from visiting internet forums and joining frame building email groups taught me that these American builders generally had a much better web-presence and were much more open to sharing information than their British counterparts.

It was then that I applied to the Winston Churchill Memorial Trust to for a grant to visit bicycle frame builders in the USA, with a view to writing this report on the skills, techniques and equipment that would benefit both my community and the quality bicycle industry in the UK.

I intend to give a brief overview of the industry in the UK and USA, looking at the historical context and the present day. Drawing from the knowledge gained during my travel fellowship I intend to examine three issues I consider important for new frame builders: viability for the UK, required skills and equipment required.

I follow this with the write-ups I prepared after each meeting. The frame builders I met with each had a different character and approach to their craft and business, and so these meetings each had a different focus.

I think the subsequent write-ups reflect this.

As part of my report I also conducted a survey of 48 US-based frame builders working at least at a semi-professional level. My aim was to use the results to provide an overview of the industry in the US and to give potential frame builders in the UK more realistic expectations of customer demographics, build times, pricing and readiness to begin trading.

**Bicycle Frame Building in the USA**



## HISTORICAL CONTEXT

After the WWII there was boom for bike frame builder in the UK. In the USA car ownership had begun to grow rapidly but economic recovery in the UK was slower, and bicycles held their place as a means of transport, as well as a sporting vehicle. The British market too began to decline with the increasing affordability and popularity of the automobile.

Some of the main cycle manufacturing companies began to merge: In 1960, Tube Investments Group -which already owned Phillips, Hercules, Sun, Armstrong and Norman- acquired Raleigh -which in 1957 had bought BSA Cycles Ltd which had already acquired Triumph Cycle Co Ltd - merged with Raleigh to form TI-Raleigh which had 75% of the UK market.

However, whilst bicycles were being replaced as a means of transport, road cycling remained a very popular past-time, both as a leisure pursuit and as a competitive sport. In the early 1970s frame building was a prospering industry with dozens of bicycle frame builders in the business. The lightweight racing frames developed in the UK were highly regarded by competitive road cyclists in other countries. In the US the bicycle industry there failed to dominate the US sport bike boom of 1971-1975, which saw millions of 10-speed bicycles sold to new cyclists as new lightweight road racing bicycles began arriving in large numbers from England, France, Italy and Japan.

It was at this time that some American cyclists travelled to the UK to race and to tour. They were exposed to bike shops where frame building still took place and other young American cycling enthusiasts who wanted to learn to build these new lightweight bikes travelled to the UK expressly to learn the skills required to fabricate frames. I was keen to meet with three of these wandering apprentices - Richard Sachs, Doug Fattic and Peter Weigle.

In the 1980s the mountain biking craze took hold. As

the techniques used in their construction were coarser than those used to make a lugged steel road frame, they could be fabricated robotically and inevitably bicycle manufacturers embraced these new manufacturing techniques and then chased further efficiencies overseas. With this the hand built bike industry declined drastically- the main supplier of frame parts in the UK today lists 58 frame builders in the UK (whereas I have a collection of pictures of over 45 head tube badges from the London area alone from before 1970).



*From Peter Weigle's collection from his time at Witcombe Cycles.*



*A photograph of the workshop at Witcomb Cycles in Peter Weigle's collection.*



## PRESENT DAY

In America 18.5 million bikes were sold in 2008 (*Gluskin, 2008*) but about 99% of them were built overseas (*Bike Europe, 2009*). Most of those manufactured in the US were produced by small workshops which specialise in high-end hand built bikes. (*Crenshaw, 2008*) I have been unable to obtain exhaustive figures, however we could use the exhibitor numbers for the North American Handmade Bicycle Show to get a sense of scale of the industry: in 2011 174 frame builders exhibited. To qualify to exhibit frame builders are required to be fully insured businesses and to have completed a minimum of 50 frames. Many other regional shows also take place.

There are frame builders across the country, however perhaps the densest hub of custom frame building is the state of Oregon: the Oregon Bicycle Constructors Association has a membership of 40 active frame builders, with 25 of these based in Portland. The organisation's secretary, Andy Newlands, estimates that 1000 frames a year are built in the area.

The UK bicycle industry in 2010 was worth an estimated £1.5 billion, while cycles sales for the year were expected to value between £800m to £850m. (*ACT, 2010*) Again the vast majority of these bicycles will have been built overseas: 60% of the 109million bicycles built globally in 2010 were built in China. (*Worldometers*)

There are very few large British bike manufacturers left, and just two large companies fabricate frames in the UK: Brompton and Pashley. Many of the brands sold here – Trek, Scott and Colnago, for instance – are built offshore by a single Taiwanese firm: Giant

There remain a few independent frame builders of the old guard – such as Roberts, Bob Jackson and Mercian – who continued to make frames, but many struggled to stay afloat in the period between the late 1970s and 2007, before the 'renaissance' of frame building began to take hold in the UK.

As in America, there is a growing interest in hand built bikes in the UK. In 2011 the inaugural UK hand built bike show 'Bespoked' took place in Bristol, with approximately 35 frame builders exhibiting. At Brixton Cycles in south London, sales of bike-making tools have doubled since 2006 as people begin to build up their bikes instead of buying complete bikes off the shelf. Some have gone one step further by building their own frame. The owner of Britain's largest supplier to the industry, Cee-way Bike Building Supplies, gave the following description of the UK market:

"There'll be framebuilders working out of or as employees of shops which give the shop another string to their bow, but even this is fairly low. More often it'll be a guy who does mostly repairs and just the occasional frame order. The last 4 or 5 years, there are a lot of people that have got into the idea of ordering parts or kits to have a go at building their own frame. Some of these have got some training at the couple of frame builder training options here and go onto to build a few more frames. An intermediate level of people doing it regularly as a hobby and some others are doing it semi professionally while holding down another job. A lot of builders on my list would fit this role, quite often they were builders professionally but having a main job made life easier, when frame building got really quiet in the 2000's, pre 2007. I think the number of newbie one-off guys is many times larger than those giving the repeat business."



## VIABILITY FOR THE UK

The Mayor of London is aiming to increase cycling by 400% in the first quarter of this century (by 2026). There has been an enthusiastic take up of the public cycle sharing scheme [known fondly as 'Boris Bikes'], and schemes such as the 'superhighway' cycle routes into central London from the suburbs. Initiatives such as 'Cycle to Work' intending to improve conditions for existing commuter cyclists and to encourage new cycle travel, coupled with the annual motor vehicle-free "Sky Ride" have played an important part in boosting cycling in the capital, as perhaps have above-inflation increases in public transport ticket and fuel prices, plus frustrating road congestion: London has seen an increase of 117% within the first decade.

The promotion of cycling has not been focused solely on the capital: in 2008 12 towns were chosen by the Government to promote cycling, with the aim of encouraging 2.5 million more people to take up cycling to improve fitness and beat traffic: Bristol –named the first 'Cycling City' saw the number of regular cyclists rise from 25,000 to 33,000 in three years (Markwell, 2011). Over the same time Blackpool saw a rise of 27%.

As well as cycling for transport, cycling is a popular leisure and sporting activity: British Cycling, the national governing body for cycling in Great Britain has seen its membership double since 2007, with 40,000 paying members today. Cycle clubs too have seen growth in popularity, with now almost 82,000 people now taking part in club rides across the country. (Ward 2011)

The recent successes of the Great Britain cycling team, with their strong medal hopes for the 2012 Olympic Games, will have also contributed to the increased profile and interest in cycling in London: It's estimated that in 2010 one in three people were 'interested in cycling' (Hickman 2010) This growth in cycling can only be a good thing for the bicycle industry, and thus the hand built frame builder.

Some cyclists seek high-performance machines that will make their commute as fast as possible, others view their bicycle as an opportunity for self expression. Bespoke hand built bikes are designed for the specific rider, and will be created to suit their fit and riding position and also their style and detail preferences.

Within the wider design world, the demand for bespoke and handmade items has seen considerable growth; some say that it is a statement against consumerism and the homogeneity of the mass-produced. Whilst brand names were very popular in the 80s and 90s, people are now seeking something that's more tailored to them. Websites like Etsy provide store-fronts for artisan makers who in 2009 sold over \$180 million worth of hand made goods- an increase of 105% on 2008 (Steiner 2010). Now eBay has set up a similar website: a web giant like eBay getting in on the action is a sure sign that hand-made has gone mainstream.

In an online poll looking at the value people place on how everyday things are made, conducted in 2009, it was found that 46% of Brits prefer handmade items to machine made ones because they are unique and have a personal touch, 60% believe handmade items will be of a higher quality, and 60% of respondents appreciate that more time and care is taken over making handmade items (Carnac, 2009).

I believe that this growing appetite for the bespoke and handmade, coupled with an resurging interest in cycling make for promising conditions for the hand built bicycle.





## MATERIALS

Some bikes are made out of titanium, magnesium, carbon fibre, bamboo and wood, however the most common materials used are steel and aluminium alloys. Each material offers different performance features and price points. I use steel for making bicycle frames, there are a number of reasons for my preference:

**DURABILITY** – I rode the first frame I made as a cycle courier in London for over 30,000 miles, often over cobble and off curbs, and I locked it against metal railings and posts many hundreds of times a week. This kind of treatment demands a durable frame, and the fact that I still ride this bike regularly has given me great confidence in the material.

**EASE OF USE** – several methods can be used – fillet brazing, brazed lugged construction and tig welding.

**AESTHETICS** – I personally prefer the more “classic” look of smaller diameter steel tubing compared to that of carbon fibre or aluminium.

**FEEL** – If the frame is designed with care, steel’s ductility means that it can offer a “lively” ride, while being resilient to road shocks, thus making for a more comfortable ride. Sometimes frames made from other materials can feel unresponsive or “dead” by comparison, which is very much the case with my carbon fibre road bike.

**EASE OF REPAIR** – if a tube or braze-on becomes damaged, most frame builders are able to repair the frame in the majority of cases, and if the frame is part of a touring bike on an expedition, it is more likely that somewhere can be found with repair equipment applicable to steel in an emergency. I have heard tales of riders cold-setting their steel forks back to rough alignment in a drain cover after a crash.

**RELATIVE SAFETY IN CASE OF FRAME FAILURE** – steel generally tends to be more resilient to metal fatigue failures than aluminium, and is less likely to fail catastrophically,

as carbon fibre can. Steel will often give warning signs such as creaking, flexing or visibly deforming before putting the rider in serious danger.

The weight disadvantages of steel are in my opinion, very small compared with the advantages steel can offer, especially with today’s advanced steel alloys which can be made with very thin wall thicknesses.

Apart from the fact that there are now some very high end stainless steel tubesets available, a non-stainless steel frame can still last a lifetime if looked after properly. I regularly ride my 1946 Bates Vegrandis made from Reynolds 531 tubing. Treatments such as J.P.Weigle’s Framesaver can be sprayed inside steel tubes to further protect from corrosion.

Perhaps above all, I use steel because I enjoy working with it.

## TUBING

Manufacturers of quality bicycle frame tubing include Reynolds, Columbus, Dedacciai and True Temper. Many different tubing diameters and wall thicknesses are available for different applications and bicycle types, and some manufacturers offer tubing in oval, teardrop or other specialist cross-section shapes.



“Double-butt” tubing is butted at both ends.

With butted tubing, the tube walls are thicker at the ends, where they will be welded or brazed, to maximise the strength of the joint and to be more resilient to the heat from the joining process. Perhaps more importantly, the thinner tube wall sections away from the butts allow significant weight savings over the straight-gauge tubing typically used to construct cheaper bike frames.





## PRACTICAL SKILLS

To make a serious go at commercial frame building, one must be able to offer a product that is superior to the type readily available “off the peg” at bike shops. The bike must fit the rider well, allowing both optimum cycling efficiency and maximum comfort, and the brazing or welding must be exemplary.

It is advisable for the novice frame builder to conduct destructive analyses of practice brazes or welds by cutting the joints into sections to check for sufficient braze penetration (for lugged construction), or to break a practice weld or fillet braze to check that the tube tears above, and not at the weld or braze.

Indications such as blackened and burnt flux after brazing and excessively large oxidation marks after Tig welding are tell-tale signs of overheating, as is the appearance of copper while brazing with brass, showing that too high a temperature was reached, which allowed the copper to separate from the brazing alloy.

Careful filing is a very important skill which cannot be overlooked, as a custom-made frame must look as well-finished as possible to justify the customer’s investment. One careless slip with a file or hacksaw can ruin a frame and be a very expensive mistake, both in time spent and financially, especially if more tubing has to be ordered in small quantities.

Apart from developing the hand-eye co-ordination and practical skills that are needed to produce a quality bike frame, the frame builder should also have a good eye for aesthetics and design, as no matter how accomplished the frame builder becomes, no-one will want to part with their money for an ugly bicycle. Unfortunately, some people look only as far as the paint on a bicycle frame, and as such, this must be afforded great attention by the frame builder. The finish, be it paint, lacquer or powder coat should be of the highest quality and tastefully carried off.

## THE DIFFERENT METHODS OF FRAME BUILDING

There are three main methods used for making light weight bike frames from thin-walled steel tubing:

**FILLET BRAZED CONSTRUCTION**—The tubes are joined to each other by a “fillet” of brass, which is added by heating the tubes with a flame until they reach the temperature at which brass melts, and the molten brass is then added around the entire joint where the tubes meet. Flux is used in the form of a powder, a paste or in the gas line itself (as with a Gasfluxer) to prevent oxidation and keep the metal clean. Brass brazing alloys have melting points between 815 and 1093 degrees C.



*A freshly fillet-brazed joint – still caked in protective flux.*

**LUGGED CONSTRUCTION**—A steel lug (a type of sleeve) is placed over the tubes to be joined at their junction, and then heated with a flame. Silver or brass brazing alloy is then flowed into the small gap between the lug and the tubes. Capillary action assists the flow of molten brazing alloy through the lug. Silver brazing alloys can have melting points as low as 618 degrees C.

