When we build, let us think that we build forever.

Let it not be for present delight nor for present use alone.

Let it be such work as our descendants will thank us for;

and let us think, as we lay stone on stone, that a time is to come

when those stones will be held sacred because our hands have touched them,

and that men will say, as they look upon the labor and wrought substance of them,

" *See!* This our father did for us."

John Ruskin.

PROJECT SUMMARY.

1:5 SCALE MINIATURE KENTUCKY RIFLE.

Damien F. Connolly

Winter 1987. It's below freezing on the NSW Southern Highlands and I'm home late, splitting a local timber supplier's offcuts for kindling. One piece just won't cooperate. Inside... into the light...and it's a piece of curly maple with a grain and fiddleback so magically close, that there is only one possible course of action.....

Winter 2002. The remains of a light snowfall are still beside the firetrail, and I'm out running. Something goes click... and for the ensuing five years, every spare moment, and a good many that should not have been spare, was devoted to this project. Always a planner - and a dreamer with my projects, my mind filled with the thinking needed to make not only the miniature itself, but the tools and techniques necessary to make and hold the tiny parts.

Judgement is as important as measurement to ensure '*the right look*,' and relative proportion of the elegant shapes that come from this era of handmade firearms. They are shapes from the mind of the artisan, that blend the instinctive human aesthetic with the demands of function. This in contrast to more easily scaleable modern shapes that are first dictated, and then generated by machining cuts. Having long ago declared war on the straight line and the constant radius, I needed no excuse to cut myself loose, and my life was soon engulfed in what seemed to be reams of both formal drawings and freehand sketches, templates and profiles.

The chosen scale had to be sufficiently small to present a real challenge, but still allow the achievement of the real goal: when photographically or otherwise enlarged, the work should be indistinguishable from a full sized rifle of the highest quality. From the outset, it was important that all parts were true to scale, looked '*right'*, and were in no way changed or compromised to facilitate construction at the small scale.

The smallest screw on these rifles is generally the *set trigger screw*, and on quality rifles measures around 0.080", which means a 0.016" screw at 1:5 scale. Taps and dies are theoretically available down to 0.012" (1:6.6 scale) but to use this would have compromised the scale of the larger screws

if available threads were to be used. Threading taps were available, but at the time, dies were not. As a consequence considerable time was spent making these from 01 tool steel, hardened and tempered after machining.

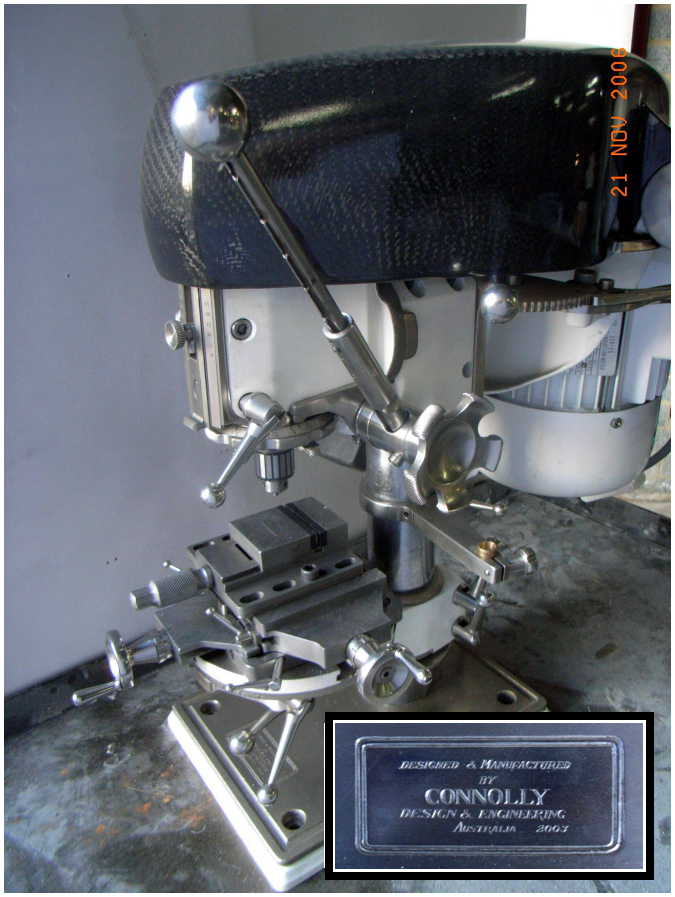
At 1:5 scale the rifle weighs just over one ounce (29g), or as the rules of cubic measurement dictate, 1/125 of the eight pounds or so of the full size rifle with a 46" barrel. So, with this scale in mind, a bore diameter of 0.490" was chosen. By the thinking of the times, the number seven was lucky and fourty nine was seven times as lucky, and to me it just seemed like a number with character. Translated to scale, the bore measures 0.098", rifled with seven grooves, at 1 in 12" twist.

