



THE ST. FLORIAN PROJECT

A Page-By-Page Summary of the Armoring Work of Robert MacPherson as posted
on the Armour Archive



*“The craftsmen of old had their secrets, and those secrets died with them.
We are not the better for that, and neither are they.”*

Summary by B. Vann

Page 1: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445>

Intro to St. Florian project by Mac. (There is much rejoicing.) Photos of project as-is. Discussion of besagew. Discussion of other methods of hitting metal that don't involve hammers and arms. Display of initial project notes. Links to original inspiration piece. Rondels = Cats Pajamas. Discussion of fluting on demi-greave and demi-cuisse – existing work, estimations/planned work. More rejoicing.

Page 2: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=35>

Discussion of tools being used for flute work, in progress photos of fluting. Comparison of source material to existing sprezzatura. Discussion of pierced decoration on edges of plates, with sketches. Progress photos of decoration. Attempts to translate Mac's handwriting in page 1 notes. More rejoicing. Discussion of the fleurs / decoration. Photos of current progress of ornamentation. Close up of fluting stake. Discussion of repetitive motion injuries and 'patina' vs 'rust'. Discussion of tools used in decoration.

Page 3: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=70>

Fluting of cuisses with photos. Hems of top edges of cuisse back plates. Question about shaping the cuisses + Mac A. Photos of files used for decoration. Breaking over the hems. Discussion of technique: thinning the edges, also thoughtfulness in hammer blows. Photos of issue found with alignment of pieces / articulation and resolution.

Page 4: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=105>

Lots of questions from Tom B. Photos of smoothed & trimmed knee pieces. Issue with range of motion in pieces. Discussion of use of plasti-dip with decorative filing. Work performed on re-shaping knee wings. Photos of original source. Conversation about stress fractures/cracks - techniques for addressing them. Answers for Tom B's questions. Progress photos of knees with fluting lines. Question about horizontal crease on poleyn.

Page 5: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=140>

A about question re: horizontal crease on poleyn, with photos. Photos of Mac's armor stand NAKED, and discussion of its awesomeness and links to additional photos of it. Photos of work on cuisse back plate to assist range of motion. Question from Dave/Aussie Yeoman about fluting techniques. Disassembly of breast. Review of fluting lines. Comparison to inspiration piece. Direct links provided to armor stand photos. Discussion of flutes on plackart. Photos in progress of fluting breast & tools used. Close-up photos of fluting on cuisses and knee wings. Question from Aussie Yeoman about fluting techniques.

Page 6: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=175>

A about question re: fluting techniques. Digression discussion about photo angles / perspective in images and its effect on how we see the piece. Close up photos of fluting process. Discussion of sharpness of flutes. Links to compression sleeves. Close up photos of knee lames. Photos of various hammers in use. Photos of breastplate sketches. Photos of greaves. Hints about rubber banding people's toes when making casts of their feet. Photos of 'dirty secrets of armor fitting.'

"Sometimes it's difficult to get people to accept this sort of "meta technique" information. They want to learn how to dish, and I want to teach them how to design. They want to know how to planish and I want to teach them how to plan a project. They want to learn how to set a rivet and I want to teach them how to see."

Page 7: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=210>

Q from Jan regarding anatomy of the shins. Question from PartsAndTechnical re: contraction of the instep and cutting greaves. Photos and discussion of work on ankle area and the points of the sabatons. Photos and discussion of work on greaves. The magic of geometry. Close-ups of hems and inside of sabatons. Question & answers about movement and how it affects fit. External links to sliding rivets in the feet (not from Greenwich workshop) provided by Wade. List of Wallace images with sliding rivets. Discussion of vertical sliders.

"It is tempting to look at the anatomy, and ask "how do I armor this?", but sometimes it helps to look at the armor and ask "how does this fit?"

Page 8: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=245>

Photos by Tom B of Wallace collection items and notation that sabatons showed are restorations and not original. More discussion with James Arlen Gillaspie (JAG), Tom B, etc., of sabaton construction. Plackart decoration. Discussion of sabaton droop. Discussion of slider technique. Lengthy Mac answer about greaves and fitting them, with diagrams and photos – Cones! External link to Jeff Wasson discussion on greaves, to which Jeff W & Wade had contributed. More close up photos of hammers. Final detail photos. Border at top of plackart.... The joy, the terror.

Page 9: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=280>

Discussion of roping vs latten. Work on repeats for border pattern. Smoldering hammer technique. Exposed or covered heels. Photos to external examples. Mac's elbow is a national treasure. Keegan provides photos of a child's armor, which gets folks excited. (Turns out to be a 1800s repro.) Discussion of fluting kicking Mac's ass. Tool repair.

"Ah, those halcyon days of dangerous chemicals, rubber boots, and manure."

Page 10: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=315>

Discussion of electrical issues at Mac's place. Work on breast fit. Discussion with August Patron about decoration. Issues with the fauld. Reshaping lames. Use of templates. More tool repair. Techniques for cutting. Techniques for arching lames. Developing templates. Getting the third lame under control. More techniques for cutting.

Page 11: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=350>

External links to books on rotary tools and abrasives. Tips for cutting using a jigsaw. Return to source material – backplate & cullet. Butt-tasset. Weirdness of black plate construction. Back flute patterns. Side topics about the end points of flutes with detail photos. Correction to prior posted image. Fluting of black lames. Progress photos on cullet modification. **Tip:** Use vice-grips, not c-clamps to hold stick to cutting bench!

Page 12: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=385>

Tips on running a line parallel to an edge. Butt-tasset work + fluting. Redrew flutes to add more life. question about fluting individual pieces, vs entire unit at once. Answers from Wade Callen. Additional work on cullet including decorative work. Adjustments to armor stand with photos. Question & answer about grinding wheels. Starting work on pauldrons. More adjustments to armor stand to support arms. Upper cannons – comparison images to source. Compromise needed.

"Everything we do has an impact on the overall look."

Page 13: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=420>

Discussion of "Tubes within tubes" construction of lames. Work on cannons. Work with body double reveals fundamental problems with pauldrons, which will need to be remade. James Arlen Gillaspie provided Mac with some ideas and sketches about 'tubes within tubes' concept, and it provides significant improvement in motion. New pauldron plates. Question & answer about leather for articulation, design of articulation, tips on where folks get it wrong. Question & answer about round rivets cutting leather. Discussion of changing pauldrons. JAG: Tapered Cones idea. Started working on templating second lames.

"If you cut it off the plate, you have to cut it off the template as well."

Page 14: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=455>

Discussion of Chinese medicine cures for ailing joints. Lame # 2 gets hemmed and shaped. Issues with wavy hems. They go into the Box of Shame. Discussion of outside hems vs inside hems. JAG provides photos of a cuirass from A 79 KMW group with rolled hems. Discussion of triangle hems: suggestion to ping Patrick Thaden for

info. Question & answer about wiring lames to prevent deformation while hemming the edges. Progress on outward leg of hem.

Page 15: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=490>

Photos of closed hems, and discussion of specific technique for closing hems. Rethinking the bevor with sketches and comparison photos. Beginning work on new bevor. **Tip:** clip the edges of your gorget lame template so the cardboard will flare. Discussion of pattern template evolution. Again: Changes to armor = changes to templates. Working with the bevor some more. Selfies wearing sallets and bevors are hard, yo. And, then a miracle happens off camera. Discussion about where and in what direction to hit, to expand the holes and make the fall plate sit higher. Mac does NOT like making tools. But did – using a ground down stake. Need for hem brainstorming – a hem symposium! HemCon!

“(Learning how to think correctly about how the armor’s form should fit the body is) the MOST important thing.”

Page 16: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=525>

Bevor catches. Spring boxes. Tempering springs. Question & answer about tempering. Working through issues of décor and matching pieces aesthetically.