In both lugged and fillet brazed construction, the steel tubing is not melted at any time, as the melting temperature of the brazing alloy is much lower than the melting point of steel.



*Lugs*

**TIG WELDED CONSTRUCTION**—The tubes are joined by melting the steel tubes together at the joint with a TIG Welding machine. Tig stands for “Tungsten Inert Gas”, referring to the tungsten electrode that produces the arc to create the weld, and the inert Argon gas that shields the weld area to prevent oxidation.



*TIG welding*



## ROUTES TO LEARNING TO BUILD FRAMES

Today, apprenticeships in frame building are almost non-existent; there is certainly no formal apprenticeship route. However, it may be possible to contact an experienced frame builder and arrange some kind of work-related experience, even if it does not amount to a full apprenticeship.

I have now been lucky enough to secure employment as a brazer at the only remaining bicycle factory in London. “Earn while you learn” is the best possible scenario for the novice frame builder; I will gain far more practical experience here than I could possibly achieve in my own workshop in the same time frame.

As Stephen Bilenky said to me when I visited his workshop in Philadelphia, 85% of all you need to learn can be found online. My experience backs up this statement. I taught myself by reading resources online, visiting forums and sourcing books. I also practiced my brazing on scrap tubes before I eventually built my first bicycle.

I found the following books very useful:

[The Paterek Manual for Bicycle Frame builders, Tim Paterek](#)  
[Soldering and Brazing \(Workshop Practice Series #9\), Tubal Cain](#)  
[Touring Bikes, Tony Oliver](#)

Learning from the practical teaching of experts however is no-doubt invaluable. United Bicycle Institute in Portland and Ashland, Oregon USA is the only dedicated, purpose built frame building school, however some frame builders teach short courses in frame building, typically these take place in the frame builders own workshop, and a group of up to five students build a bicycle under the instruction of the professional frame builder. I attended a course run by Doug Fattic whilst I was in the States; similar courses are available in the UK. The internet can be useful to research these.

In addition to these types of courses, it is advisable to complete a basic gas welding and/or tig welding course, which are often offered at local community colleges, as this will give the student a good basic knowledge of the techniques involved, and perhaps more importantly, the safety implications.



## EQUIPMENT

It is possible to build a bicycle frame with very little equipment. I have done it myself. It took me a lot longer than it would if I had a few more items of quality equipment, and it was awkward and took lots of concentration.

Deciding on the right amount of equipment is up to the individual frame builder. It will depend on how he/she wishes to make frames, the space available to house the equipment and the finances at their disposal.

As can be seen in my case studies, frame builders can be successful using several different “philosophies” with regard to equipment. Take Richard Sachs for example: he is one of the most well-known and successful frame builders in the world, yet he doesn’t have a milling machine or a lathe. In fact, his workshop is noticeably devoid of equipment apart from a frame jig, a couple of benches, a vice and some hand tools.

At the other end of the spectrum, Drew Guldalian of Engin Cycles in Philadelphia has a workshop full of machines. His approach to frame building is totally different to that of Richard Sachs. Both have built good reputations based upon their very different methods and philosophies, because their respective customers can see value in both the precision and accuracy of machines, and the time spent by a highly experienced person working with their hands.

When I was starting to make my first frame, I found that the most valuable pieces of equipment were a solid workbench, a good vice, a hacksaw, a good long steel ruler and some tubing blocks that I had made.

I constructed my own jigs from thick plywood braced with box section steel, and I checked the alignment of my frame and fork with V blocks and a surface gauge on top of a piece of 12mm toughened glass. I checked the alignment of the rear triangle by using a length of slightly

elastic string tied to each rear dropout and then looped around the head tube. I measured the distance between the string and the seat tube on both sides of the frame to check that the rear end was centred correctly.

When I was satisfied that I wanted to continue building frames, I began to save up my money to invest in more professional equipment. Here follows a selection of professional frame building equipment available today.



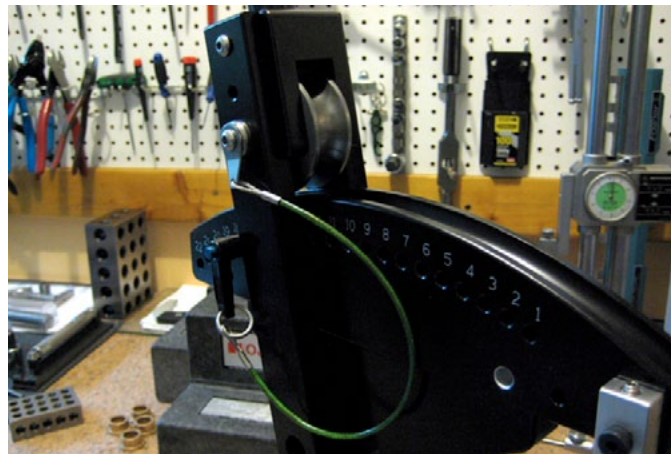
*Anvil fork jig.*



*Alignment table.*



*Anvil Super Journeyman frame jig.*



*Anvil fork blade bender.*

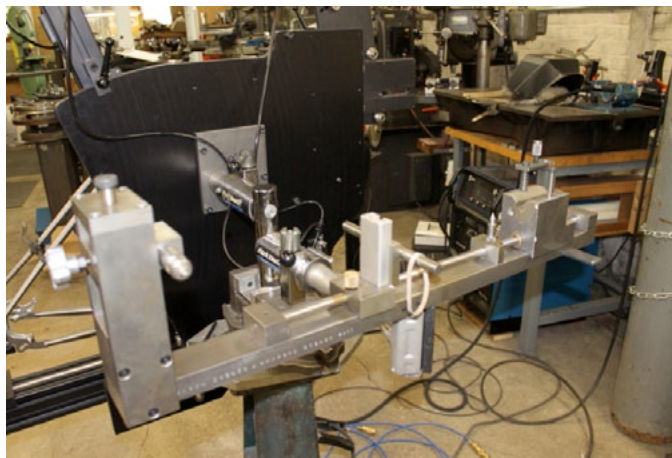


*Arctos frame jig.*





*Bike Machinery Hydra frame jig.*



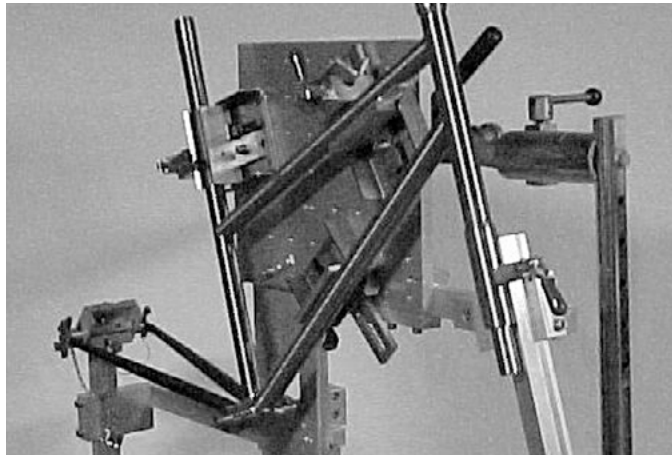
*Engin fork jig.*



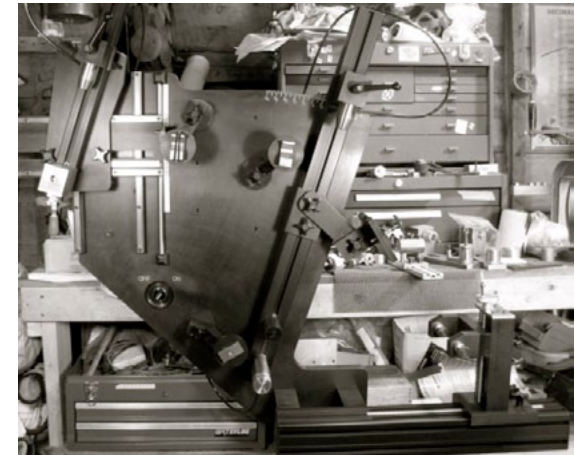
*Oxy-Acetylene kit and bottles.*



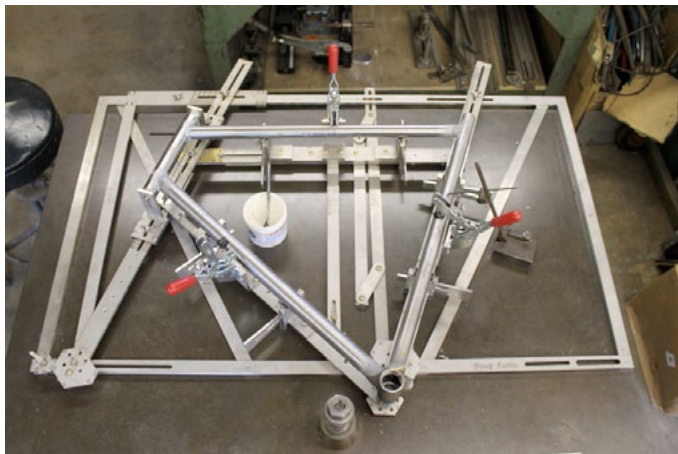
*Bringheli frame jig.*



*Henry James frame jig.*



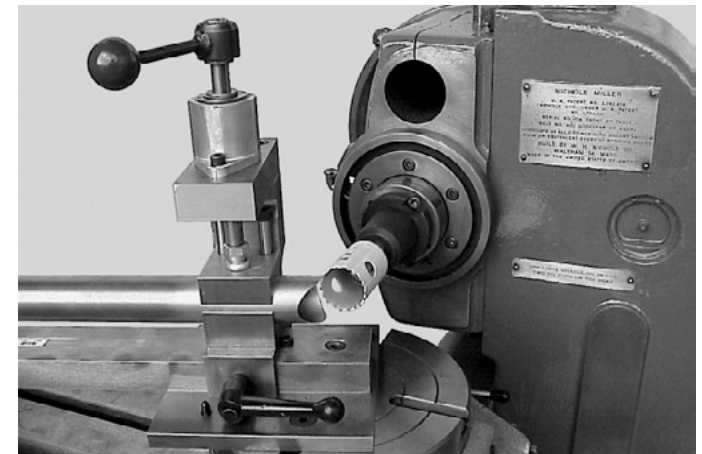
*Sputnik Tool frame jig.*



*Doug Fattic frame jig.*



*Marchetti frame jig.*



*Sputnik Tool main tube mitering fixture.*



## BUSINESS SKILLS: DEVELOPING A BRAND AND MARKETING SKILLS

As I was told again and again by many frame builders in America, the single most important factor that has enabled the recent surge in numbers of people making bicycles is the internet: independent builders are able to promote and source their work far beyond their immediate geographic location.

Most of the builders that I visited concurred that the most effective form of marketing is the publishing of quality photographs via the internet, and that the ordering process is done mostly by email. Geekhouse, for example, sell 90% of their bikes by email, and view their website as their retail store.

Whilst it is vital to focus on creating good frames, the promotion of them is key if one is to build up a sufficient client base to make a viable business, this of course is true of all product based enterprises.

All of the frame builders I met with had carved a distinctive niche for themselves. They create frames to appeal to different markets, for example, Peter Weigle's bikes might appeal more to people with a taste for more classically inspired aesthetics, whereas Geekhouse Bikes, with their bright colours and snappy web marketing, are aimed at a younger, trendier market, and Bilenky is well known for his tandems. A frame builder might well focus their marketing on unique aspects - whether it be machined parts, carved lugs, curved or super-light tubing or even colours and graphics. By identifying their market and by making distinctive frames they are able to establish a brand that prospective customers can identify with.

### PEOPLE MAKE THEIR OWN MARKET

I asked Stephen Bilenky whether he thought an increase in the number of apprenticeships would benefit the industry, or whether he thought it could potentially increase competition too much. He replied that individual frame builders tend to make their own market, so in-

creasing numbers would most likely benefit the industry as a whole, rather than increase competition.

### BECOMING ESTABLISHED WITHIN YOUR LOCALITY

Talking to people, giving out cards, and generally being open, approachable and courteous to people regardless of their experience or knowledge is obviously advisable.

Many of the frame builders I visited held events which would enhance their links to the local community: My visit to Geekhouse coincided with their annual open house weekend, Owen Lloyd celebrates Blue City Cycles' birthday with a barbecue, and Bilenky hosts the world's only Junkyard Cyclocross, where riders brave a course through the neighbouring junkyard.

The densest hub of custom frame building is the state of Oregon. The secretary of the Oregon Bicycle Constructors' Association, Andy Newlands, estimates that 1000 frames are made per year in Portland alone. Whilst that's a lot of expensive product for a limited market to absorb, and it's true that some established builders, like Newlands, sell their frames internationally, with help from the internet; it would also seem that the presence of frame builders helps build an appetite for custom frames amongst the local cycling community.

### THE CHOCOLATE BROWNIE PHENOMENON

I can be walking through a market in London, with no real intention of buying anything, when I see some delicious-looking chocolate brownies for sale, and I find them irresistible. The innovative Apple co-founder Steve Jobs once said *'People don't know what they want until you show it to them'*.

Although many potential frame customers will know exactly what they want in a bicycle frame, the successful frame builder should be able to make an irresistible brownie of a bike, ... a bicycle that they didn't know they wanted or needed until they saw it.

### HARNESSING THE POWER OF THE INTERNET

Building a website full of great photos of the frames you have built was universally recommended by the frame builders I met with. Many also made regular website updates/ blog posts to share stories from their workshop to build interest in their frames. Making links with forums and via social networks is a good way to circulate this information as is building and using mailing lists.

### SPONSORING TEAMS AND EVENTS

Richard Sachs sponsors a cyclo-cross team, as does Geekhouse. This raises the profile of the bikes greatly among the right people – those interested in the sport, and shows dedication. A bike builder who can say that his/her frames are race-proven has greater marketing power.