With John Ruskin's words: *"when we build, let us think that we build forever"* in mind, I decided to make all but the barrel in appropriate grades of stainless steel, hardened and tempered to suit the application. I just couldn't stand the thought that in five years, or a hundred and five years time, some corrosion would set in somewhere and it might be taken to with a buffing wheel. Deep hole drilling is fraught with difficulty, and I just didn't have the courage to try drilling close to 250mm(10") through a stainless blank with a 2.4mm (.096) drill. So, 1020 carbon steel it was, and after applying a considerable portion of my life to experimenting, making the necessary guides etc, and modifying my smaller (3 1/2") lathe to spin at 3800 rpm, the drill emerged only .005" off center at the other end of the blank. First full length attempt too!

The bore was flooded with lubricant and reamed with a specially made "D" bit, then lapped to size before rifling with seven grooves. Each groove was cut individually using an old style "saw type" cutter made from DF2 tool steel embedded in a hardened plug of similar material. This was pulled through the bore using an attachment designed and made for the little lathe to impart the 1 in 12" twist. Eight to ten passes with the cutter were made to cut each .002" deep groove.

Off then to the specially made indexing , filing and polishing fixture for the swamped octagon profile and a stoned finish using various stones up to a hard arkansas. Fron here it only needs an ebony lap charged with successive grades of compound to give the degree of finish for the finest of protective nickel plating. But..... to arrive at this point, we're talking in the region of 250hrs tool and jig making, blind alleys, dummy runs and productive work. In short, I found it all a bit difficult.

Over the next 18 months, I spent 600 hours, plus the usual inordinate amount of drawing and planning, making a small *high speed drilling/milling machine* in its entirety. As friends were fond of reminding me, there are various machines available that will do more or less the same job. My excuse for making it is however, is that along with it's *matching compound table and precision vice,* it was a very satisfying challenge that resulted in a highly finished and accurate machine, capable of 16 speeds between 1,000 and 28,000 rpm.



The use of a pantograph or CNC machinery is now common in miniature work. I've got to admit, that stuff does fascinate me, but it's use in this regard is anathema to me. So, a *micrometer*

adjusted spacing device was made to allow *precise miniature grid*s to be drawn on the stock to be used. This allowed accurate reduction of scale from full size drawings, and all parts were laid out using this method.

And...thwack!!! The realities of small scale work came home as I began the *sights and breechplug.* How on earth are you supposed to hang on to something this small... and still work on it? Few situations are the same as it turns out, and I have a collection of miniature vises, ball pedestals and mandrels to remind me. Rule number one however, applies to work of any scale; leave the work attached to the stock you are cutting it from...until you are sure there is no alternative but to cut it free.

A dummy, or trial stock was begun, to allow establishment of contours for *inlays*, and checking the relative scale of parts that had existed only as pencil lines in paper until now. I still worship at the altar of "Superglue and Bodyfiller" for the freedom they gave to cut, shut ,bend and extend the stock to fit my mental picture of the classic "*Lancaster Schoo*l" Longrifle.

The aesthetic values of any rifle are heavily influenced by the datums set by the *butt plate, trigge*r *guard, barrel and forend cap.* I went to great trouble to set these as I felt they should be, and ended up remaking both the guard and buttplate to achieve this. I kept reducing the depth of the forend cap until the ramrod and barrel were covered to half their depth, and the barrel tenons didn't quite break through into the ramrod channel. The last thing I wanted was a rifle that looked the least bit muzzle heavy. With the exception of the barrel, all were cut from 6mm *316 stainless* using files and angle grinder, and fitted to the dummy stock for adjustment of contours. *Escapement files,* (next step down in size from needle files, many of them custom ground to suit the situation) were used for fine shaping/ surfacing, and a variety of laps for polishing. No papers or cloths can be used in polishing parts of this scale if the edges and flatness of planes are to be maintained. *Stone*s can be carefully used on the larger parts at times but otherwise, the finest escapement files will deliver a sufficiently good finish that *mild steel, cast iron,and ebony la*ps can be custom shaped to the task and used with abrasive pastes. Taken from 700 through to 1500 grit and the various rouges, not only is a beatuifully polished surface created, but it will also be *true to the form originally chiselled and filed.*