“In an ideal universe, all the details of an armor are worked out on paper before anything is committed to steel.”

Page 17: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=560>

Discussion of materials used for latch and staple. Discussion of final product use, in regards to fluting and gorget lames. Bevor work: Boxing, tapering, fluting. A couple days work summarized but without photos: shoulders of gorget plate are too high. Pauldrons having issues. External link to a lazy Susan heavy duty swivel. Turntable added to Massimo (the armor stand) to make a turn-torso, which is declared to be vastly more helpful than even guessed. Four stars, highly recommended.

Page 18: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=595>

Turn-Torso widget is the bee’s knees! Re-familiarizing with shoulder issues. Fitting work with August Patron (AP). Discussion of various solutions, including JAPs ‘tubes’ concept. Re-templating, old vs new photos. Cutting and shaping the new arms. Reducing internal bulk by thinning overlaps and using headless rivets. Making second and third lames. Fitting process. Fitting the upper lames and main plates of pauldrons. Cutting process discussion. Photos of grinder.

Page 19: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=630>

Work on fluting on arms. **Tip:** Give your brain time to evaluate things, left brain vs right. Discussion of the Mystery Line on the shoulders of the origin piece. External photos. Fluting the upper arms. **Tip:** When fluting, do pieces one at a time and check them against their opposite numbers, and against their mates, as fluting distorts the work. Keeping fluting dramatic. Dealing with edges and overlaps. Conversation with Tom B about offsetting from the tabs for pointing the pauldron. Fiddly stuff on flaring lower edges of lames/tubes. Moving rivets. Connecting pieces together using internal leather pieces. Assembling lames. Working with the leather. The vexing question of attaching the besagews. Three issues with pauldrons and arms. How to fix them.

“It’s important to keep your face out of the “plane of destruction” when drilling anything.... especially old rivets.”

Page 20: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=665>

Discussion of using Mac’s armor on the field – but it’s too pretty! Quote from Konstantin: “You spend steel to buy learning.” Chris Gilman recommends a band-saw instead of the Electric Jig Saw. Question from Tom B about brayette & mail fauld, with photos. Mail sleeves: Fitting and fixing bad rings. Side project: Weather vane for Master Galleron de Cressy as a thank you for body-stand-in work.

Page 21: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=700>

Discussion of body-stand-ins. Mock up work with vest / chainmail sleeves. Discussion of original. Metal vs sewn eyelets. Fitting the vest. Gratuitous use of red laces. Ckanite discussion about force applied to vest impacting the body. Discussion of weight saving methods for sleeves.

Page 22: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=735>

"Mail wallahs.." "There must be a trick we are missing." "Scotch." :D Sewing the sleeves onto the vest. Links to external sites for fabrics used. Discussion of cutting rivets techniques. Qs about fit for the vest. Fitting test reveals adjustments needed. Mail sleeves sent to AP. Discussion about fit, involving Hastings Manuscript illustration. Reveal of the shoe-maker: Francis Classe.

"I am making what I think and hope are reasonable decisions, but we may never know for sure what was usual and typical historically."

Page 23: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=770>

Estervig asks about mail sleeves, and Keegan provides links to existing threads that address his question. Mac is back at work on the mail, changing the mail standard. Techniques for joining different gauges of mail. "I just hope it does not go against some little known Levitanic prohibition about mixing different sorts of mail. I would not like to be leading us into abomination." Fitting issues. Patching in. Collar sag = needs lining! Review of Tom B's Pinterest page of mail neck defenses and conversation about hooks with sketches. Work on developing mail hooks and making them pretty. Super-cool pics of antique hand vises. Discussion of use/purpose of the collar hook with Wade & Tom B contributing info with links to external sources and archive threads.

Page 24: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=805>

Mac catches up on a bunch of various questions about the collar hook, the built in elbow, and collar liner. Discussion with Tom B about overlap direction of the collar. External link to painting that shows mail collar with clasps. Photos of hand-vice collection. Punching brass rings. Making jigs to help with process. Making brass dags for the skirt. Discussion of technique – right slope / left slope. Installing brass dags, and math didn't make much sense. Fitting the pieces together. Discussion of closure for skirt – tie vs buckled. Questions from Tom B about brayette and skirt positioning with multiple configurations posited.

Page 25: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=840>

Mac discusses positioning the pieces, which matches up to Tom B's Scenario C. Mac redoes the slit in the side of the mail skirt. Suggestion of Ian Laspina's girdle/lendinier method for suspending the brayette, with external links. Mac discusses AP's new fitting session, and finding out what works and what doesn't, what fits and what doesn't. Some pieces will have to be completely reworked due to AP body changes. JAG provides photos to help address one of the possible re-works. Mac chills and makes notes for re-working plan. Updates templates, cuts new pieces to weld on to body. More add-on work. Tips for opening up a rolled hem. Question & answer about welding technique. Discussion of welds cracking due to temperature.

"The whole point of this thread is for people to learn what they can from my mistakes as well as my successes."

Page 26: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=875>

More work on adding to the faults and fixing problematic welds. Group discussion of cracking welds, with sketches. Follow-up testing/experimentation on weld issues. Group discussion of welds and issues. Edge trimming of chest pieces. More welding experimentation. Photos of welding. **Tip:** It is important to always re-melt your tacks when you run the weld.

Page 27: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=910>

Fixing misaligned hems on backplate. Discussion about front/back plate overlap. 13 hour fitting session with August Patron. Things are better. Mail brayette is being troublesome. Sketches on how to fix mail sleeve

issues. Work on sleeves. Discussion of vambrace issues and statue vagueness. Work on making a new vambrace. Comparison photos to Golls (Broken external links) Links to Roe Renman's Flickr, showing different angles on the vambraces. Tom B discusses that oftentimes armor is disassembled and reassembled incorrectly, in different configurations. Work on hinges and hems of vambraces. Possible decorative schemes for vambraces. External links to photos by Durer, showing no lower canons with vambraces.

Page 28: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=945>

Mac gets approval for fluting/decorating plan, and begins work on it. **Tip: When fluting, keep the fingertips of the hand (that is holding the piece) in contact with the stake.** Mad Matt adds that using a laser pointer hung from the ceiling to indicate the stake location can help, too. Fluting completed on pieces, matching up to original dimensions. Old jackhammer bits make nice stakes. Discussion of how to 'coax' the pieces back into shape. Leather Mallets Should NEVER Be Used For Dishing. (Note the use of the absolute.) Discussion with JAG on techniques. Beginning work on the gauntlets and knuckle plates. Going back to source material on gauntlet knuckle plates. (see Goll's numbers 1049, 1071, 1323, 1325, 1326, and 4904) Discussion of gauntlet design. More work on knuckle plates. Discussion of a troublesome 4-rivet metacarpal and varying hinges. JAG provides photos of a piece in Berlin.

Page 29: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=980>

External links (broken and functional) are provided for some metacarpal plates/thumb hinges. More work on knuckle plates. Cutting finger-plates. Discussion about 2D vs 3D when templating finger pieces. Wade provides some info, and external links. Mac discusses finger-tapering in detail, and specific elements of hands and finger-shapes. Folks go absolutely bonkers with joy about that particular post and the insights it provides. More external pics from Golls' by Tom. JAG provides info that some linked items are restorations and not original. Mac gets more work done on the fingers, but feels the base of the thumb feels cramped. Tom offers link to his gauntlet photo collection: <https://drive.google.com/folderview?id=0B7VQpDdg9VywSTVQX0tTTzE0d1E&usp=sharing>

Page 30: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1015>

Discussion of overlap issues. Looking at gauntlets in Goll. Mac is testing the gauntlets to work with different types of items grasped: swords, lances, etc. The question of whether or not to use hand casts is raised: Mac hates working with them. Tom provides external links to Wade's gauntlets. Mac decides to replace the metacarpal plates. He makes new templates and provides tips on making them. Photos and guidance on making the new gauntlet pieces and discussion on fitting and fluting. Mac finishes the gauntlet pieces and moves on to discussing the helmet. Link provided to his Pinterest board for helms: https://www.Pinterest.com/macs_shop/sallets/

Page 31: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1050>

Discussion of various sallet shapes. Mac finds a new source for welding gasses and a bigger tank, and that makes him feel much better. Time to start working on that helmet. Tom B provides some external links to some German harnesses with short tailed sallets (Bayerische Fürstengenealogie 'Ulrich Fuetrer, ,Bayerische Chronik'). Mac starts dinking around with the helmet. Before and after pics of working on the helmet. Pondering fancy rivets from the lining strip with sketches. Long discussion about rivets, and soldering decorative caps onto them. Tom B provides links to Leeds photos of decorative rivet caps.