### EXHIBITING AT TRADE SHOWS AND OTHER EVENTS

The first ever North American Handmade Bicycle Show was held the weekend of January 15th 2005 in the city of Houston, Texas. There were 23 exhibitors and 700 attendees. In 2011 numbers had swelled to 174 exhibitors and 7316 attendees. The first show in the UK like this took place in Bristol in 2011, with 35 exhibitors. Exhibitions can be a good way to bring together bicycle makers, enthusiasts and prospective customers.

Whilst some consider them to be an important promotional tool, Peter Weigle's opinion is that 80% of exhibitors at hand built bicycle shows have no real reason to attend, especially as for many the internet is the main vehicle for their sales. He suggested that 'The older guys see the shows as a community, and know each other well. [Whilst] The young guys see it as a rite of passage to show their bikes.'



## FRAME BUILDING TOUR OF AMERICA

Having prepared a list of people I'd be keen to meet in America, I contacted them asking if they would be prepared to meet with me, to show me their work, and to talk about their experience as frame builders. Given the cool reception I had experienced when I contacted frame builders in this country I was pleasantly surprised by the enthusiasm with which they responded to my requests.



I flew into Chicago, IL. on 28th April 2010 and departed from Portland, OR. on 4th June 2010. Travelling by plane, train, bus, car and folding bike I visited frame builders in eight states.

Keen to meet with some of the people that learned their trade in the UK in the 1970s, I arranged to meet with Richard Sachs and Peter Weigle, and booked a place on Doug Fattic's frame building course.

I also wanted to meet with some of other established frame builders - Andy Newlands of Strawberry Cycles and Stephen Bilenky fitted this category brilliantly.

To get a sense of what it's like to be setting up as a frame builder now I wanted to meet with some of the 'new kids on the block' so to speak- meeting with Lance

Mercado of SquareBuilt, and the guys at GeekHouse Bikes was illuminating and encouraging.

I also included visits to meet Jeff Bucholz of Sputnik Tool, who produces specialist frame building equipment, and I was given a tour of the Chris King bearings factory. This was to get a more rounded view of the cycle industry and other supporting businesses. Other small bicycle factories I visited included Serotta, Seven Cycles and Independent Fabrication.

As well as these main meetings I was also introduced to many other frame builders in each locality, which greatly added to my experience.

On the following pages I have prepared write-ups of some of these meetings. Since each person had a different character and approach to their craft and business, each meeting had a different focus, and the subsequent write-ups reflect this.



## OWEN LLOYD BLUE CITY CYCLES

### Bubbly Dynamics Frame building Co-operative, Chicago

Blue City Cycles, 3201 S. Halsted, Chicago, IL

Bubbly Dynamics, 1048 West 37th Street, Chicago IL

Whilst in Chicago, I visited Owen Lloyd at Blue City Cycles full-service neighbourhood bike shop that he opened in 2009 with partner Clare Knipper.

As well as owning Blue City Cycles, Owen is a founder member of a frame builders' co-operative which has a workshop in an old paint warehouse turned small/sustainable business incubator in Bridgeport's historic Central Manufacturing District. The wonderfully-named Bubbly Dynamics Building, named after Bubbly Creek which flows nearby is owned by John Edel. He is sympathetic to the ideals and benefits that cycling and local manufacture bring to the community, and has proven to be very supportive to the craft. Seven frame builders share the fully-equipped 900 square foot code compliant manufacturing space complete with a goods lift.

Owen describes building bike frames as the logical outcome of a career he started working in other people's bike shops. He learned the mechanics of gears, brakes and bearing systems, then he learned to build wheels: frame building was the obvious next step.

Having completed a course at UBI, Owen moved into the workshop five years ago. He currently builds 3 to 4 framesets a year under the name Lloyd Cycles, but spends more time repairing or modifying steel frames: he is the only person in Chicago that offers this service.

Like Owen most of the other frame builders in the co-op work part-time in the workshop, although some, including Michael Catano, who I had the pleasure of meeting, work there full-time. When I visited the co-op he was working on a small production run of frames for a retail shop.



Blue City Cycles.



Frame building workshop on the first floor.



The loading area of the building.



Owen with a Victor torch.



The building on the outside before the transformation.



Granite surface table - the beer can is for scale.



I asked Owen what the benefits of the co-operative were. Aside from the two obvious financial advantages of cheap rent and shared tooling, Owen highlighted other advantages: In the absence of apprenticeships or factories, where a young builder might build frames under the instruction of more experienced frame builders before launching out on his own, access to the tools and experience of other co-op members may be one of the most important benefits the co-op has to offer.

**CHEAP RENT** – By finding a sympathetic landlord -one that sought to encourage ‘boutique manufacturing’- the co-op were able to agree a low rent with agreeable terms. The building owner only charged each tenant of the workshop their share of the rent, even before all the other places were filled, enabling each person to get on with their craft straight away without having to find others to pay the remainder of the rent.

**SHARED TOOLING** – This has saved a great deal of money and space within the workshop. Only the larger tools/ fixtures are shared, whereas hand tools and smaller items are used only by their respective owners.

**SHARED KNOWLEDGE** – Each person can help fill gaps in the knowledge of others.

**SHARED CONTACTS** – If a certain skill, tool, material or service is required, other co-op members can often recommend a suitable person or company.

**INCREASED “WORD OF MOUTH ”** promotion of the frame building activity to the local and internet market. Chicago’s frame building scene is just beginning, and by working together the co-op members are able to promote themselves more dynamically.

The main problem Owen raised was that sometimes- although not often, personalities can clash, and there can be issues if shared equipment is damaged.



*The Bubbly Dynamics Building.*



*4130 cro-mo tubing for wishbone seatstay rear ends.*



*Michael Catano's bench.*



*Anvil cantilever brake boss jig.*



*A short production run of frames.*



*A repair in progress.*



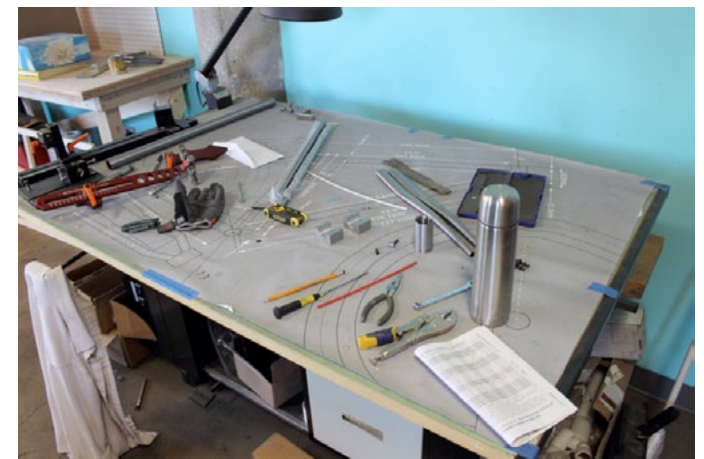




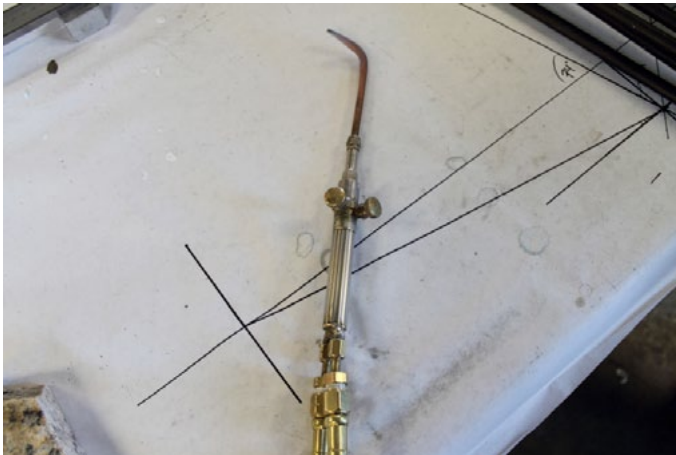
Tubing bender.



Henry James frame jig.



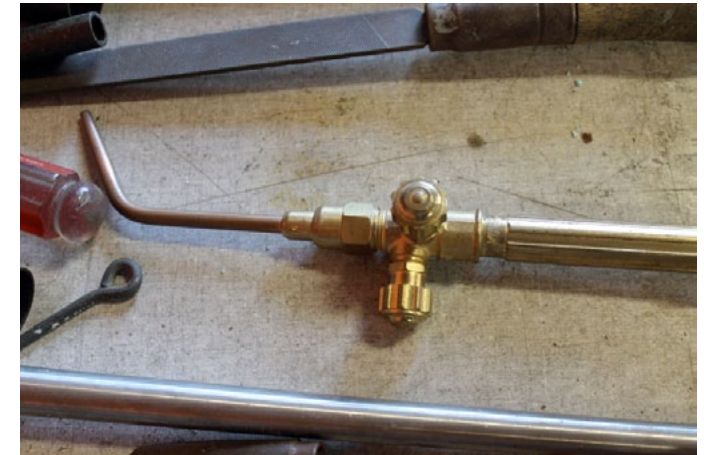
One of the benches in the workshop.



Michael's Smith torch.



Anvil frame jig.



Victor J-28 torch.



Fork blade bender.



The building's green roof.



Uvay's powder-coating and fabrication shop



## RICHARD SACHS

Warwick, MA.

[www.richardsachs.com](http://www.richardsachs.com)

I met Richard Sachs at his workshop in a very quiet part of Warwick, Massachusetts.

Richard is an accomplished and successful frame builder with decades of experience. He works alone, building 4 to 6 frames each month. He started building frames in the US after returning from England where he apprenticed with Witcomb Cycles, Deptford SE London in the early 1970s.

During my visit, Richard explained how his unconventional career path began when he didn't get a bike mechanic job he saw advertised (he only intended to work there for a few months before concentrating on becoming a writer), and then, almost out of spite he wrote to several frame builders in England, partly to prove that he could transcend that role. Witcomb replied, inviting him to come over to England, and welcomed him into the fold almost as a family member.

In his youth Richard's enthusiasm for competitive cycling was coupled with a great interest in the equipment used by the top athletes of the day. Good bikes had to be sourced from a frame builder, especially for racing. Richard's career has combined competitive cycling and frame building, and he remains part of the racing community to this day. This has been an important part of promoting his bikes. He now sponsors a cyclo-cross team. He was working on his team bike frames when I visited.

I spoke to Richard about his equipment, noting that the shop wasn't full of machines like some of the people I had visited previously on my trip. Richard uses no powered machinery – a hangover from his Witcomb days, where there were no machines, and even the drill was hand-powered. "Because technology alone is a poor substitute for experience". "Manual labour, muscle memory and hand-eye co-ordination can be just as good and



*Richard cuts a crown race on one of his cross team forks.*



*Richard's workshop.*

quick with experience" he argued, describing machinery as unnecessary for him.

Richard's frame jig is made by Bicycle Machinery, and apart from a few other small fixtures in the workshop, it looks almost lonely in the shop, surrounded only by benches, hand tools and lugs.

I spoke to Richard about the realities of working as a frame builder today. I asked Richard how important it is to establish a brand identity – He replied "Good frames come first, but talking online is very important, and extra merchandise has provided more revenue streams". When I asked what was the most difficult part in running

a frame building business, Richard told me that it was the administration of a high volume of incoming orders, with the accompanying requirement to be accommodating and gracious to everyone, regardless of how much correspondence each person in the queue demands.

I rounded up my meeting by asking whether Richard thought that frame building has a bright future in the US, and he expressed concern that he thought a saturation point has been reached in the number of frame builders in America, but he was more optimistic about the UK.

He gave me the following advice:

**DON'T ROMANTICISE**, think of it as a business, not a craft.

**DON'T SELL AT TOO LOW A PRICE** just to get things started.

**CLEARLY DETERMINE YOUR MARKET** – you are competing against the Treks and Cannondales of this world.

**GET PROFESSIONAL EXPERIENCE**- try to work at a bike factory, where you will gain much more experience, and then, maybe hundreds of frames later, you can take your skills to your own shop.

**INVEST IN THE WORKSHOP FIRST.**

**DEPOSITS AREN'T INCOME**: they secure a place in the frame builder's queue.

**PEOPLE SKILLS** can be more difficult than frame building skills.



## GEEKHOUSE BIKES

### Boston, MA.

15 West Sorrento St Boston, Ma. 02134

[www.geekhousebikes.com](http://www.geekhousebikes.com)

I met with Marty Walsh who established Geekhouse in 2002, and Greg and Brad who joined the company in 2009 and 2010 respectively. They spoke to me openly about launching and running a modern bike company.

Geekhouse is a custom steel TIG welding operation, making mainly track, road, cyclo-cross, mountain and touring bikes for a young, modern urban clientel. Geekhouse has capitalised on the fixed gear scene, taking influences for their aesthetic and colours from the bmx scene. Their bikes and brand have a sense of fun and include lots of bright colours.

Geekhouse began in 2002, when Marty, who has worked in bike shops since the age of 16, started out by designing dirt jump bikes on napkins, and then enlisted the help of a friendly mechanical engineer. The bikes were firstly outsourced to a US company, and then to Taiwan. This meant long development times, bulk orders, transport times and inventory hassles.

Marty liked bikes by Fat City, Merlin and Independent Fabrication, so approached one of "Indy Fab" founder Mike Flanigan when he wanted someone to teach him how to build frames. It was important to Marty that his teacher was connected to the lineage of these Boston-based bike builders that he respected. The trouble was, Mike said no, he didn't teach frame building. Undeterred, Marty thought outside of the box and later took a broken frame to Mike to get his foot in the door. Marty's bike store experience was sales-only, and so he didn't have any hands-on skills to offer, but Mike told Marty that he could use his book-keeping skills, so this was what Marty traded for being shown the skills of frame building.

After a two year apprenticeship Marty secured funding from the City of Boston, and Geekhouse was born.

**Matt Wilkinson**

The Winston Churchill Memorial Trust Travelling Fellowship 2011



*Marty, Greg and Brad in the Geekhouse shop.*



*Geekhouse Bikes were holding an open house event whilst I visited.*

Marty gave me the following advice and lessons about marketing from his own experiences:

**BOND WITH YOUR TARGET MARKET** – it's important to have a story about how you came to build bikes.

**CHOOSE A NAME** – Marty was a bike geek, really into bikes and bike parts; in his own words, they were a "bunch of geeks in a garage".