Indecision struck heavily during the design stages for the *patchbox and other stock furniture.* Should I take a folk art approach to the design, or apply the full engravers aesthetic? After all, many

of these rifles were made and decorated by one man, who blended the developing colonial style with his own ernest, but nonetheless semi skilled interpretation of the decoration he saw on imported furniture, household items, and of course firearms. But John Armstrong, and a little later Henry Derringer, were among the makers with a sense of line in their rifles, and a grace in decorative style that suggests a professional expertise in this area.

I took this as license to follow my heart, and sometime later emerged from under the pile of discarded drawings, picked up my *jewelers saw* with its finest blade, and cut the patchbox from 0.6mm stainless sheet. It was bent to the curvature of the stock on the anvil, and embedded in the temporary stock with epoxy glue, where it was filed almost flush, leaving just enough for finishing in the final stock. *The five tiny tubes that comprise the hinge*, two with a cam section to contact the closure springs, were drilled and turned on the miniature lathe. They were silver soldered to the p*atchbox lid and forepiece*, then filed to a precise meshing fit before the 0.012" diam. hinge pin was fitted.

A new hickory axe handle was sacrificed to make the *ramrod.* A 250mm length was machined to leave a little square section tongue protruding along it's length. Machined to the same lengthwise taper as the finished ramrod was to have, the square section was scraped to roundness, and was in the process undercut sufficiently to part it from the mother piece.

I wanted to capture *the slightly eccentric, "not quite classical " elegance possessed by s*et triggers on early American rifles, and did an awful lot of drawing as a consequence. Laid out to scale on a 0.5mm grid drawn using the micrometer scribing fixture, the triggers are made from 420 stainless tool steel, hardened and tempered before final polish. Sear engagement is adjustable, and both springs are filed to a taper from new carbon spring steel stock, hardened and tempered in the traditional manner. That's actually pretty hard on a spring that weighs less than .05gm, and requires a good hard temper to function as it should.

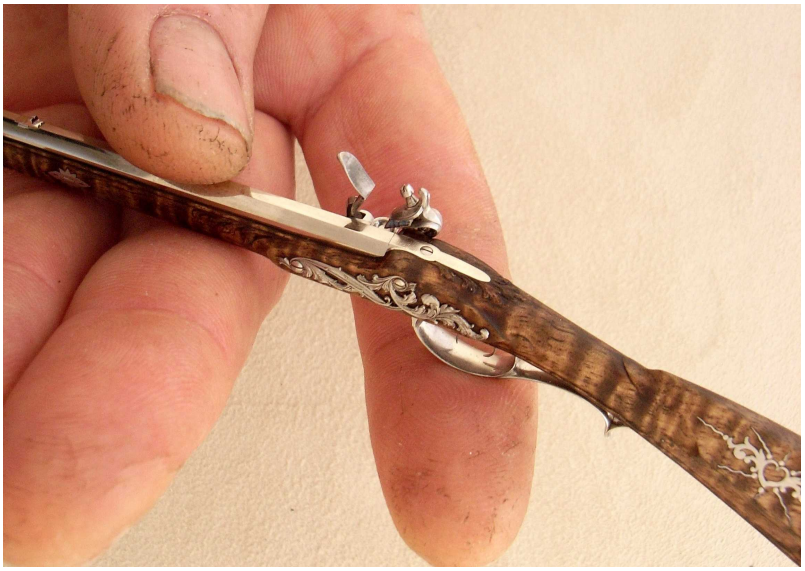
Set triggers at rough filed stage.

A hardened and tempered filing jig was made for the *barrel key escutcheons.* The .024" thick blanks were drilled (on another jig made for the purpose) and the slots through them cut at the

Rifle with dummy stock, barrel key blanks and roughed out escutcheons.

required angle using a jewelers saw and specially modified escapement files. They were bent to match the forearm curvature and fitted to the jig with tiny rivets, before being filed to shape. Not as easy as it sounds. At this scale, a discrepancy of the thickness of a piece of paper is enough to make this sort of shape worryingly assimetrical.