Page 32: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1085>

Links to more rivets, including those made by Jiri Klepac. Tom B provides some Goll #s to use for reference. Mac makes a Pinterest page of all the references Tom provided: https://www.Pinterest.com/macs_shop/decorative-rivets-on-armor/ Tom provides more links to his Sallet research Picasa album. Rob/Zanetto provides some links to capped rivets he's been making, and notes on how. Mac suggests rotating the punch to all the orientations to average out inaccuracies. Mac shares photos of the tools he made for the "Jello-Mold Rivet Caps." Mac finds a 'smoking gun': Object S-30 from Churburg shows several examples where brass caps have come away revealing the impression of the cap in what is almost certainly

tin/lead solder. Jason Grimes provides links to more examples. Discussion of technique for making the iron spiral caps in the Churburg photos.

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Mac does a bunch of experimenting on soldering caps onto rivets with Dave Rylac. He posts their findings and tips, along with issues they were still having. Tom B posts external links to images with questions about Where Does the Solder Go? Mac posts some progress photos of how he does the soldered cones. Good failures vs bad failures of the rivets with cross-sections. Rob/Zanetto provides links to some experimenting he's doing with decorative caps, with some of his progress notes. (Mac admits punch-envy.) Mac does some more experimenting on 'good' failures and reports his results. **TIP:** Key take away is that *"What does matter is whether or not the flux has had a chance to finish boiling and out-gassing before the solder freezes. If there is any chance that gas from the flux can get trapped under the rivet head, the resulting solder joint is weak."* Tom B links to a 2009 discussion of Jiri's brass caps on rivets thread on the Archive. Mac switches gears to work on the fitting of the cuirasse and issues with the straps, posting before and after pics. LOTS of work on this with progress photos. Tom B and JAG provide links and photos of backplate overlap issues. Mac putters away at various fit issues and cleaning his shop.

Page 34: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1155>

Side discussion about pewter casting projects. Links to pewter suppliers. Everyone REALLY misses Mac's updates during his Pennsic break. Discussion of home wiring projects. Wade: "Any time you open up electrical, or plumbing you are likely to find something crazy." Mac reviews his last few pages worth of progress. Discusses issues with quenching/hardening and prepping the shop for those activities. He sorta sets his bench top on fire during some welding...

Page 35: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1190>

Mac gets to work reviewing his quenching supplies and discusses different quenching media. "Since giving up water quenches for aqueous polymers, I have had less warpage and no cracking." Discussion on techniques / ideas for Mac Not Setting His Building On Fire. Discussion of electric heaters for drums. Kiln issues which Mac fixes.

Page 36: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1225>

Sources for black silicone. Kiln repair. Making quenching barrel. Cutting stainless. Mac makes even a barrel look pretty. Tom B comes to the rescue with info about thermocouples. Mac recalibrates the kiln and gets the quench tank to the point where it is usable. He reviews his past notes about austinitizing temperatures and is puzzled by some of the data.

Page 37: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1260>

More discussion of austinitizing temperatures. Mac begins heat treating the cuisses. Documents process and best-practices. **Tip:** When removing straps for heat treating, circle the holes that have the correct tension. **Tip:** Trace the outlines of the main plates, so you have a reference to return them to if they warp during heat treating. Mac demonstrates cold runs to test whether the wiring that holds the armor pieces will work. Test the in-process and exit process. Mac begins final tempering and warp remediation, and provides examples of bracing and wiring techniques to reduce the warping. He takes time to note and mourn the passing of Will McLean (Master Galleron de Cressy: http://op.eastkingdom.org/op_ind.php?atlantian_id=1243) who has been serving as his body-stand in. Mac returns to warp remediation: torching doesn't work, but time in the kiln with pieces bolted together and braces in place does. Mac stops armoring to make a Memorial badge for Will's funeral service, and discusses that process. (see also: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=4&t=181121>)

"Don't be like me. Take more notes and look back at them sometimes."

Page 38: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1295>

Mac discusses abrasive supplies & grinding discs and disc wobble. Instructions on how to get the grinding disc to true up. He begins the process of grinding the pieces. When to use the belt sander and when to switch to a grinding disc. Repeated re-dressing of the grinding discs is important. Discussion of Personal Protective

Equipment when sanding: gloves, ear plugs, respirator, gloves. Side conversation about some photos of Mac's work for Toby having been stolen and used for advertisement for some armor being sold on Ebay. Discussion with examples of abrasive process tests: The effect of heat treatment on the degree of luster in the finish and whether or not to skip grits in the sanding process. The particulars of Mac's process are detailed: *"The other thing I want to say is about finishing processes in general. Many folks will tell you that the key to getting a good finish is in not skipping over any of the grits. They would have you go dutifully from one to the next... 80gr-120gr-180gr-220gr-280gr-320gr-400gr-600gr, and then on to a series of polishing compounds. I have to disagree. The vambrace plate above has had the following treatment.....*
--three passes at different angles of an 80gr belt, backed with a firm platen to remove the hammer marks and level the surface
--one pass of an 80gr belt, backed with padded platen to remove the facets from the firm platen passes
--one pass under a slack 80gr belt to blend the surface a bit more
--two passes at different angles with 320gr"

He shares photos of his home made grinding wheel, which is Nifty. Discussion of adhesives used to put the abrasive strip on the wheel – hive mind is asked for help.

Page 39: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1330>

Continued discussion of adhesives. Goodies arrive from Supergrit, so Mac does more abrasive testing. Shows how to prep the backing pads for use. Discussion of some particulars of the setup. Mac does some filework on the demigreaves and demicuissees with a Dremel and set of files. Discussions of arbors. Discussion of PPE / respirator fit with beards/glasses.

Page 40: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1365>

Discussion of PPE setups. Grinding the fluting on knee wings is officially a pain in the ass. Examples of his grinding setup. Links to available stuff that helped. Addressing the knee pivot sliders. Tom B provides requested link to a photo of A62's left leg, showing slotting. (non-working exterior link), and one of Goll 2284 & 2412. Mac removes some extra metal tabs that had been left on to stabilize the parts during construction & heat treating. Discussion of sliding rivets on knees vs hips vs ankles. Questions about the particular Dremel tool parts he's using for cutting. More discussion about articulation, with exterior links to medical sites. Incised lines on the armor: techniques, discussion of medieval practices, external links to examples including breastplates from Wade's collection and KHM. Photos of Wade's armor taken under a microscope (non-working exterior link).

Page 41: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1400>

Chiseled vs cut vs hand-saw vs sanding for armor decorations. JAG discusses data on insides of incised lines: some are chiseled and some are engraved. Further extensive discussion of possible techniques / setups to assist with the process of incising. Ernst shares micrographs of Wade's lance arret: A-237.

Page 42: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1435>

Mac posts photos of the polished cuisses. Suggestions made on the proprieties of photography / ways to make the pics better / less irritating to Mac. Sabatons and greaves get wired and braced for heat treatment. He does a test run on the rigging for lowering and raising the items in and out of the kiln. Items are heat treated. Discussion of triple normalizing. Grinding of greaves.