**TRY TO HAVE A UNIQUE ASPECT** – whether it be colour, machined parts, carved lugs, curved or super-light tubing.

**DEVELOP YOUR BRAND GRAPHICALLY**– You have to have a logo and a font that you stick to and repeat.

**THE INTERNET** allows the smaller frame builders to exist – the recent growth in numbers of builders is all due to the internet. (Geekhouse are now selling to Indonesia, and are also being counterfeited in the Far East).

Find a good website guy if you're not orientated that way yourself.

**AWESOME STUDIO PICTURES** of your bikes are vital. Include all information on your website.

**YOUR WEBSITE IS YOUR RETAIL STORE** – Geekhouse sell 90% of their bikes by email.

**BLOG** – communicate stories and make regular updates. You must demonstrate consistency and that you will be there tomorrow, but also show progression.

**BIKE SHOWS CAN BE IMPORTANT** – Geekhouse put in a lot of effort to their shows and they're always really successful.

**THINK OF OTHER WAYS TO PROMOTE YOUR BIKES** – Geekhouse now have a cyclo-cross team.

**TALK** to everyone, treat everyone the same, regardless of age, experience or knowledge.

**NEVER STOP TALKING**, emailing, giving out cards and custom-building mailing lists for different groups of people based on their interests.

**ASK OPEN-ENDED QUESTIONS** to people you want to talk to.

**ALWAYS BE READY TO HAND OUT BUSINESS CARDS.**

**MAILING LISTS** are a good way to keep people informed- Most people are looking for information at least for a while every day.

**Bicycle Frame Building in the USA**



## SQUAREBUILT BICYCLES

### Brooklyn, NY.

868 Myrtle Ave, Lower Level, Brooklyn NY 11206

[www.sqaurebuilt.com](http://www.sqaurebuilt.com)

Lance Mercado started building bikes back in 2003 after studying at UBI in Oregon. He now has a very well-equipped workshop in the basement of his apartment on Myrtle Avenue in Brooklyn, and specializes in urban-style custom frames, whether they be single speed, track, road frames or polo bikes.

During my visit Lance was designing a bike for a very small person, with a 650 front wheel and curved top tube. Lance really enjoys making any bike that's a challenge, for instance freestyle bikes, or where the customer gives Lance the task of designing the right frame for a very specific job.

I thought that SquareBuilt Bikes demonstrated a good example of a home-based frame building workshop in a large city. Lance had made good efforts to establish the brand in his local community, and the bikes identify strongly and proudly with Brooklyn in their livery.

Lance has offered short apprenticeships to several keen cyclists who have expressed an interest in frame building. This has helped to build Lance's reputation in his locality, and customers seem to find Lance very open and welcoming. I'm sure that this kind of approach to business could be applied to frame building workshops in London.



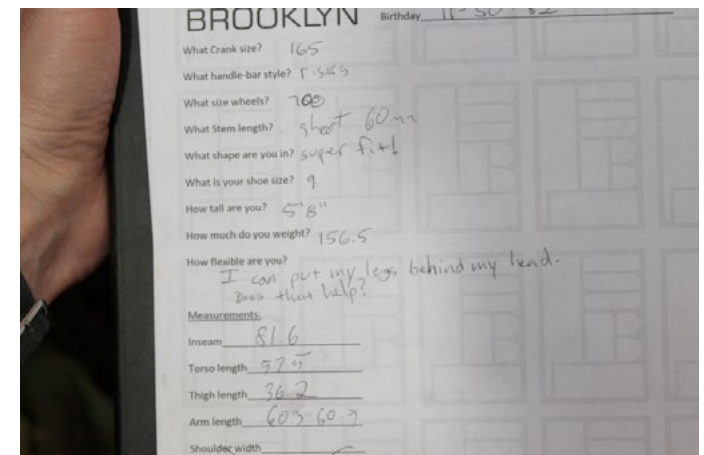
Finished frames on the wall.



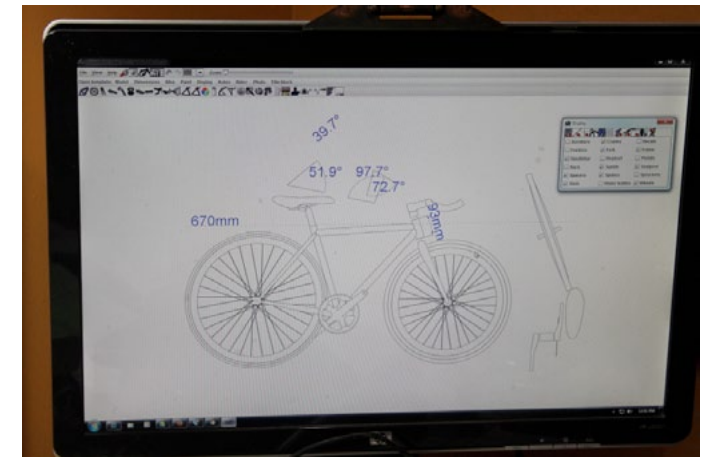
SquareBuilt's basement shop.



Lance brazing with brass



Sizing Form.



BikeCAD software makes things easy to visualise.



Small alignment surface.



**PETER WEIGLE**  
**Lyme, Connecticut.**

313 Hamburg Rd. Lyme, CT 06371

In Lyme Connecticut I met with Peter Weigle, one of my favourite frame builders.

Peter came to England in early 1973 to work at Witcomb Cycles in London, a few months after Richard Sachs arrived there. He spent seven months at Witcomb cycles in the UK before returning to Witcomb USA in Connecticut from 1973 until it closed in 1977. He then set up his own frame building workshop. He started to build road frames on his own, then his first mountain bike in 1982. During the late '90's, he went back to his roots focusing on traditional road bikes again, particularly the randonneur bicycle.

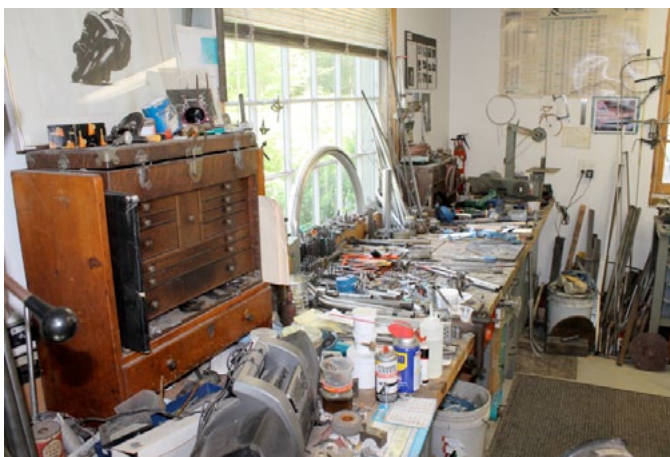
*[In randonneuring, riders attempt courses of 200 km or more, passing through predetermined "controls" every few tens of kilometers. A "typical" randonneuring bike is somewhere between a dedicated road-racing bike and a touring bike. Such bicycles usually have lightweight steel frames, drop handlebars, relaxed frame geometry, medium-width tyres, triple chainsets, moderately low gearing, and the capacity to carry lightweight luggage. Mudguards and lighting systems are also common.]*

I asked Peter what it felt like to have played such a big part in the revival and popularization of the randonneur bicycle – he replied that it felt very special, especially as he was becoming slightly disillusioned with making road racing bikes, which he felt were becoming very generic and mainly in the Italian or classic English style.

His interest in the French style randonneur bikes, borne partly out of his collection of fenders from bikes of this type, began in about 2003. He explained to me how these bikes, as well as being very elegant and having graceful, balanced lines and exquisite racks that sit perfectly in harmony with the rest of the bike, are also



Inside Peter's workshop.



A bench in the workshop.



Nice road frame with chromed lugs.

extremely practical, as they owe their heritage to a time when the riders of these machines would not own a car, and so they had to be used in all weathers and for carrying small loads on all types of road surface.

Peter described how they are fast enough for him to keep up with friends on high-end road bikes (Peter does come from a racing background..), and they are very stable on descents and over poor roads or loose surfaces. I put this question to Peter: Are vision, taste and style as important as the hand skills required in custom frame building? Peter replied "Without question". To Peter, proportion, lines and balance are key factors.

Peter's customers often enjoy being part of the process of buying and ordering his bikes, sometimes having discussions at weekend meetings.

I asked Peter how important bike shows are to his business, and he replied that the handmade show (NAHBS) is not so important to him. "I don't do bells and whistles or peacock feathers", however, Peter explained that "Le Cirque du Cyclisme" is absolutely key and important to his business.

Peter gave me some advice: "Don't show anything you don't want to make, and consider that shows are very expensive to attend."

In Peter's opinion, 80 per cent of the hand built show exhibitors have no real reason to attend, especially with the internet being the main vehicle for their sales. "The older guys see the shows as a community, and know each other very well. The young guys see it as a rite of passage to show their bikes."





A lathe with constantly variable speed.



Peter with the first ever frame he made at Witcomb Cycles, England.



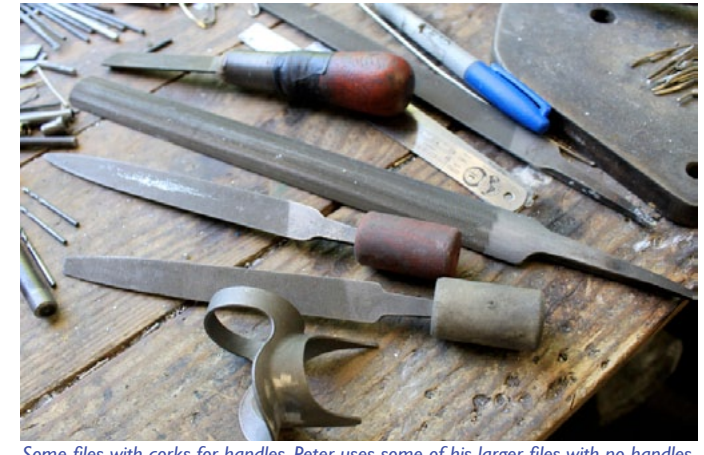
Some files are shortened to make them more suitable for certain tasks



Another lathe with a rubber-flex collet.



Peter told me that this belt sanding machine is one of the most useful tools he has.



Some files with corks for handles. Peter uses some of his larger files with no handles, but smooths off the edges slightly to make them more comfortable.



Peter's frame jig.



A very drilled track end from back in the day.



A collection of lug mandrels.



## ENGIN CYCLES, Philadelphia, PA

7837 Germantown Avenue, Philadelphia, PA PA 19118

[www.engincycles.com](http://www.engincycles.com)

I met with Drew Guldalian at his workshop in Philadelphia. Drew has been running the bike shop Wissahickon Cyclery for 16 years, and started to build frames in a workshop behind the shop 7 years ago. Engin Cycle Works is a very well-equipped frame building workshop. Drew has concentrated his time on getting his frame building process right, and then having the best machines and fixtures for the job. Drew agreed to show and demonstrate to how he uses some of the tools he uses to build his frames.



*The Engin Workshop.*



*The man behind the machines- Drew Guldalin.*

Engin primarily work with steel but are not limited to any one form of construction: Drew Tig welds, fillet brazes and makes custom lugs for maximum versatility. He tried many commercially available jigs and fixtures, but having found them lacking in accuracy he began to make his own. Drew owns several milling machines, lathes and fixtures, and explained how they all have a valid purpose.

One horizontal milling machine is used only for tube mitring, and so has the table bolted in place so that the mitring fixture is always dead-centre around its pivot point. The fixture has interchangeable butt-stops of different sizes, which represent the different tubing sizes. This way, the tube length can be measured very accurately.



*Tube mitring fixture.*

Drew explained that horizontal milling machines are very useful for mitring tubes, and are very accurate. He showed me a German-made horizontal machine made by Deckel that he said was extremely accurate, and also came with a detachable vertical milling head.



*Deckel name plate.*



*Deckel milling machine.*



*Vertical milling head for Deckel mill.*



Next, I was shown a tool that Drew uses when milling his fixtures, an “edge-finder”. Drew explained the importance of using an edge finder when precision machining.

If I remember correctly, the conical pointed part is to find the centre point of a hole. He explained how this is essential when making precision equipment. The edge-finder is held in the headstock of the milling machine and spun. A parallel is held in the machine vice next to the workpiece to give an extended edge to take a measurement from.

It can be seen to wobble around its centre on its own built-in spring. When it comes close to the edge of the piece and touches it, it can be seen to wobble less. When the edge-finder moves closer to the edge, the wobbling stops, and when it is right at the edge, the sprung edge-finder kicks out slightly.

To find the exact point of the edge, the width of the edge-finder is then halved to find the centre point of the milling spindle (a parallel bar is used in the machine vice next to the workpiece to give a convenient extended edge).

The exact centre line of the workpiece can now be calculated by halving the measured width of the piece, then moving the table by this distance exactly with the graduated handwheel.

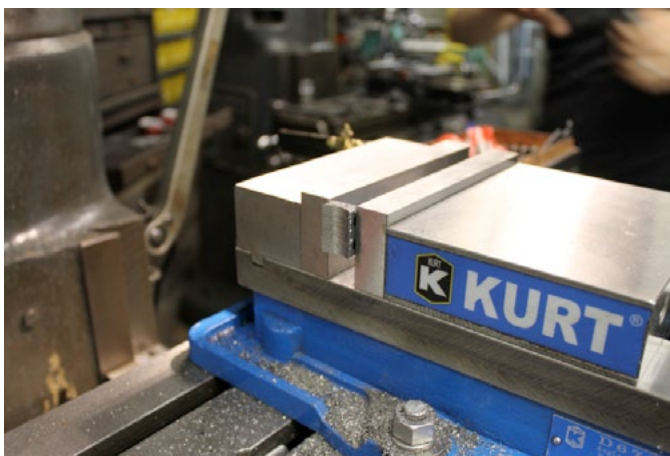
In this case, the piece was a stem/steerer binder made from 4130 chro-moly, which had to be mitred to fit on the stem, and slotted along the centreline to allow it to open and close. A hole saw was put into the milling machine to cut the mitre into the now-centred binder. The mitre was then cut and cleaned up with an end-mill. The central binder slot was cut with a slotting saw on a horizontal milling machine; the distance from the edge to the centre noted and transposed from the previous exercise.