A great deal of design work went into designing an attractive sideplate. I wanted it to appear balanced and centered on the side panel of the stock and still have the requisite screws in the appropriate places. The full sized design was reduced using the micrometer spaced grid system, the holes located and drilled, and the design sawn from the .032" stainless sheet before being filed to precise shape. The relief modelling was engraved using traditional hand gravers, burnishers and laps. In all, no less than 80hrs of work.



The lockplate: A real challenge: All holes in a lockplate have to be in the right place or the lock simply doesn't work. This was complicated by the fact that the starting thickness of the blank had to be nearly .220", and the only way to mark and drill the holes accurately was on the flat, full thickness blank before the pan was machined/filed on one side and the mainspring boss on the other. To drill that deep with a 0.021" diam drill in stainless is very difficult, even if I managed to get them in the right place. On my third attempt, I got all eight holes in the right place, I didn't break a drill off in the last hole, and I got to keep one.....only to suffer a consequence of the large crystaline structure of 440C tool steel. I found out later that it is not much smaller than the thickness of the clevis that the frizzen pivots in. So it broke off when I was trying to polish it didn't it!! There not being a convenient cliff to jump off, or even some innocent person to blame, I went away and made something else for a few weeks, then came back and made one out of 420 grade stainless tool steel. It was only a chance conversation with a metalurgist (well after the miniature was finished) that enlightened me as to what must have happened.

The shape of the hammer, or cock as it's so fetchingly called, is very subtle and no amount of care in scaling seemed to work. Once again because of the thick stock required, holding the precise shape I had drawn on the marked grid became wholly dependent upon how squarely I had filed out its tiny profile. By the time I had made the third one, using the first two as examples of what not to do, the secret of how to do ones best work had been revealed to me: "*Try really hard, And Take a Long Time*". Bit depressing really.

The square hole in the cock is cut with a broach made on the same filing jig as the square on the tumbler to ensure a precise fit, while the shaping and modeling is all needle files, escapement files, chisels and laps.

The frizzen is also 420 stainless steel, (yes, I know stainless won't strike sparks with a flint) and to my immense relief I only had to make one. The frizzen spring was for it's tiny size, a very long job. The blank was drilled, pre tapered and polished on one side before "bending in just the right place". Then it was just a long and careful filing job, working back toward the finial, polishing as I went. The point of the finial was filed and polished finer and finer, until it separated from the bar stock.

The making of the lock required the majority of the 25 or so special cutters, slitting saws and counterbores etc that were specially made as the project went along. A special screw slotting saw was made. The blade is .008" thick and about 10mm long with about 170 teeth to the inch. This equates to a .040" wide slot, which is common on fine guns. The main tang screw and sideplate screws have a slightly wider slot however.

(Above) Cutting screw slots with fine toothed saw.

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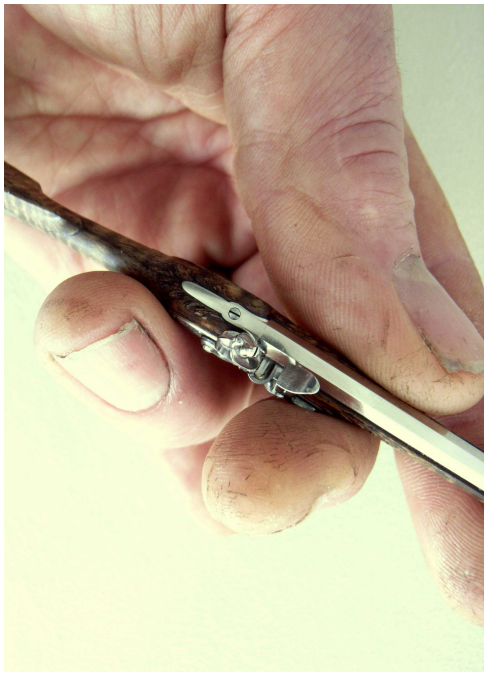
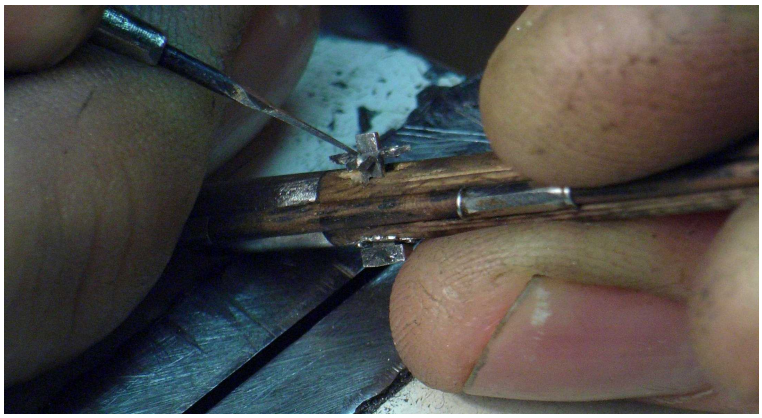
The lock internals were a little more straight forward, or maybe I was starting work out how to do this stuff. Careful layout, microscope aided machining that used both the miniature mill/drill and a miniature lathe, set the parameters for the filing of the graceful contours that so characterise the inner workings of this period's finer arms. *The fly on the tumbler* (necessary for reliable set trigger function) required very precise fitting and is hardened and tempered, as are all lock internals. The *half cock notch i*s a full and matching fit on the nose of the sear, and is a true safety notch. The taper on the *mainspring* has been refined until when fully cocked, the main blade has bent evenly and is straight. The mainspring stirrup is cut from a single piece of steel. No pins.