Page 43: <http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=169445&start=1470>

Moar grinding: *"I cannot over-stress the importance of changing directions with every pass."* Detailed instructions and guidance for grinding and why the direction change is Really Important. Nifty tools made for the process. More grinding, this time on the sabatons. **Tip:** One pound propane cans make nifty parts bins because the bottoms are round. Links provided (<https://drive.google.com/open?id=0B7VQpDdg9VywajlSMmc2RWVVUUE>) to a "scrote grinder" and links to other threads about grinding/polishing. Discussion on where to rivet the leather straps for the cuisses. Demonstration of how to make mounting plates. J.G.Elmslie provides info on a supplier in the UK for 3/32nd rivets with low, flat mushroom heads, and Cet provides a domestic distributor for a similar

product. Mac begins work on the larger buckles. **Tip:** Make templates for buckles out of pallet strapping. Holds up better than cardboard and don't take that much longer to make.

"An important thing with buckles is that the center bar end up more or less round. Otherwise, the tongue does not move smoothly on the bar, and the buckle does not move well in its mount."

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Mac shovels a path through the snow to the shop so he can work on buckles some more. He details the process of building the various buckle parts and makes them pretty. (No bulges in the turns for the plates, mind you!) He shares info about a particular vise he uses, and why it's awesome. Tons of detailed photos of this process. Mac continues working on attending to the fitting of the greaves. Source material photos and photos of his working notes. We get a glimpse at Mac's collection of files and hand vices and are reminded to get our minds out of the gutter in one of the photos. He gets more than 20 buckles put together in a remarkably short time, and of course, they're pretty, with detail filing displayed in before & after pics. There's a discussion of tumbling vs filing, and that moves into a chat about tumbling media. Chris Gilman and others chime in with various ideas. Mac is unimpressed with the results he's had. In the meantime... he sets to working on tongues for all the buckles, and documents his process for doing so. He is Not Amused with the status of the tumbled buckles – rusty spots are popping out like zits on a teenager.

"Sometimes one must deliver precise blows with a hammer, and other times it is sufficient and proper to simply use it to bonk. Next time I will try to work around to "smite.""

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The buckles are declared a ruinous mess. He starts making a new batch. There's discussion of installing a shop cam, which Mac politely says hell no to, and after questioning, admits he's *"one of the seven frigging dwarfs..."* Mac chats with an aerospace engineer friend, who provides some insights on why the buckles got all funky and rusty. External links to very Sciencey Stuff are provided.

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Mac provides some more details as to just how, exactly, he reduces the ends of the buckle shanks. There are links to a supplier for a nifty "new toy" that allows him to "chuck up the other end of the turning pins very reliably." There's some bawdy banter about "vibrator and oil experiments." Mark Chapman asks some questions about the beautiful lines Mac is able to create with the double fluting at the wing/cop junction. It's been quite some time, but Mac describes his technique to the best of his recollection. Mac lets us all know that he's going to be out for a surgery for a bit, and receives well wishes.

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Yay! All are glad Mac is feeling better... but now he's taking a break to work up his pewter stock for Pennsic. There are renewed pleas for a photoblog of the pewtering process as well. Once that's past, Mac asks the hive-mind for some help with how he's storing and hosting the images being used for this documentary. He gets lots of help. There's some further delay while he deals with an injury. He discusses some of his thought process about planning out next steps. He reassembles the armor stand and puts the armor together on it... this reveals a "tasset situation" caused by expanding the cuirasse earlier in the year. They will need to be redone. He finds his original templates, and finds he neglected to follow his own mantra of 'trim the metal, trim the template' during a previous tweak of the piece. Going back to his source material, he creates a new template. (This will be the third set of front tassets made for this armor.)

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Mac investigates his pile of stock, and finds that he's running dangerously low on some materials. He lays out the tasset template and cuts them out. Next is shaping: **TIP** - *It's important to give the parts the right subtle shapes and curves before any of the fluting goes in. "If they are not first imbued with tasset goodness, they will just look like fluted shovels."* He takes a moment to make sure that the central point on the tassets looks like the other points on the fauld lames, with a reminder to update templates AFTER the metal, in case of last minute

changes in plans. Mac discusses the importance of the strap locations, and how they relate to and impact upon the rest of the project. Next, he looks at the side tassets. They, too, will need re-creating and new & different strap holes. So: time for more new templates! Lots of detail photos of this process, and the importance of the tassety goodness. Again, he looks at the strapping situation, and how the pieces will behave under movement. Not wanting things to go catawampus, he decides that the front strap will get two rivets and the rear strap only needs one. This seemed really important advice about regaining perspective: *“Everything seemed daunting, and my path was muddy and unattractive. I thought maybe if I just put everything back up onto the stand I would see what needed doing most urgently and that might start me back up again. It seems to have worked.”* There is much lustful discussion about the quality of Mac’s discard pile, and the truly terribly things people would do to get their hands on it. Next up is how to deal with having BOTH a mail skirt and a mail brayette... attach the skirt to the inside of the fauld and cullet! He provides some images of such attached skirt from the Thunn sketchbook and other sources. Then we get to see the second lames, and where he’ll be attaching a leather lining strip. Mounting the mail skirt this way will have two advantages over wearing it as a separate garment. . It will reduce the bulk on the hips, and it will ensure that the proper amount of mail is showing every time. He also attacks the “unruly overlaps” on the inside of the cuirasse, and details that process.

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Mac examines the spots where the plates don’t meet up well at the edges, and shows us how he makes small adjustments by heating them up and tapping them down, inside and out. He mentions that this can cause less than graceful transitions – the solution is to disassemble everything and planish out the bad spots. Which will cause other issues that will have to be addressed in time. But before all that... there’s some stress relief that needs to be addressed on the cuirasse. He also works on some asymmetry in the shoulders. (Lots of detail photos of the braces he creates to hold the pieces in their proper place – including adding the needed fluting to the braces so they sit properly.) He introduces a clever use for a Harbor Freight weed burner – heating armor (and roll-up doors). Once that’s been put to use, he pulls apart the entire cuirasse one lame at a time, and planishes the bits that dared to be ungraceful. The pieces are reassembled, and he does another round of spot heating. (When asked about the heat, he replies that he brings it to just barely glowing – maybe 900° or so.) Next, Mac tackles the bevor/breast interface. The central crest is a touch too high, and needs to be tamed a bit. He reiterates that this sort of adjustment is a ‘bridge burning step’ and needs careful consideration before proceeding. The plan is to put as much of the cuirasse into the kiln as possible, to stress relieve it as a unit. (Shades of Jaws – I think we’re gonna need a bigger kiln...) Dry runs shows that the armor as-is will not fit into the kiln. He redesigns the lifting system to allow the kiln door to close properly. Then he tackles ways to brace the fauld and cullet as individual assemblies. He shows us some templates for the frame he has in mind, and then his process in making them. This reveals issues with how the pieces will go into the quench. He tries to come up with a cunning plan on dealing with that, but only comes up with an adequate one. A question from Sean Powell causes Mac to rethink whether or not the faulds are going to actually fit in the kiln. Mac acknowledges that “Experience has taught me that if I ignore Sean’s intuitions, I do so at my peril.” This reveals that the fauld will fit okay, but the cullet is going to be a real problem. He comes up with two possible solutions, which he will experiment with the following day. Folks jump in with recommendations on high-heat PPE, which might give Mac more time to position the pieces in the kiln before his limbs get burned off. Mac comes up with a third option, which he posts few pictures of because the welds are disgraceful. JAG suggests the addition of a second hook to help with spin. Sean provides a couple more suggestions. Tom touches on an earlier frustration of Mac’s, in dealing with photo albums, and provides suggestions/instructions/guidance, including a way to save the changes to edited images, which Mac finds very helpful. Back to armor – he discovers that the hook he’s been using to sling armor in and out of the kiln has developed a bit of a curve to it. As the task he has before him is one of vary exacting orientation and allowances, he decides it’s time to make a new and improved hook and bracing system – lifting TUBES rather than rings. It makes life so much easier for the tasks at hand, he considers it a sort of paradigm shift. It grants MUCH more control over the armor as it’s lowered in and out. Sean cautions that it may affect the stability of the armor in an unexpected way, and provides some further suggestions on ways to improve it.