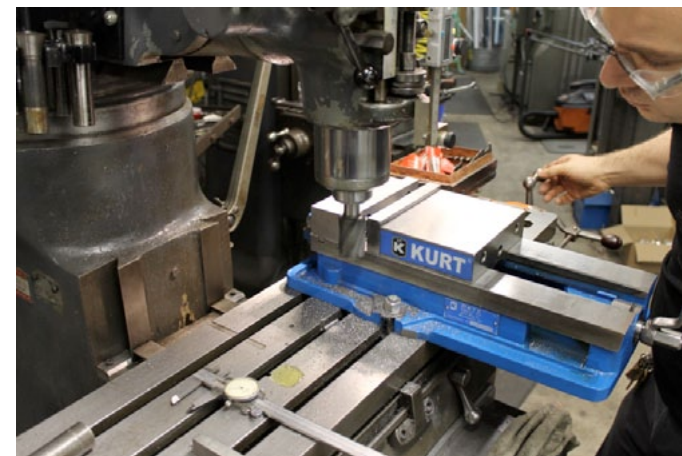
*Dis-assembled edge finder.*



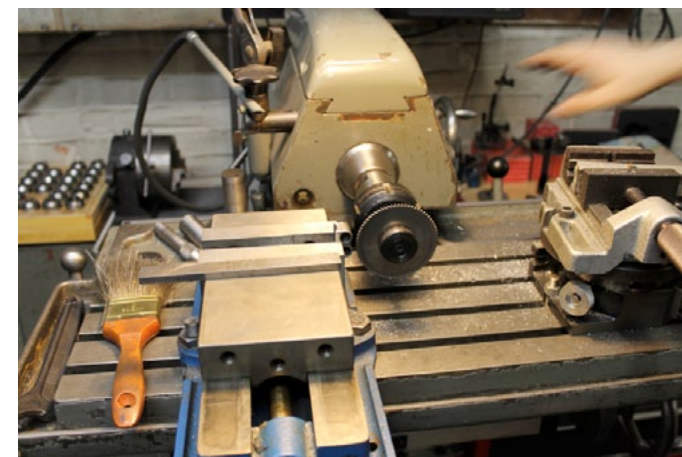
*The edge finder in action.*



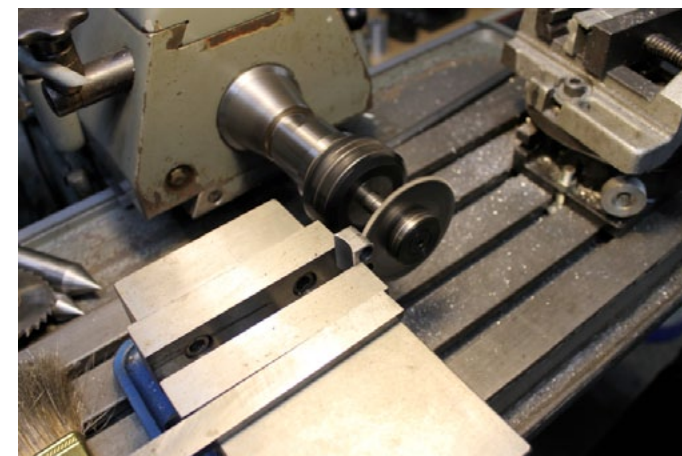
*Centrally milled binder.*



*Cleaning up the cut with an endmill.*

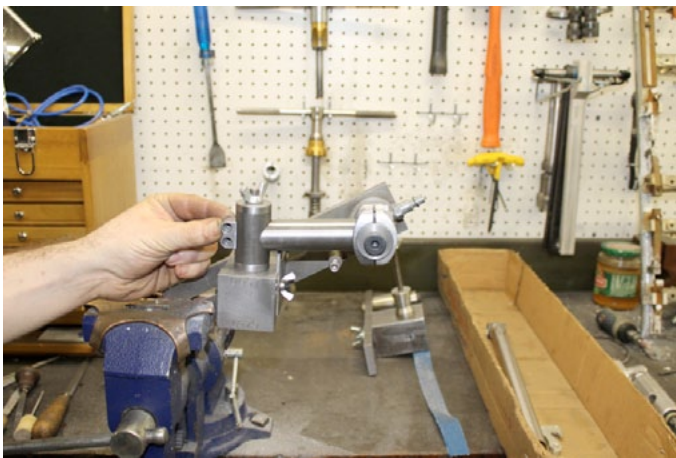


*Preparing to slot the binder centrally on a horizontal mill.*



*Taking the cut.*





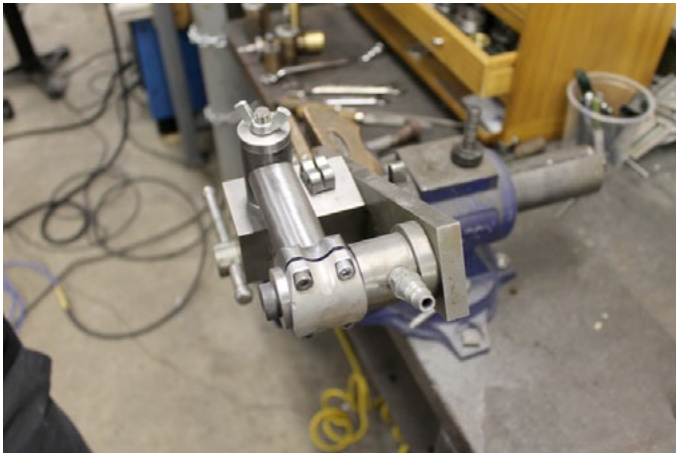
*Binder held in position on stem*



*Unicrown fork jig. The fork blades are held at the bottom on cones, before the dropouts are added.*



*Diacro tubing benders.*



*The stem is held in a stem jig, ready to be welded.*



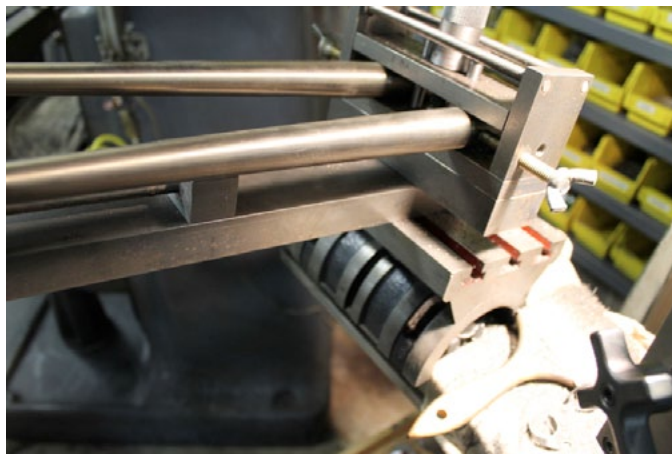
*The tops of the blades are clamped down to keep the blades in phase.*



*Bender closeup.*

Drew also showed me his unicrown fork fixture, designed to hold the blades very precisely and in phase with each other. Drew only uses straight fork blades with his road and cyclo-cross bikes.

There was also a large selection of Diacro tubing benders in the workshop, each one set up for a specific tubing size and task, and marked and graduated for each desired bend radius. This is all part of Drew's striving toward his mantra of accuracy, consistency, repeatability and speed.



*Fixture detail.*



*Bender graduations.*





*Mountain bike fork detail.*

Next, Drew showed me a newly Tig-welded mountain bike fork, with two cross-pieces between the steerer and the straight blades. There are many angles to be considered when mitring and constructing this type of fork, and Drew showed me a very clever fixture he had just developed for mitring the component tubes.

He went on to show me a Sputnik Tool frame jig. I liked the way the angle graduations are moved further outward than with other jigs of this type, thus making them further apart and easier to read and fine-tune



*Carefully bent stays.*



*Rear frame view.*



*The press in action on a bottom bracket shell. Bearing cups or machined substitutes are inserted into the press to prevent distortion of the shell.*



*Surface table.*

Drew takes his alignment datum from the head-tube, not the bottom bracket shell face, and also incorporates seat tube clamps into the surface table, machined specifically for each tube size to retain the centreline with relation to the head tube.



*A frame in a Sputnik Tool frame jig.*



*Frame number stamping press.*



## SPUTNIK TOOL, Sedgewick, Maine

[www.sputniktool.com](http://www.sputniktool.com)

I hired a car in Boston and drove about 6 hours north to Sedgewick, Maine, to visit Jeff Bucholz of Sputnik Tool. Jeff has built his own workshop, and I was really impressed to see that his finely-made fixtures and tools are all made in-house by him alone on a lathe, a Bridgeport milling machine, and only recently, a CNC Millport milling machine.

I thought that it would be good to give an example of a business that has started up to support the frame building industry in America, which is why I decided to include Sputnik Tool.

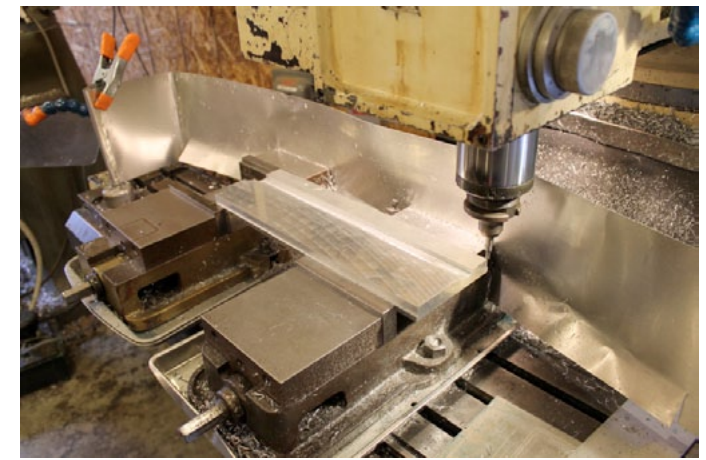
Jeff talked to me about how he used to work at Fat City Cycles (one of the early mountain bike manufacturers in the USA that was based in Boston 1982-1999) and its successor Independent Fabrication (makers of bikes in steel, titanium and carbon fibre and twice winner of Bicycling magazines 'Dream Bike of the Year') but is mostly self-taught with regard to machining. He struck out on his own when his previous role became more managerial, and he wanted to work with his hands.

Sputnik Tool offers a frame jig, jigs for mitring main tubes, chainstays and seatstays, and several smaller tools to aid brazing, alignment, clamping or drilling. Sputnik ships equipment globally, and for some time now business has been good enough to enable Jeff to work solely as a maker of frame building equipment.

The tools that Jeff makes will save frame builders time and money. I half-jokingly suggested that due to the weight of some of the bigger fixtures, maybe Jeff could licence production in Europe, where many of his customers are based, but Jeff replied that the whole point for him was that he enjoys making things himself.



*Jeff in the Sputnik workshop.*



*A workpiece on the Millport machine with swarf shield behind.*



*Jeff's new CNC machine.*



*Some fixture parts awaiting machining.*



## BILENKY CYCLE WORKS

### Philadelphia, PA.

5319 N Second Street, Philadelphia, Pennsylvania 19120

[www.bilenky.com](http://www.bilenky.com)

I rode up to North 2nd St to visit Bilenky Cycles, where I met with Stephen Bilenky to find out about his company.

Stephen Bilenky started building bike frames in 1984. Today he has 5 employees working for him. Bilenky make fillet-brazed, lugged and Tig welded steel frames, and also some titanium frames. He describes his mission as building 'self propelled fun' for 'world cup racers, planet crossings and cross town hauling' Bilenky produces between 100 and 150 bikes per year, depending on the type and level of customisation, as the build-time can vary greatly. They also undertake all kinds of frame repairs.

Several years ago, Bilenky decided to focus on tandem frames, and as the market was small, they became well-known in this specialised field. This helped the business to grow.

Before getting online in 1998, Bilenky relied on articles in magazines and word of mouth for marketing. Bilenky's bicycles were reviewed by *Bicycling* magazine twice in the 1980's, and also in the 90's. He would receive letters from people interested in his bikes, and reminisced that the only other form of communication was the telephone.

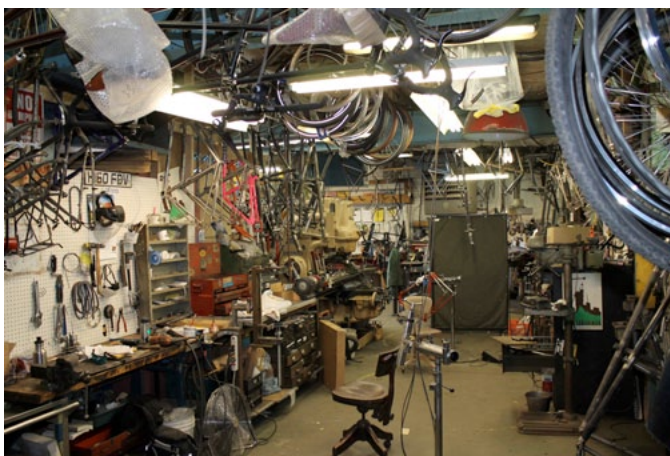
Nowadays, Bilenky relies mainly on internet promotion, but shows are also important: Since the local Philadelphia market is not particularly strong, the main market is national and international. At the time of my visit, two frames were being built for customers in Denmark, and another was being built for someone in Japan.