The final stock is precisely inletted and wax oil finished, after being vacuum/pressure impregnated with low viscosity two-pack resin that will assist it in withstanding the rigors of life.

The stock furniture is secured with real *wood screws*, countersunk with the top flange of the head vertical sided to ensure no feather edges and resultant exposed countersinks when the head is filed flush with the surface. All are of 0.6mm diam. and of varying lengths with a coarse ,wide grooved pitch of 0.4mm per turn to hold the wood securely. Each screw is fitted to it's hole while attached to its piece of stock and the slot marked for inline position. The screw is then removed, the slot cut in the marked position, and then reinstalled to be filed flush. Get them mixed up and your'e sunk.



(Above left) Cutting coarse pitch (0.4mm) wood screw threads with form toothed saw. Screw blank is advanced past guided saw by (partially obscured) master thread at other end of brass holder. (Right) Fitting escutcheons to their inlet recesses.

The fully shaped and inleted stage of a stock is the time to do any *decorative inlays, wood carving and engraving.* A special set of wood carving chisels and "micro rasps" was made for the wood carving, which has been cyanoacrylate impregnated to prevent time and weather from causing deterioration due to grain lifting and pores opening. The c*heekpiece inlay* is stainless steel, and is bedded 0.020" deep in the wood.

Illustration 1: Wood carving chisels and 'micro rasps'.

The engraving is a couple of orders of magnitude smaller than I have had to do before. The design was drawn at full size and copied onto the work with the most finely sharpened pencil I could muster, then cut with a slightly modified"knife" graver. I found a very light touch is required, (who would have thought) with the script lettering "CONNOLLY" presenting real problems of access with its proximity to the protruding pan.

All that remained to do was sand, fill and finish the woodwork, and as usual I underestimated the task that it was. The finish has to stand up to 5X magnification to pass the test of photographic enlargement to real size, and there is such a danger of blurring the detail with the sanding of filler etc. The only way was... guess what: '*Try Really Hard, and Take a Long Time*".....using shaped paddle pop sticks with abrasive paper glued to them and the sharpest scrapers I could make. A few days of my own mix of stock finish, and then a complete cleanup before a few coats of pure canauba wax, delicately applied under magnification to ensure no buildup in the wood carving and on the metal. A final light buff with a lint free cloth.... and that was that.

THE CASE

Just the right amount of the original block of wood was left for the manufacture of the rifle's display case. Throughout the build period I had been drawing and ruminating on designs, all of them more ornate and "out there" than the one that in the end got built. The sketching began again when the moment arrived, and the case that exists is just what came off the end of the pencil. The timber was sawn as close size as I dared, and put aside to "relax" while the fittings were designed and made.

Being me, (it gets tiresome sometimes) I didn't want ordinary hinges. I like if possible, to add a touch of the unique to every component. In line with this, I designed a hinge that showed a minimum of metal at the back, and included an opening and closing detent to add a feeling of control to the movement of the lid. The wood screws were made in the same way as those on the rifle, but were left with a faint dome on the head to enable them to sparkle a little as they reflected the light. I think this kind of thing is very important to the unconscious impression made on the beholder of a premium quality work. After a series of experiments I decided to grind the pigskin suede lining material .020" thick, to maintain the scale of all radii where the lining wraps over an edge. When not attended to, this type of thing often adds a "clunky, and not real" look to miniature work.