“One can't always have the better idea until one sees what the bad idea looks like in three dimensions.”

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Mac examines whether the 'feet' of the braces will properly support the armor in the kiln. He looks at the bending load will cause an issue or not, and seeks out Sean's feedback as to whether or not his current plan is madness. All of this talk of loads under heat has caused him to be concerned about how the cullet flange of the backplate is up to the task of supporting its share of the weight while everything is hot. His ponderings lead him to create a leg for the backplate to sit on. This will obviate the need for the kiln furniture and take the load off the flange by jacking it up and out of contact with the kiln floor. Sean responds that he thinks the proposed solutions will work out well. Based on some info Sean's provided, Mac sets up an experiment to see how much some similar metal will respond to weight pressure when heated to orange. It gives him enough data that he is comfortable with the current bracing setup for the cullet. He adds some more feet to the rigging per Sean's suggestions... and at long last, its heat treating day! At day's end, the heat treating goes well. A few pieces emerge with need for minor adjustments, but otherwise, it's a success. **TIP: when lames fan out a bit during hardening, it's easy to fix them in the tempering by using a C-clap and a couple small bits of steel to close them up while in the kiln for the final tempering.** Mac disassembles all the pieces, and starts the rough grinding on the upper breastplate. Grinding fills several days. During this process, he discovers a small crack in the upper backplate, even though reasonable precautions were taken. He reviews the various options, and settles on drilling a hole at the end of the crack and filling it with a bit of rivet wire. He answers a question about how to grind in the complex areas where two or more flutes converge, providing photos of the areas in focus. Wade provides some external links to authentic pieces with intersecting flutes. (A-283 & A-98, from his collection). Several more days are spent grinding, then fixing the changes that occur when a few thousandths of an inch are removed – causing things to curl or warp.

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Mac reports that all of the welds where he had to add material to the sides of the breast and back have held up well during the hardening process. There are some minor issues with carbon content affecting the color, but he feels they will resolve during the polishing process fairly well. However... he discovers that the cullet has taken on a bit of a twist to one side, which is placing some strain on the pieces... He discusses how he's going to address this through some fairly aggressive clamping and heating. More and more grinding. One of his machines grumbles until it gets some maintenance. Mac has a catastrophic accidental deletion of an entire Google Photos album and folks jump in with suggestions. Tom provides some mentoring. Mac begins the tedious process of rebuilding prior posts with new photo links. He also works on bringing the skirts up to the near-final finish. A trip to the Philadelphia Museum of Art to deliver and set up Will McLean's armor occurs, giving Mac a much needed break from the evils of Google Photos. Back to armoring, he finds a small crack appear on one of the faults where he had to weld on additional material. He documents his process for addressing the cracks with several close up photos. Next he tackles the finish work on the breastplate, removing all the bracing structure. ("I took the breast



and back apart and tossed all the angle iron into the "land of lost braces". That's right between Job's dung heap and the medieval piss-pot." There's a bazillion images that could be added to this summary, but this one just had to be included.) He spends a solid hour reducing the finial to its final shape, as it had been left with no sharp internal corners to minimize cracking in the hardening process. After a brief jaunt to Florida, Mac's back in the shop and working on grinding the breast. It is during this process that an issue that developed previously came back to haunt him, when he accidentally ground through a bump made during filing, and in doing so, caused a hole. Working through several options for possible fixes, he finally decides

to regularize and chamfer the hole with a 60° countersink. He created a tiny plug and shows his process for customizing it, putting it into place, and cleaning up the final fix by hand. Sir Roland Ansbacher (OL) commiserates with Mac on the delicacy of the repair and shares a story about a restoration he did on a Prussian Garde du Corps helmet eagle. Mac is intrigued, and asks for links.

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Grinding and polishing continue. The cuirasse is now at 'rough polish.' **Tip:** blue painters tape can be used to keep parts from scratching each other while they are being messed with. He begins heat treating another batch of parts, to give his parts a rest. Into the kiln go the bevor and remaining tassets. To fill the kiln, he considers the gauntlets. Before disassembling them, he carefully makes identification marks on them, so they can be reassembled properly. The postman arrives with presents: More polishing wheels. He makes adjustments to them so they will better fit the arbor on his machine. Heating day arrives, and he wires up all the teeny tiny parts of the gauntlets – each marked to allow correct assembly later. The bevor will be placed in the kiln upside down to reduce the chance of the bib plate bending under heat. Because the piece is heavy, he doubles up on the wire being used as a handle. While he's waiting for things to heat up, he makes another hook to put things into the kiln. Hours later, the hardening of this batch of pieces is done. "All of the parts were heated to 1450°F and quenched at about 100°F in the usual aqueous polymer. They then spent about ten or fifteen minutes in the range at 450° or 500°. Realistically, they probably only got up to about 350°, but that will do for now." Tempering gets finished at 750. Some gauntlet pieces need clamping for correcting bits that did weird things under heat, and the tassets need some adjustments as they flattened a bit. **TIP: DO NOT Put blue painters tape into a kiln. It leaves a very tenacious stain on the metal.** Mac heats some pieces back up to be able to work out some of the issues that arose during hardening. A first attempt in the oven range doesn't work at all, so into the kiln it goes. That works nicely, and soon thereafter the tassets are 'reeducated' as well. Tom B asks for some details into what exactly that unloading and quenching procedure is, and how it was arrived at. Mac provides a detailed breakdown, step by step. Returning to the shop, he gets the front and side tassets up to the same level of polish, and puts his maker's mark on any piece that can be separated from the armor. The question arises as to placement of the mark, and Mac's response is that he puts it in the same sorts of spots he's found in actual examples. He starts grinding the bevor, and realizes he's got his hands full with the border on the bib plate. Only a Dremel tool is getting into all the spots with any kind of precision. He reiterates the maxim, "if you can't get a grinding wheel in there then you shouldn't have made it that way" - but knows this way will accord nicely with the border on the lower breast. Wade is able to provide some photos of unusual maker mark placements (A-212 from his collection) and JAG mentions some German craftsman that were so bad about marking their work that it's often attributed to others in error.

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Mac spends several days cleaning up the bevor, but runs into some spots of difficulty: the bib plate and fall plate have too much furrowing from the 80gr disc. It takes a bit of rework – remember that hint about grinding from multiple directions? Yeah. That. More detail work on the bevor includes a very slightly oval pin hole for range of motion and decorative filing around the rivets on the bevor attachment. He's asked about technique for grinding and the plans for the interior surfaces with regards to rust protection. (The bevor will get a padded lining but he doesn't have any plans to paint the inner surfaces.) Next is the huge task of grinding the gauntlets, and he stops to take LOTS of photos to document his techniques.

"... This is the most visually disheartening part of armor making. The parts looked "vigorous" and "lively" in the black, but as soon as we start covering them with grind lines, the details are lost in the play of light from the scratches. It's tempting to feel that they are ruined and that they will never look good again. Not to worry. This will pass."