*Bilenky Bikes door.*



*Stephen Bilenky.*



*The workshop.*

Stephen is largely self-taught, but had lots of vocational training at an agricultural college where he was taught shop skills, repairs and fabrication. He also took more vocational post-college courses in welding and brazing. For a time Stephen studied under Jim Gittins who at one time built under contract for Condor amongst others.

Stephen said that 85% of the information needed to start out can now be found on the internet.

I asked Stephen whether he thought an increase in the number of apprenticeships would benefit the industry, or whether he thought it could potentially increase competition too much. He replied that individual frame builders tend to make their own market, so increasing numbers would most likely benefit the industry as a whole, rather than increase competition.

At Bilenky's cavernous workshop, where perhaps hundreds of frames hang from the rafters in various states of completion, it would be easy to assume that this is a quaintly traditional operation, however, a modern CAD program is used to design the frames with frame fit being worked out using body measurements, a size cycle or the customer's current bike. Tubing is cut and mitred by machine, and the frames are built using fixtures made by Anvil Bikeworks.





*Lots of frames.*



*Painted frames.*



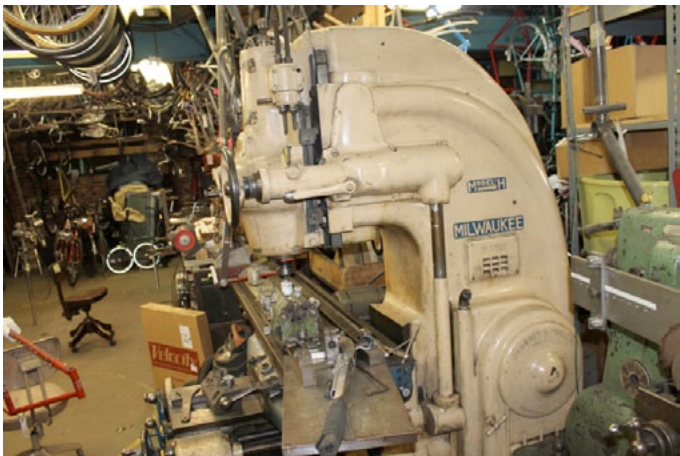
*Tandem frame in an Anvil frame jig.*



*Masked and primed frames.*



*Stephen discusses paint with an employee.*



*Enormous Milwaukee mill.*



*Tandem frames.*



# UNITED BICYCLE INSTITUTE

## Portland, Oregon.

3961 N. Williams Ave., Portland, OR 97227 USA

[www.bikeschool.com](http://www.bikeschool.com)

Steve Glass, UBI faculty member, agreed to give me a tour of the facilities whilst I was staying in Portland.

UBI is a technical school offering courses in repair, frame building, and mechanic certification for beginner to advanced technicians. Now in it's 30th year of operation, UBI's frame building classes started in 1990.

Over the years, students from 40 different countries have studied at UBI, but students from the UK make up a very small percentage. Many students come from Japan, Korea and the Far East.

Three different two-week frame building courses are offered: Brazed Chromoly, TIG Welded Chromoly, and TIG Welded Titanium. The frame building classes are taught by notable master frame builders, with guest instructors such as Tony Pereira and Joseph Ahearne occasionally taking classes.

The classes, with a 4:1 student to tutor ratio, generally follow a pattern of lecture and demonstration, with students applying the techniques learnt in the classroom to build their own frame in the UBI purpose built workshops. Students can build a mountain bike, road bike, hybrid bike, cyclocross bike, track bike or trial bike.



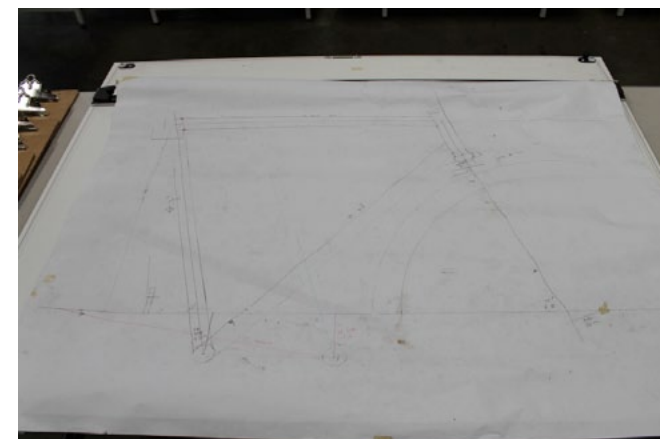
*Bike mechanic training classroom.*



*Frame building workshop / classroom*



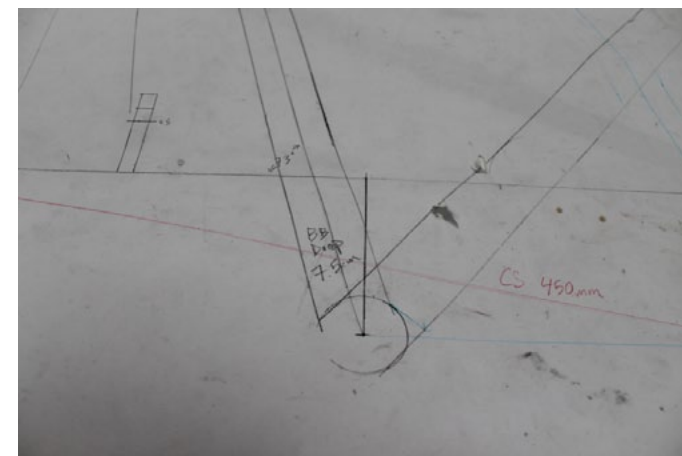
*Mechanic workstation.*



*Frames are designed on paper rather than computers to increase the learning experience.*



*Mechanic students get a Park Tool book and a UBI water bottle.*



*Frame drawing detail.*





Tubeing stocks. UBI keep stocks of Dedacciai, Columbus & Kasei tubing.



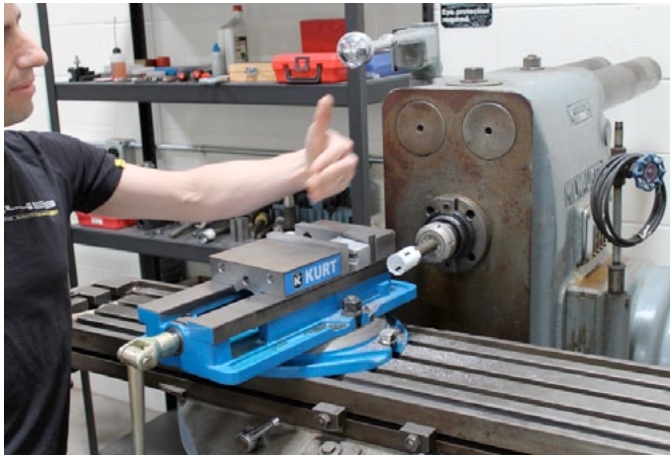
Trued and perfectly dished wheels for checking alignment when building frame rear triangles.



Students are given practice joins to complete.



Richard Sachs lugs.



Chainstays are mitred on this machine, with a fixture.



The welded or brazed joins are then tested by inserting a bar and levered on. A break on the weld = failure. Above the weld = good join.



All the lugs a budding frame builder could want.



Head tubes, steerers and crown race seats are cut on this lathe.



This triangular practice piece is used for Tig welding.





We all have to start somewhere.



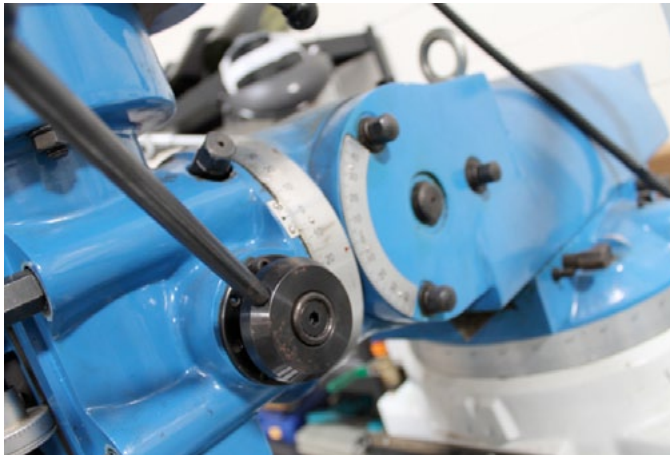
Main tube mitring is done on this milling machine.



Frame building workstations.



Bottle boss brazing practice.



Milling head is angled to cut the mitres into the tubes.



Workstation detail.



Arctos frame jig.



Tig welding machines.



Oxy-acetylene rig.





## DOUG FATTIC FRAME BUILDING COURSE

Niles, Michigan

914 South Third St., Niles, Michigan 49120

fatticbicycles@qtm.net

I chose Doug Fattic's 5-day course based on his location, experience and credentials – Doug has an MA in teaching, and learned the skills of his trade in England at Ellis Briggs in Shipley, Yorkshire. Doug explained how he was one of about 10 young men from the US who went to England to learn to build lightweight frames in the early 1970's, as it wasn't possible to learn these skills in the USA at that time. On this course I built a fillet brazed steel utility, or "transportation" bike frame, this frame being the main type that Doug builds on this shorter 5 day course. Longer courses are available where most types of custom frames can be made.

On the first day, together with my fellow student Bill from Tennessee I chose tubing and parts. We worked out the size of our frames using our body measurements, preferred crank length, and desired standover clearance. We also decided how much mudguard clearance we would need depending on our intended use of the bike.

We had a look at Doug's frame jig, which is his own design loosely based on the type used by FW Evans in England many years ago. The jig is used to hold the frame tubes at exactly the right angles, and on the same centre-line, ready to be tacked together with a little braze alloy. Many elements of this fixture move in relation to each other to allow virtually any size of conventional frame design. Fork rake, tyre size, mudguard clearance, standover height and reach all play an important role in the frame design process.



Doug Fattic's workshop, behind his house.



A look sizing bike in the workshop.



Inside the workshop



Doug's jig



Bill and I sort our tubes into sets.



Protractor



On day two, after noting down all our tubing specifications, dimensions and angles, we marked and mitred our frame tubes. Mitring is all about cutting the tubes accurately so they intersect their corresponding tube perfectly and with no gaps.

We rolled the tubes on a flat surface plate, watching to see daylight underneath, so that we could tell which side of the tube was straightest. This plane of the tube will end up as vertical on our bikes, so that there is as little lateral deviation as possible. Next, we put the tube into the fixture on Connecticut's famous milling machine, the Bridgeport. The angle is set on the mitre fixture and then we mitre the tube with a cutter the same diameter as the tube this one will join to. Using the autofeed function on the Bridgeport the cutter worked through the tube automatically; we just had to remember not to walk off and let the cutter eat through Doug's fixture.

My bottom bracket shell was a lugged type, and lugs need to be worked on before they're used – if necessary by filing or reaming their internal dimensions to make a tube fit easily. Whilst lugs are a structural element they can also be key decorative features, so attention should be utilised in their preparation. We prepared our bottom bracket shells by filing the edges to clean perpendicular angles with straight points. To prepare my chainstay sockets Doug let me use his prized chainstay socket reamer, that once belonged to his favourite English builder of all time, Johnny Berry. Doug had also acquired Johnny's vice and alignment table.

Next, Doug showed us how he made the wooden blocks he uses to hold the tubes in a vice when they are filed and worked on. They are made from two pieces of hard maple with a leather hinge. When the blocks are made, some pieces of paper or card are placed between the two halves before the hole saw cuts through, so that when the paper is removed the block will be a tight fit around the tube before the two halves touch each other. These blocks are some of the most useful tools that a frame builder can have.



Tube held in mitring fixture on the Bridgeport milling machine.



Tubing blocks for different sized tubes, made of hard maple.



The tube is held in a collet on the milling machine.



Johnny Berry's chainstay socket reamer.



Bottom bracket: cleaning up the edges and putting a point on the tip. We used a Swiss file, and Doug showed us some neat tricks.



Herbie Helm's own design lug vice, for holding lugs firmly while they are filed.



During the third day of the course we focused on brazing. Most basically, when brazing with silver, you clean all the pieces, cover them in flux to keep the steel clean and free from oxidation, then heat the tubes. The flux is a good indicator of the steel's temperature, and when it goes clear you melt silver at a top edge of the joint (called the shore) and draw it through the joint with your flame (the silver will flow by capillary action, attracted to areas that are the correct temperature and fluxed sufficiently). Gravity helps, although silver can flow uphill.

It was very useful to observe and be given instruction by someone as skilled as Doug (and his ever patient apprentice Herbie) He is a very good teacher, with a deep understanding of what he is doing coupled with the ability to explain it clearly. This was a great opportunity to improve my silver brazing technique.

We began by tacking the seat tube into the bottom bracket socket, and then we removed this sub-assembly from the jig and brazed it together fully. We also brazed the steerer into the fork crown.

Afterwards we had to file away any extra steerer or braze material so that it no longer protruded from the bottom of the fork crown and was flush with the underside of the crown.



*Herbie tacks a seat tube into a bottom bracket shell*



*Excess silver braze and steerer material is filed away.*



*Doug watches Bill silver braze his fork crown.*



*Crisp bottom bracket shoreline.*



*Doug cleans the 'shoreline' of the bottom bracket shell with the flame.*



*Deer often visit Doug's garden in leafy Niles, Michigan*



On my fourth day we were shown how to braze drop-outs into the fork blades by inserting small pieces of silver brazing rod inside the plug-in type ends and then heating them.

We then cleaned them up nicely and used the fork blade bender to add a curve to the blades, giving just the right amount of rake. For each fork we measured the rake with a rule, a square '123 block' and the corner of Doug's frame jig. When both fork blades matched the desired rake, we cut the blades squarely to the right length, allowing for tyre radius and mudguard clearance, and put them into the Anvil fork jig ready for brazing.



Doug sets up the fork blades for brazing. X



After sanding, the dropouts appear perfectly blended into the fork blades.