Having arrived at a layout for the rifle and accessories in the design stage, I cut the apertures in a cast block of urethane resin. This is very stable and quite hard, enabling the lips surrounding the components to be precisely carved. Edges were left dead sharp to maintain as small a radius as possible adjacent to the displayed items.

Delicate task though it was, the case body was really just a very careful joinery job. The sawn strips of maple were tacked to a piece of steel with superglue, and all rebates etc machined before cutting to length. The lid was also tacked down and shaped to it's "violin" back form, being released and let rest twice during the process to allow it to warp and accommodate to the release of stress. And it did, believe me! The process paid off though, as the lid hasn't moved since the completion of the case. A thorough sanding and filling job, all the while creating and then nurturing sharp edges and smooth radii. Twelve coats of well thinned automotive acrylic laquer, cut with 2000 grit paper and removed from carefully waxed hinge recesses, and a careful polish with rotten stone and oil to

achieve a satiny glow, and the body was ready for lining.

Next job, buy a large box of latex gloves and be prepared to use most of them in an (often vain) effort to prevent the greasy engineering part of my operations from applying itself to the pristine beige of the lining material. The completed case hasn't a single grubby pawmark on it, but next time I'm going to hire a "clean room" from NASA and save a lot of headaches.

The case wall lining was glued in and tucked into its groove just above the display surface before the urethane block was lined and fitted up into the case perimeter from underneath. The task of lining the top, or "display surface" of this block was extremely difficult, arriving at a pattern of cut leather by experiment, then working quickly to stretch and massage it into place over still wet contact glue. The glue had to be thick enough not to dry too quickly, but not so thick as to soak through the thinly ground leather.

In fitting the narrow curly maple trim that runs lengthwise down the display surface, the incredibly fragile little "Tee" section molding magnified a trembling in my hand..... and deftly applied a dab of glue to the display surface lining. Rather than detail the scene that followed, I'll just say "I did the whole lining job again".

I still hadn't solved the headache of the design for the *compartment lids*. Only after numerous experiments and failures did I arrive at the design of the lids and display stand stowage as it came to be. The display stand was also paired back from a number of draft designs that when I look at them now, seem to vary between grandiose and grotesque. I had to realise that the stand musn't compete with the rifle. It is just to enable the rifle to be displayed without needing to be handled.

Finally .. it was time to put my name to the project. After some experimentation to determine the lettering size, I cut a separate die from 01 tool steel using hand gravers. To form, or coin the letters, a 0.5mm (.020") piece of annealed 24ct gold sheet was placed between the die and an anvil piece, and the 'sandwich' sqeezed in the big vise until the rim of the die bottomed out on the anvil. This left a severely work hardened little sprue around the letter that could be cracked off with gravers under the microscope. As it turned out, I had to take the anvil to a harder temper to stop a dent appearing under the die. The gold, which began with a hardness of somewhere around zero, had nowhere to go as the die and anvil closed. So it was trying to get out through the back of the anvil....very educational!

After many dummy runs and a lot of precise fitting to make the letters run together, I took a very deep breath and epoxied the pieces to the leather using a slot cut in a piece of paper with slope lines ruled on it as an aligning device. And then I exhaled.

I***n completing*** a project like this for delivery, a great many hours are spent detailing and redoing partsof an apparently completed work. The chance that a poorly finished detail could be spotted in the future is a spur that drives me at this point, and remains I'm afraid, a niggle forever. But there comes a point when I have to realise that nothing I try to fix is getting any better; in fact it's sometimes getting worse. It's simply as good as I can do.

The re-reading of the ledger kept for this project has bought freshly to mind the all consuming journey that it was. Totally immersed in it, working on paying jobs during the day, and starting work after dinner every night, often working until 3.00 am, and at least to midnight. Oblivious to the hours, and toward the end questioning myself as to the worth...even the sanity of what I was doing. The loss of my beloved 23 year old son Dylan, the birth of my little boy Ethan, and the growth of my second son Zac from a youth into a man are events from the period of this project, and are bound in my mind to the memory of this time doing the work that is my life.