He provides some Sharpie-enhanced images that show direction of grinding on the various passes, to illustrate why it's so important to change grind directions repeatedly. It is his practice to make the first grind in the direction he would like the 'final' grain to be in. JAG provides a photo showing working life finish hiding under a liner washer from a North Italian morion, which sparks some discussion about polishing in period. Wade posts some detail images from his collection that reference manufacturer finishes (A-184 & A-178). Mac has a brief, cathartic rant about modern armorers wearing lots of hats, when the process was separated out by various specialists in period, and that he doesn't know as much about polishing as he wishes he did. He goes back to the image posted by JAG, and notes that it gives a rare look at shop practices, and makes him certain that he knows less about holes than he thought he did. He asks folks to go out to their shops and see what it takes to reproduce

that particular hole. Folks discuss. While they're experimenting, he goes back to the shop to work on the gauntlets.... LOTS of detail photos of working on the pieces and reasoning behind using particular tools.

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Mac talks about that darned hole that has him so puzzled. James Arlen Gillaspie is asked for any photos that might let folks evaluate Mac's theories. JAG says he'll start a new thread on the topic, seeking the help of the Archive's blacksmiths: (<http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=184677>) Mac spends time working on the gauntlets and provides photos of that process and the finished polished pieces. When he is asked about grinding speeds he provides that he generally uses his larger grinder at 875rpm. Time for the slots in the gauntlet articulations! He begins finishing the finger plates, which heat up quickly when being ground but are too small to hold while wearing gloves. (*"This is what I look like while slowly burning my fingers."* A solution was to work at four at a time, moving from one to the next as one heated up too much to hold comfortably.) Sean M hopes that St. Florian, being the patron Saint of firefighters will keep Mac's fingers safe, to which he replies that he counts on St. Florian to keep his dust collector from catching fire – and burned fingers are his own fault! Sean follows up with a question about gauntlet fingers with 'cops and cannons' and that sparks a discussion across a couple posts with links to exterior sources. (A-62 in Wien, the gauntlets on A60, etc.) JAG states that having held the gauntlets in question, that he concluded that while the fingers are real and could well be by a member of the Helmschmid family for a later(?) pair of gauntlets, they do not belong, and adds some notes about slot cutting. Mac gets the gauntlet parts polished up to the same level as the rest of the armor and posts drool-worthy photos. He decides the ends of the thumb plates aren't quite fancy enough and adds some pierced hearts to match the ones on the knuckles. Folks ask about doing such detail work before or after hardening, and Tom B explains that stress concentrations during heating would make it too risky to do before heat treating. Mac returns his attention to the elbows, and sorting out the decoration of the inner edge. He shares his sketches from several years back. Comparing them to the original, he realizes that he's misinterpreted. With this new understanding, he sketches up some ideas. Tom B provides an external link to some St. Wolfgang photos. Mac decides he doesn't like his sketches from the night before and comes up with some new ideas to make them less likely to catch on things. He goes ahead and starts the process of punching out rough details. He goes over them to look for issues that might not grind out readily, then wires them up for hardening. He also examines the lower cannons, which the sculptor really didn't give much attention to. He sets aside time to survey the surviving Gothic lower cannons to see what they did.

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Mac shares a link to a 'Gothic shorty' vambrace (ref_arm_85_003) and asks for other examples. JAG references the A 62 KMW lower canons, and R. Kohlstruck provides photos of some from Nuremberg. Tom notes that A60 has buckles, and sends Mac some info offline that might be helpful. Mac does test runs to make sure the pauldrons will fit in the kiln – another close fit. He disassembles them, removing the leathers, being sure to label everything for later reassembly. They're temporarily put back together using nuts and bolts *that have already been through the heat treating process*. Temporary steel straps are added to keep the upper lames fully extended. Support tubes are installed to move the pauldrons in and out of the kiln. We get a sneak peek at the vambraces, and how the straps and buckles will be added. Some discussion occurs on single vs double buckles on the vambraces.

Mac's Rule on rivets on a strap: "If you expect the strap to experience a more or less constant tension, then use a single. If you expect the strap to sometimes be in compression, or for there to be a lot of jostling, then use a double."

Lots of parts get wired up for the kiln, and the pauldrons get extra braces to give extra insurance for their good behavior in the heat treating. There's discussion on how to finish the besegews as they are some very elaborate repousse. Folks suggest ideas – tumbling is quickly and firmly nixed, based on the last experience. Folks provide links to various tools and widgets. Mac picks up a used Porter Cable profile sander to play with. The discussion wanders to air compressors and Signo, Ckanite and John Vernier provide some details. John ColdIron provides a link to an external Sciency Chart about compressors and the tools driven by them. We arrive on heat treating day for the pauldrons, elbows, cannons and besagews are austenitized at 1450°F and quenched at about

100°F. Each of the parts then went into the range (set at 500°F) for about 10 minutes. There's some minor warpages, which Mac works on fixing. Things get braced and clamped and tossed back into the heat. He also provides photos of the difference in color between things that have been 'stop tempered' and 'final tempered.'

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Tableau asks about annealing before hardening, and Mac responds that while he might make an effort to stress relieve the work, he does not do a full annealing. Books addressing the importance of annealing are generally working with much heavier sections. He provides that all of his heat treating failures and troubles come from three fundamental sources:

- The armor sags under its own weight at the austinitizing temperature.
- The uneven stresses induced by quenching cause a part to warp, or move.
- The shape of the armor makes tension inevitable in some areas, and the contraction of cooling gets resolved by cracking.

Next he provides a grinder's eye view of the process of working on the elbows. The images show areas that he's already reviewed and noted will need picking out from the back with a rounded hammer. He shares tips on not letting the edge of the disc slip into the big punched holes on the elbows, as it would create grooves across the diameter of the holes. Ilkka Salokannel asks some questions about the specific finishing process, including what finish medieval plate was generally brought to. Mac references some of the images provided by JAG. He also answers questions about the gauge of the metal being used for various pieces. Wade provides some links to items in his collection, and their specific gauges/thicknesses (A-237, A-66, A-186, A-214, A-185, A-199). There's additional discussion on metal thicknesses. Scott Martin chimes in on the conversation, teasing Ilkka about stepping out of the shadows, and helping with additional info on converting thicknesses to gauges. Mac's Ebay purchase shows up, and he gives it a try. It works. . . Okay, but not spectacularly. He starts file work on the elbows and makes them all sexy. The elbows are then polished up to the level of the rest of the armor. A Christmas cold keeps him from putting his runny nose to the grindstone, but he gets some work on the pauldron lames. He provides links to an angle grinder wheel that he's using (Airgas Part #:NOR66253370275) which are the 'antithesis of a Scotchbrite wheel.' He reiterates the importance of balancing and truing the wheel, which is VERY IMPORTANT for this kind of work. Clean up your sanding!! *"There's just nothing medieval looking about swirly scratches."*

TIP: *"The first grinding operation differs from all subsequent processes in an important way. It must remove the hammer marks and other small irregularities from the surface. It is a leveling process. This requires an unyielding presentation of the abrasive that will take off the high spots without flowing into the low spots. The first grinding operation defines the final form of the armor. All subsequent processes are just about removing scratches."*

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Work progresses on the pauldrons. **Tip:** In General -- Use the wheel with the largest radius that can be made to fit the work! He then does the exact opposite, and explains why, along with photos of the various discs he's using. Scott Martin provides some details about grinding wheels with rubberized abrasives and a bit of his process/techniques for grinding. Mac responds with general info about how firm vs yielding abrasives work, and makes the suggestion to put the flutes in after the planishing is done. Tom reminds folks that back on page 38-40 of the thread, Mac already addressed a bunch of folks questions about abrasives, how to set up truing wheels. In a lovely surprise, we get to meet the August Patron (AP), who joins the thread and shares some thoughts about what he's asked Mac to make, and some of the finishing decisions. AP also shares that he plans on having a formal photo shoot to feature the finished product, and assures everyone that pictures will be shared. Bender shares some info on his grinding process, which Mac appreciates and asks some follow up questions. Chris Gilman provides some links on good places to buy scotch bright pads from McMaster-Carr. Mac shares photos of the last several days work, including the tools being used. [Tue Jan 10, 2017: Two nights ago, I kept waking up with the thought that I could actually see the end of this project. It's the first time I have had that feeling.]