The plug-in dropouts and the fork tube



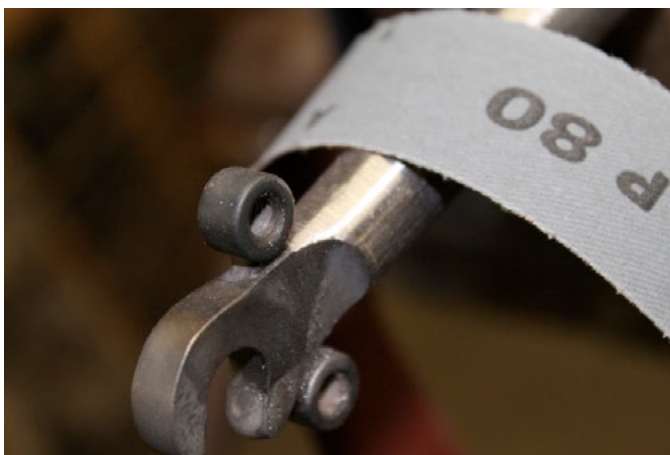
After heating the joint with a flame.



Setting up the Nova fork bender.



Loading the plug-in dropouts with bits of silver.



Time for the 'shoe-shine' sanding with emery paper.



Fork in Anvil fork jig: Doug gives us a Brazing demo.





*Using a brass hammer to improve the fit between the fork crown and blades.*

When brazing with silver, the gap into which the silver must flow has to be very small. To improve the fit I gave my fork crown some blacksmithing with a brass hammer. Since steel is much harder than brass it is less likely to get marked by the hammering.

Herbie then taught us how to braise in the rear dropouts into the chainstays with brass and how to file the brass back to a more aesthetically-pleasing scalloped finish. I hadn't had much experience with brass before this course, so there was a lot to take in. Great care was needed to make sure that the steel wasn't overheated, which could compromise its strength, and that molten brass didn't go everywhere, resulting in time-consuming filing.

I filled the ends of the chainstays with brass, securing the rear dropouts, and left them with a slightly bulbous rise to the brass that could later be filed back to a nice scalloped finish.

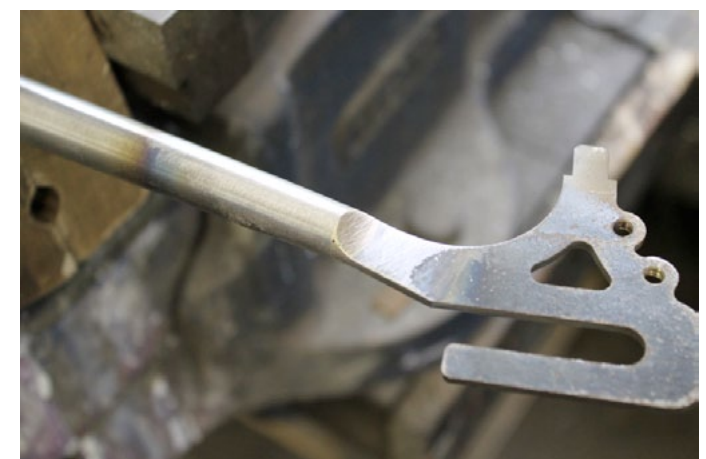
We also attached top eyes to the seat stays by filling them with small silver coils and then heating them, much in the same way as we brazed the front dropouts into the fork blades.



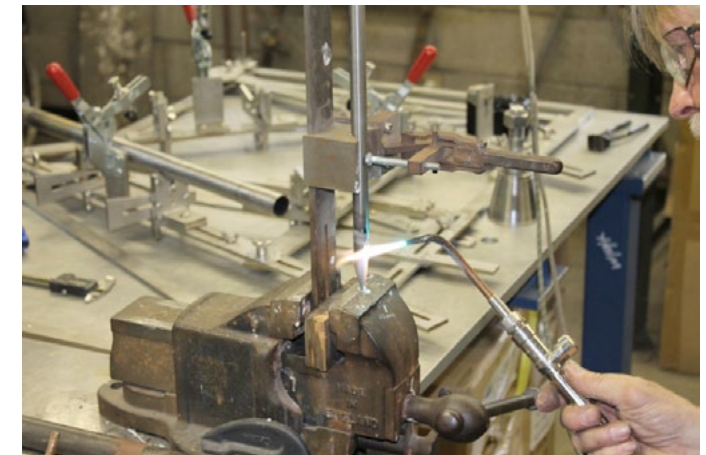
*Herbie brazing the rear dropouts*



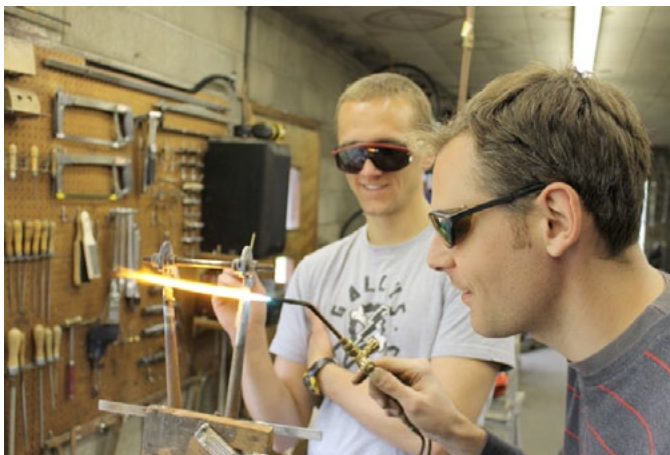
*Brass is added*



*The brass is filed back to a scalloped finish.*



*Doug brazing a top eye on to a seat stay. Silver is placed inside before before brazing.*



*Herbie teaching me some brass tricks. I learned lots from Herbie.*



*Here the silver has been flowed from inside.*



On the last day of the course, we concentrated on fillet brazing the main triangle of the frame, starting by tacking the tubes in place, then removing the frame from the jig and holding it by a wooden tubing block held in a vice.

The fillet brazing took a lot of concentration, co-ordination and patience.

I tacked the tubes to hold them all in place so I could take the front triangle out of the jig and finish fillet brazing. I had to keep turning the frame in the tubing block so that the molten brass would sit in the crease of the mitre with gravity's help, and not run off.

Next we checked the alignment of our main frames, as heat causes the metal tubing to distort and move. If the surface gauge showed that any tube was no longer correctly aligned perfectly, we would have to carefully lever on the tube a little (known as "cold-setting"), checking it constantly until it was true and had no twist or high/low points.

When we had finished brazing the main triangle, we brazed on a seat binder to allow seatpost to be tightened in the frame. This also allowed us to use a "T Tool" as it gave a point to attach it.

Herbie demonstrated how he uses a metal right angle and an engineers square to make sure that the seat binder was brazed on with correct alignment and square with relation to the alignment table.



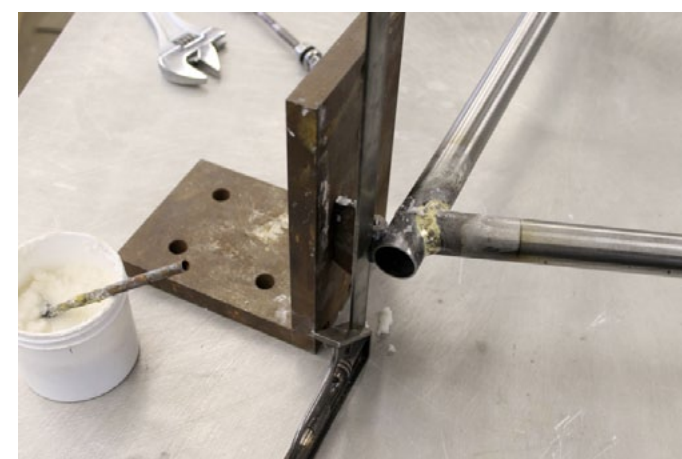
*Taking the main tubes in place with brass.*



*Main tubes tacked with brass.*



*Part of the frame ready to be brazed.*



*Seat binder held in place in preparation for brazing.*



*Checking the post braze frame alignment with a surface gauge on the table.*



*Ensuring that the seat binder is square to the alignment table.*



I then had to file an 8 degree mitre into the chainstays where they will enter the bottom bracket shell. I was shown how to use an "H tool" (normally use for aligning dropouts) in the dropout below the vice to help me file straight at 90 degrees. As long as the tool's handle was pointing directly to me, I knew that filing directly forward was at 90 degrees to the dropout.

I ordered my bottom bracket shell from a supplier called Ceeway in the UK, and took it with me to the US. I had to file the chainstay sockets to let the stays move up a bit and achieve my desired BB drop.

We built the rear triangles of our frames next; one was set up using the Anvil frame jig for speed, but the other rear frame was built "jigless" by Doug so that he could show us the method.

Firstly, a "T tool" is used to hold the chainstays at the desired spacing and height. The stays can be cold set left and right.

Next, a "Park" frame alignment tool can be used to check that the dropouts are centred.

After this, a straight edge tool with an adjustable screw at 90 degrees is used to contact the head tube, seat tube and the wheel rim of a perfectly dished and trued wheel to fine tune the rear end.

Doug showed us how to clean up the fillet brazing with a Dynafile. Great care is needed when using this air-powered sanding tool to ensure that the tubes are not damaged.



Filing an 8 degree mitre in the chainstay



...and then a Park alignment tool.



Filing the chainstay sockets: The surface rust is only a very thin layer - caused by soaking off the flux in hot water after brazing. It's honest American rust.



A straight edge tool is used with a wheel for a final alignment check.



Using a 'T Tool'....



The fillets look nice after a buzz with the Dynafile.

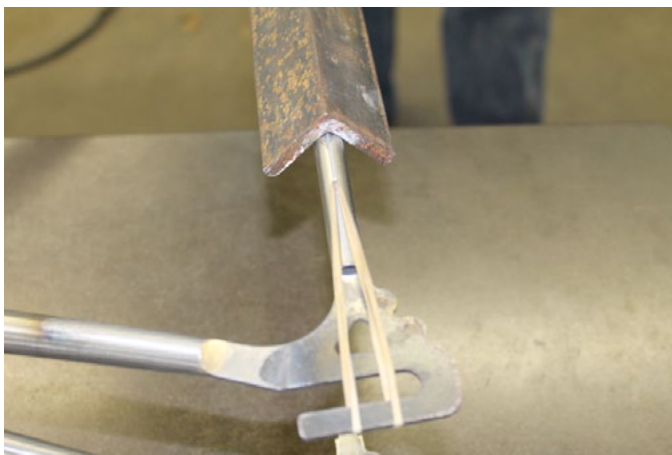


After the chain stays were aligned using the various tools, it was time to braze on the seatstays. They were cut to the right length, then weighted down with some angle iron. A pin was placed into a hole drilled in the seat stay to allow a rubber band to hold the stay to the rear drop out. This would ensure that the top of the seatstay was placed exactly in the right place ready to be silver brazed.

The seatstays were then brazed to the rear dropouts to complete the frame.

I felt that this course very useful, especially as I also came away with a large folder of frame building course notes written by Doug. Combined with the many photographs I took I now have a clear and thorough documentation of the frame building process to refer to in future.

Doug is currently writing a frame building manual which will be available to buy.



*Seatstay is held in position.*



*Doug brazes on a seatstay.*



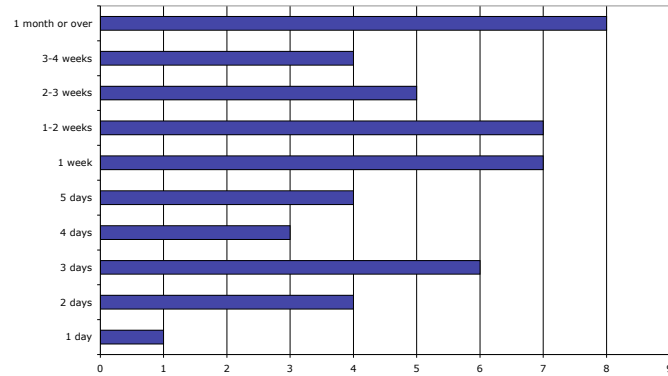
*Pre-braze set up on the alignment table.*





# US FRAME BUILDER SURVEY

I used the frame builders' google group to post a link to a short questionnaire that I had written. My aim was to get an overview of the industry in the US. The only criteria I specified was that all participants should be based in the US, and they must be working as frame builders at least at a semi-professional level. 48 frame builders completed the survey.

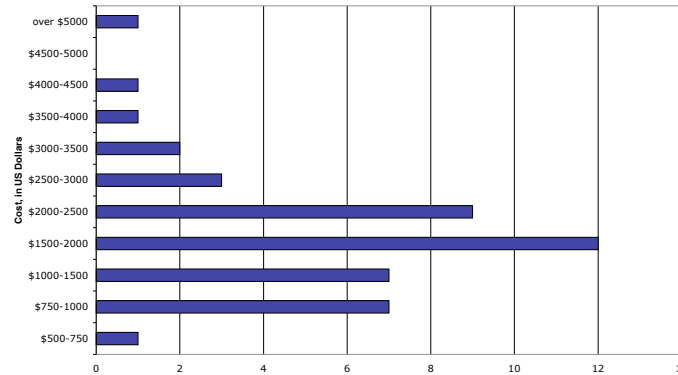


## HOW LONG ON AVERAGE DOES IT TAKE YOU TO MAKE A FRAMESET (A FRAME AND FORK)?

The responses to this question indicate a very wide spread of results. With the largest proportion being in the 1 month or over bracket, the data suggests that a high proportion of the frame builders are working in a semi-professional capacity.

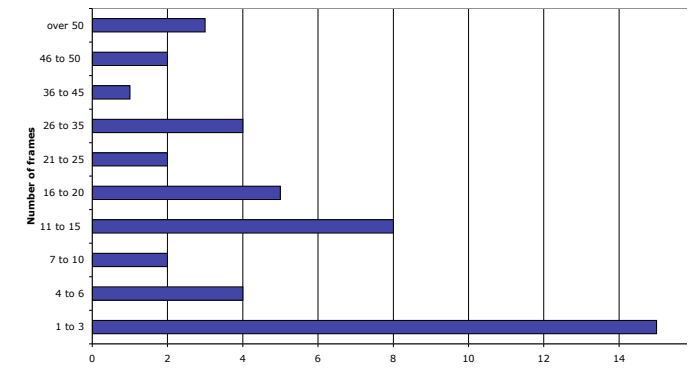
There are also significant peaks in the 3 days bracket, and also the 1 week and 1 to 2 week brackets, suggesting that a fairly high number of builders are working to a more efficient smaller time frame.