Mac Says: *In general, we modern armorers are pretty tight lipped about our finishing processes: more so even than our metal forming processes or our beloved templates. I don't know how many of us are kept quiet by uncertainty, and how many by a desire for secrecy. Either way, the silence is rooted in insecurity, and **we all need to "grow a pair" and start discussing this subject.***

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Folks express their appreciation for the 'grinders eye' pics, as they really help to illustrate some hard to explain aspects of the process. Scott Martin suggests the use of jeweler's discs and a foredom/Dremel flex shaft tool (that just sounds wrong). Mac gets the vambraces polished, using much the same process as the pauldrons. The thread reaches 2,000 posts. So... the besegews.... Mac asks the hive-mind how they should be finished. They're repousse – should all the tool marks get cleaned off? Or no? No middle ground in such a task, which will take several days involving "specialized little sanding blocks and a promise of strong drink at the end of each day." Folks all chime in that polished would be awesome. Mac and the August Patron concur, and so begins the tedium... Out of desperation, he chucks up a moated wheel (Dremel 85422 Silicon Carbide Grinding Stone) and is happy with the results. His elbows, however, are not very happy. Additional supplies are ordered from <http://www.supergrit.com>. While he's waiting on them to arrive, he takes a look at the helmet and decides that the lower edge of the tail is too deep. So some gets chopped off. He provides before and after photos, as well as comparison photos. He heads off to a model engineer's convention, and comes back with some cool loot, including lathe collets, acid brushes, drill bits and more goodies. CoreyThompsonHM asks some questions about Mac's Atlas lathe and the milling setup, which Mac is happy to answer, along with photos. The supplies arrive from Supergrit, and Mac gets back to work. Progress pictures look awesome, but he's concerned about some rough spots that he hasn't found a solution to yet.

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Chris Gilman says those besegews are just *begging* for gold plating. Arrakis notices that the central hole on the besegews looks strangely like the (non-round, ragged edged) hole that everyone was discussing back on page 54. IN considering this, Mac decides that the more he thinks about it, that local delamination of the metal was the culprit. Friethjoph begs for the besegews to be added to the already polished pieces to see it all together, which Mac obliges. He also addresses the gilding question, with a list of the items that he and the August Patron have decided to gild: buckles, knuckles, strap plates, hinges, rivets, turning pins, and bevor catch. All else will be black. Mac then gets back to the helmet, working on the edge to remove a couple of high spots. He then marks the hemlines, and gets to work on them cold. He decides to grind a taper on the helmet edge, rather than forging one, and turns the edge an inch or so at a time. The traditional trouble spot at the end of the tail actually behaves itself. There's a bit more work to do before heat treating, but that step is coming soon. He ponders how to handle the chin strap, and starts a thread on the subject:

<http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=184980>

He fixes a few spots on the helmet crest that weren't sharp enough and laid out the lining holes. Consensus reached on the chinstrap thread indicates that German sallets have Y-shaped straps. Fittings reveal that the strap is uncomfortable when the helmet is tipped forward, so the adjustments are made. Mac posts some comparison images from Italian and German helmets. After some pre-cleanup, the helmet goes into the kiln. Because it's heavy, he goes with three loops of wire. Kcanite makes some chin strap suggestions, which Mac addresses. ("Once a split strap is stretched in a bit, it takes on the shape it needs and lays smooth. You can cut them that shape *ab initio*, but it's wasteful of leather.") which Tom B concurs with.

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The hardening of the helm appears to have gone well. It came out of the kiln and 1450°f and went into the 100°f quench. It spent about 20minutes in the range at 500°f. It then goes in for final tempering (the color changes between the two processes are quite remarkable to those unfamiliar with heat treating.) The helm is the last item to be heat treated, so that stage of the process is complete. Mac begins the rough grind of the visor, and finds that his 'fussy hammer work' has paid off in the clean lines of the shelf. A construction hole gets closed up, with detail photos of each step of that process. Next to hit the grinder is the helmet skull. Grinding continues for a couple days. TIP: Leather gloves don't grip well when you're getting rid of the 80gr scratches, and bare skin gets slippery with fine metal dust. Try using disposable nitrile gloves. Cet says he'll send some gloves for Mac to try, and CoreyThompsonHM suggests some maxiflex gloves. Johann ColdIron says he uses laminate worker's tape on his fingers to help grip things when gloves are too cumbersome, and provides an external link to woodworker.com where they're sold. A couple folks think that tape looks pretty darned interesting. Mac shares some of the process for making the visor catch, with lots of detail photos of the steps involved and the tools used. He also files up a very pretty rose headed release pin to tie into the roses on the besagews. He notes that even though the pics don't show it, he beveled the leading edge of the pin, so that the visor will close without having to push the button. He runs the sisal buff over the helmet, and it looks gorgeous. Chris Gilman asks (without further comment) if Mac has a pocket watch, and Mac replies that he does, and posts photos of the clear reflection of the watch showing the time, and a photo of a historical helm in much the same level of polish (also with a watch reflection). Mac posts some long awaited photos of the armor in full assembly in its current configuration.

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Mac gets the gloves that Cet sent over, and is Very Impressed. He reveals the visor pivots and (shocker) they are beautiful. Tom B shares some good detail images of the rivets used on the besagews. R. Kohlstruck shares some images of domed rivets that he was motivated to try, based on what Mac has shared of his techniques. Mac chats with the guys who blackened Toby C's armor, and they are ready for his project whenever he's ready. Mac comes down sick, which delays the final polishing on the armor pieces, and the packing for the blacking process. Each piece is wrapped individually and packed into sturdy boxes. He'll be handing it over to Metlab (www.metlabheattreat.com) soon. He's asked about the specific plating process, and replies that it's a black oxide. He's going to need somewhere around 275 brass capped rivets, and reviews the pages in this thread in which he discussed his experimental results, to good effect. Tom B also reminds him of another thread with some really good information:

<http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=100180>

Mac starts working on them, and notes, *"The difference between the worst and best cap shape is only a few thousandths of an inch."* He details the steps of his new process with lots of really detailed photos and greater detail, but the basics are:

- cut the stock
- anneal the stock then clean off the resulting oxide
- Cut the stock into squares
- Dap up the squares with a punch and pewter block
- Clean up 100 rivets with clean heads – each gets twisted against the surface of a Scotchbrite pad to remove oxides and oil
- Soldering begins: anoint a cap with flux and the corresponding rivet head.
- Assemble cap, rivet and solder on a fork. Work over the flame for a few seconds. Set aside to cool.

(Process continues on next page)

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- Wash rivets in isopropyl alcohol, then water + baking soda, then in dish soapy water & rinse.
- Roughly trim with a shear.
- Remove corners using an 'eggbeater' drill and an 80gr disc.
- Run the edges over a Scotchbrite wheel to remove the burr.
- Chuck it into a pin-vise and apply to a sisal buff with black emery compound – carefully.

- Wash them again in dish soap to remove black emery.
- Apply the rivets to a cotton buff with red rouge.

The armor returns from the blackening process, and Mac assembles them using the new gorgeous brass rivets. Chris Gilman teases Mac about a decided lack of rolled edges and asks how Mac could possibly call himself an armorer... Oliver L'Beaulieu asks about the washers being used, and why Mac hasn't made his own. Mac says it's because he's lazy. There's a question about the gilded rivets, and Peter Spatling provides info that the "Leibrüstammer I" A62 has gilded brass edges, and buckles of gilded brass. Wade provides a link to the capped iron rivets he has. Mac begins work on the lining for the bevor, and shares his templates. (This reveals that he has the World's Most Interesting Pincushion.) As with metal, when the fabric pieces are adjusted, so are the templates. Once he gets the exterior together, he ponders the padding. The August Patron visits the thread, and chats about the planned photos. Sean M provides some data on his experiences with batting, and provides links to sources of info on bowing cotton and quilt frames.