As speed and efficiency comes with experience, and working professionally demands a faster work turnaround time to be economically successful, it can be assumed to a certain extent that those builders with lower build times are more professional, or at least less likely to be reliant on other revenue streams.



## DURING THE LAST 12 MONTHS HOW MUCH DID YOU CHARGE FOR A FRAMESET ON AVERAGE?

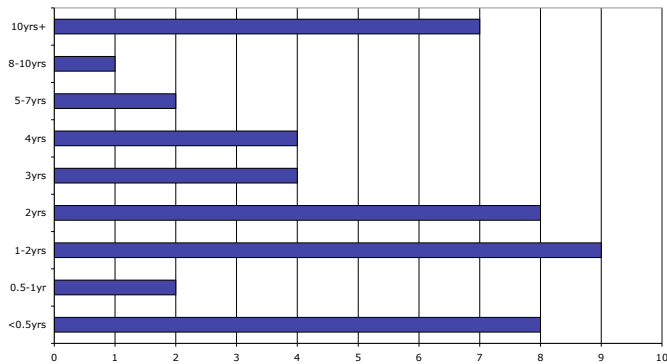
The most-ticked box here was in the \$1500 - \$2000 price bracket, followed by the \$2000 - \$2500 group. Only one frame builder charged an average of between \$500 and \$750, and only one maker ticked the over \$5000 box. This gives some idea of the "going rate" for a custom frame in America. When looked at along with the answers to the first survey question on average build times, one can get some realistic idea of possible income boundaries from this data.



## HOW MANY FRAMES DID YOU BUILD BEFORE YOU BEGAN TO SELL FRAMES COMMERCIALY?

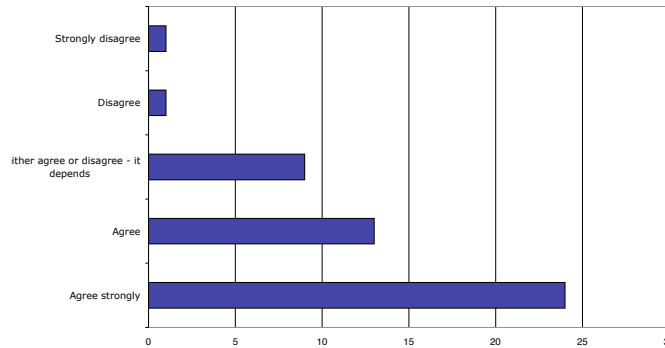
By far the largest group of respondents said that they built only 1 to 3 frames before they began to sell commercially, although there is another fairly large group that built between 11 and 15 frames before building to sell.





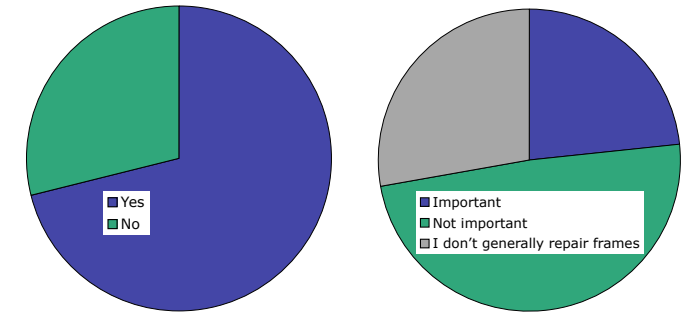
HOW MUCH TIME DID IT TAKE FROM BUILDING YOUR FIRST FRAME TO SELLING YOUR FRAMES COMMERCIALY?

The majority of respondents took less than 2 years or less to make the step to becoming a commercial frame builder, with a considerable amount taking only 6 months or less to begin selling. However, at the other end of the spectrum, there is also another significant peak of frame builders that took ten years or more to go professional.



IT IS IMPORTANT FOR A NEW FRAME BUILDER TO HAVE ANOTHER SOURCE OF INCOME EITHER AS A FINANCIAL "SAFETY NET" OR TO SUPPLEMENT THEIR FRAME BUILDING INCOME?

50% of the poll agreed strongly with this statement, with 27.1% ticking the "agree" box. 18.8% thought that it depended on other conditions, whereas only 2 respondents disagreed with the statement. This is a clear indication that frame building is a difficult job to make a steady living at, at least when starting out. I think this serves as a stark warning to the prospective frame builder that it may be unwise to have all their eggs in one basket.



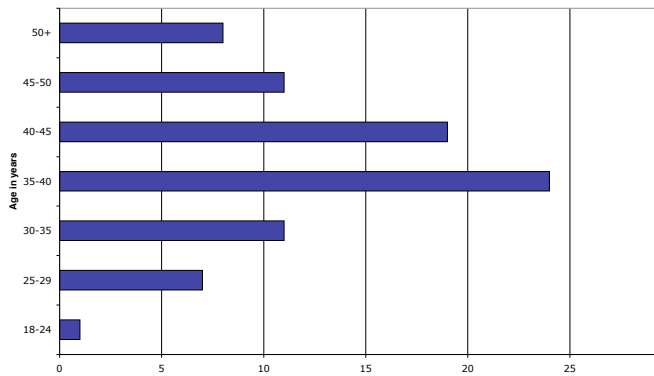
DO YOU OFFER A FRAME REPAIR SERVICE?

IF YOU REPAIR FRAMES, HOW IMPORTANT IS THIS TO YOUR BUSINESS AS A SOURCE OF REVENUE?

71.1% of the survey group provide a repair service, 29.9% do not, indicating that a large majority can repair frames. Of the people that repair frames, over twice as many people viewed it as being an unimportant source of revenue for their business as those that considered it as important.

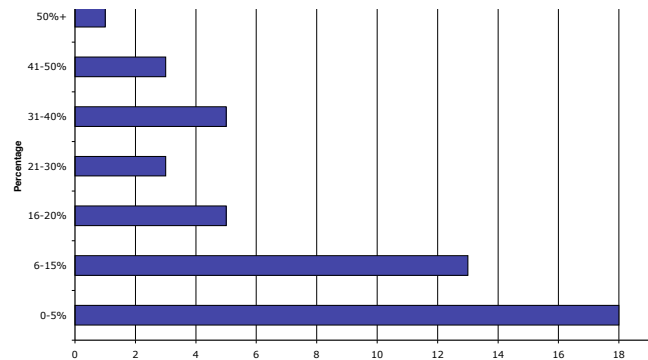
This seems to convey that many frame builders may offer a repair service almost as a courtesy, an extra but not totally necessary revenue stream, or just to give a comprehensive frame service to their customers.





WHAT AGE GROUP DO MOST OF YOUR CUSTOMERS FALL INTO?

The highest percentage of respondents stated that their customers fell into the 35-40 age group, with the next largest age group being 40-45. I suspect that this is due to the fact that people in these age groups generally have a higher disposable income than younger people, and the fact that the higher age groups are not represented quite as highly may be due to a loss of interest in cycling with age, less desire to follow trends, or perhaps they just still ride their great hand built bicycle that was made several decades ago.



WHAT PROPORTION OF YOUR CUSTOMERS ARE FEMALE?

The highest-ranking (37.5% of responses) category was 0-5%, followed by the 6-15% bracket. Only 1 respondent indicated that they had a customer base that was over 50% female. Responses that indicated a female proportion of 16-20% accounted for only 10.4% of the poll, as did the 31-40% female bracket. Taken in context with the previous question, it can be inferred that the hand built frame market is mainly driven by 35-45 year-old males. The disparity between the numbers of men and women buying custom bikes could possibly be seen as an opportunity for a frame builder to aim towards the female market.



## CONCLUSION

Many of the skills and techniques that I have learned in the US are wholly practical for the UK, and I have been able to take a huge wealth of ideas away with me from my US trip.

I have learned a great deal about the equipment used in frame-building from seeing it close up, and in several cases, watching how it should be used.

Talking to so many frame-builders on a down-to-earth level has given me a great amount of confidence to go ahead and produce lots more work. I feel greatly inspired by my interactions with these people.

The market for bicycles is growing steadily in the UK, especially in London. It stands to reason that with higher numbers of people cycling, the percentage of people who desire a hand built frame should also rise.

Frame building is not a business that most people can become wealthy doing. With the exception of some very well-marketed makes, most frame-builders have to substitute their incomes with other revenue streams, such as welding, selling merchandise, components or tools, or by running a bike shop. Many frame-builders teach others frame-building.

Frame-building is once again attracting a lot of interest in the UK. The launch of Britain's first hand built bike show in 2011 is testament to this, as is the popularity of frame-building classes.

A quality, hand built bicycle frame is still a luxury item, and one that not everyone can afford. It is up to each frame-builder to make their own market and to justify their price tags.

Frame-building equipment can be very expensive, and this can be a big obstacle when trying to start a frame-building business. Resourcefulness is a good trait to have

when starting out as a frame builder. Any equipment or fixture that can be made or improvised will save money. Small jigs and tools can be constructed using basic metal-work and brazing skills, and this can become an interesting challenge.

Brazing equipment, ie an oxy-acetylene kit, can be highly dangerous, and should only be operated by those that have had suitable training. Finding a space that is suitable to operate and store such equipment safely is possibly as inhibitive as the finance needed to buy frame building equipment. Recent trends have helped stir up an interest in quality bike frames once more, for instance the fixed gear cycling scene, as well as Great Britain's success at cycling events in the last Olympic Games.

## WHAT NEXT?

The Winston Churchill Memorial Trust encourages its fellows to disseminate the results of their fellowships widely, so that the benefits reach the widest audience. Writing this report is only one way in which I will be doing this.

Whilst travelling I blogged about my experience, and having alerted cycling and frame building forums to my plans this blog received thousands of visits each week. I intend to continue to update this blog, documenting my experience of establishing myself as a frame builder.

In September 2011, I gave a talk about my experiences to a group of about 40 keen cyclists at a Hackney Bicycle Film Society event and have since been asked to repeat my presentation to the London Branch of the Veteran Cycling Club.

I am pleased that there seem to be many people interested in bicycle frame building and I am happy to help foster and develop this interest in any way I can.



## BIBLIOGRAPHY

### REFERENCES CITED ABOVE

Gluskin, E., & Townley, J. (2008). Industry Overview 2008 - National Bicycle Dealers Association. National Bicycle Dealers' Association. Retrieved from <http://nbda.com/articles/industry-overview-2008-pg34.html>

Bike Europe: Website for Bike Professionals.

(2009, August 16).

Facts & Figures - Market Reports: USA 2008: Bike Market Not Immune to Recession.

Retrieve from <http://www.bike-eu.com/facts-figures/market-reports/3534/usa-2008-bike-market-not-immune-to-recession.html>

Crenshaw, J., & McClellan, D. (2008).

China Remains On Top Despite Pressures. Bicycle Retailer & Industry News, 17(11).

Retrieved from <http://www.bicycleretailer.com/downloads/01,%2032-33%20PROD%20STATS%207-1-08.pdf>

The National Association of Cycle Traders, (2010)

ActSmart's analysis of the UK cycle market in 2010

Retrieved from <http://www.thecyclingexperts.co.uk/the-cycling-industry/opening-a-bike-shop/>

Bicycles produced in the world - Worldometers. (n.d.).

Worldometers: world statistics updated in real time.

Retrieved from <http://www.worldometers.info/bicycles/>

Markwell, R., BBC News Bristol, 7/3/11

Retrieved from <http://www.bbc.co.uk/news/uk-england-bristol-12663323>

Ward, A., The Guardian. 20/9/11

Retrieved from <http://www.guardian.co.uk/environment/bike-blog/2011/sep/20/cycling-clubs>

Hickman, L., The Guardian, 20/7/11

Retrieved from <http://www.guardian.co.uk/environment/2010/jul/20/london-bike-hire-scheme-paris-velib>

Steiner, I., EcommerceBytes.com, 15/1/10

Retrieved from <http://www.auctionbytes.com/cab/cab/abn/y10/m01/i15/s01>

Carnac, H., 'Handmade is Favourite', 2009

Retrieved from [https://docs.google.com/a/network.rca.ac.uk/viewer?a=v&q=cache:Op-Gq830legj:www.costa.co.uk/pdf/press/handmade\\_media\\_report.pdf+%E2%80%98Handmade+is+Favourite%E2%80%99,+Helen+Carnac+2009&hl=en&gl=uk&pid=bl&srcid=ADGEEsGa-HsfYAq4xaIBIskURsSx535rXk38TKRImoc50aLUzm-rQ5wkTlxELP\\_bKmmOBldqV4vUTq49zEkiyHwxu-aGyjiYr9ItQ85iGiVjkzWV88WGOgvMN8XkwU85Nuu3SdUZ0EYbjz&sig=AHIEtbR7SeX2zN5IY0Z\\_-quvkZgvRmZLmg&pli=1](https://docs.google.com/a/network.rca.ac.uk/viewer?a=v&q=cache:Op-Gq830legj:www.costa.co.uk/pdf/press/handmade_media_report.pdf+%E2%80%98Handmade+is+Favourite%E2%80%99,+Helen+Carnac+2009&hl=en&gl=uk&pid=bl&srcid=ADGEEsGa-HsfYAq4xaIBIskURsSx535rXk38TKRImoc50aLUzm-rQ5wkTlxELP_bKmmOBldqV4vUTq49zEkiyHwxu-aGyjiYr9ItQ85iGiVjkzWV88WGOgvMN8XkwU85Nuu3SdUZ0EYbjz&sig=AHIEtbR7SeX2zN5IY0Z_-quvkZgvRmZLmg&pli=1)