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Mac gets three layers of cotton batting into the liner and bastes it into place, with a slight tapering to avoid bulk the seams. He uses a mortician's needle, which has a sharp, three-cornered cutting point, to sew the liner to the leather strips. After trimming, the raw edges are turned under and whipped down to the leather. Metlab returns the remainder of the parts (some didn't take properly and had to be stripped and re-polished and re-treated). Everything looks ok, and Mac is greatly relieved. But then... he realizes he's gotten ahead of himself with the locating pins that have been gilt, because they don't really fit well because of the crests of the greaves. So. Time to make new ones, which requires creating some tools to help with the specific shapes required. He provides step by step photos of this process. Time to make the plates that go over the fixed ends of the straps: time to make another tool. He makes all the strap ends, and then shares photos of the greaves all assembled in their black and brass glory. He makes some more of the larger strap ends then puts them on the straps after cleanup and gilding. He also begins assembling some of the pieces that require internal leather strapping, showing how much of the rivet he leaves above the leather before peening them down. Hinges get riveted onto the main cuisse plates. Because they were numbered months ago, they all go back to the right spots. Photos of the stages of assembly are shared. **TIP: Assemble things so that the object doesn't get unwieldy any sooner than it has to.** Sean M asks about the amount of the strap that closes the greave, and Mac notes that 15C armor tends to have more exposed strap than what came before or after. 14C had only as much strap as had to, and in 16C, mechanical fasteners are seen a lot. As of this point, Feb 21, 2017, the thread reaches 3 years of age. Tom B asks about the eyelets being used, and Mac reveals they are, in fact, Billy and Charlie's finest quality pewter eyelets (Which can be found here: <http://www.billyandcharlie.com/studs.html>)! Mac does some more work on straps, which are riveted into the knee cops. The various knee parts get assembled, and then they are attached to the legs. Folks chime in with ideas on what Mac could take on next after this project is done: mention is repeatedly and pleadingly made of turning this thread into a book.

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Mac makes some new shoulder buckles. The ones made a year ago (discussed back on page 45) Simply Will Not Do, and beautifully filed and ornamental roller buckles are made. Eltz-Kempenich asks why the poleyns are not done in latten, as the statue is, and the August Patron answers that it was due to his expressed preference. Mac begins assembling the cuirasse. Next is the cullet, and we get to see the interior with the leather support strapping. When it comes to strapping... **TIP: It's better to waste an inch of leather than to be 1/4" short at the end of the assembly and have kludge something.** Mac takes some time off to help with a side project that involves ballistics testing, and Jeff Wasson's bloomery-steel Greenwich cuirasse vs. a musket at close range. Johann ColdIron mentions an account of original Graz firearms tested against original 16C breastplates, and promises to look up citations later. **Thomas Gallowglass sums up what everyone's been thinking:** *"Usually when a magician reveals his secrets the 'awe' goes away. With Mac the opposite is true for me, the 'awe' factor has been going up since the thread opened. As the project nears completion the on-going peeks behind the curtain has deepened the appreciation of this magic."* Mac temporarily assembles the cuirasse so he can ponder the mail skirt, and while he's cogitating, he assembles the cullet. He chats about the length of the shakes on the plug rivets, and how they

should have been a bit shorter. He adds a lining strip to the culet and then places the internal leathers. Additional pieces are bolted in place. Mac realizes that the skirting needs to be attached differently, and removes some of its length in a painful but necessary decision. Folks ask about his gilding, and Mac replies he'll put something together on that process in a bit. His inner nerd gets mortified as he works through a solution for attaching the mail in an ideal spacing. He sews both skirt pieces on, and reassembles the armor to see how it worked. It's awesome. He ponders buckles, and Tom B suggests hooks instead.

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Mac bolts on some test buckles, but ponders Tom's suggestion of hooks. Research into two hooks from Churburg follows, and he makes a couple prototypes. A heart-shaped hook is worked up and made of brass. He fixes some asymmetries in the chain on the sides, and adds the hooks. Next, Mac works on cover plates for the tasset straps. This time, he's made a "cheesy little plate to cover the checkering on the vise jaw" which saves a goodly bit of clean-up work, showing that yes, this old dog can learn new tricks. The plates are made, cleaned up, gilt, and installed over the straps. Mac returns to an issue from several months ago, involving the strapping on the side tassets. Because the tassets had to be remade, the attachment points altered. This creates an interference problem, which he puzzles through. The best solution is to make the top of the strap round, and secure it with a large headed rivet. Extant examples from Curtatone di Mantova have decorated flat head rivets... and so he makes some. He flattens out some unsightly but amply headed rivets, then annealed the heads. Cleanup of the oxide is next, using a flap wheel, and then they are stamped using a punch. Buffed and plated, and voila. With the mail and tasset straps sorted out, Mac turns his attention to the cuirasse. The second fauld lame (with attached skirt) gets riveted to the first lame. Then the third lame and the butt lame are added. The new buckles for the tassets have been assembled and gilded. All the tongues made the prior year were too long, so he trims, reshapes, re-polishes and re-gilds all the tips. They are riveted to the tassets. These pieces are added to those already on the armor stand, and wow. Mac begins assembling the pauldrons, planning to make them in two assemblies. **TIP: It's important (as always) to make sure that any exposed construction holes get plugged while you can still get at them.** At this point, Mac runs out of brass capped rivets, and has to make up more. A package arrives from Rene Kohlstruck – it's a batch of beautiful, decorative brass caps. Mac finishes the rivets and begins assembling the lower sub-assembly of the pauldrons. The temporary tabs are replaced with nice leather (and those spiffy Billy & Charlie pewter eyelets).

"These are just two of the many ways that the better armorers avoid getting paid enough. 😊 Fixing our mistakes and dealing with unexpected troubles just aren't in our price calculations."

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Mac gets the straps, buckles and hinges riveted onto the vambrace parts, then rivets them together. Next is fitting up the elbows. Temporary straps are replaced with fine leather ones. There's some finagling involved in assembling the elbows, which may be a taste of things to come. The arms get finished, and adds the brass caps that Rene Kohlstruck provided. Gauntlets are assembled next, as sub-assemblies. The fingers are assembled, beginning with the thumbs. More gold solution for plating is ordered from Rio Grande, as all the pieces he's been making have run through his supply. Mac provides some details on the plating pen he's using, and other systems he's considered. Folks ask some clarifying questions. Tom B asks about replacing brass rivet caps in situ, which Mac thinks is possible, but wouldn't want to attempt. Tableau asks about the temporary assembly of the fingers, which Mac details, then details some more with lots of pics. James Arlen Gillaspie suggests that Tom B obtain some 'Heat Fence' to protect the bits around the rivet, and gives tips on how to utilize it. Mac begins sewing the fingers to the gloves, but promptly stabs himself. After a break, he finishes the left glove sewing, then turns to cleaning up the twisty brass rivet caps and soldering them onto roofing nails. Mac finishes the right glove sewing. **TIP: When sewing in this fashion - sharpen the needle any time it hits the metal, as keeping it sharp makes a tremendous difference on how easily it pierces the leather.** Sean M's question about finger assembly gives Mac an insight on an easier way to have done it – knocking out the rivets and replacing them. Arrakis asks about the color of the leather being used, and Mac works through his thought process in choosing the colors he did.

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Folks chat about the leather color choice. Mac begins the process of trimming the glove cuffs. We get to see his antique Singer (drool!) machine in action. The gauntlets get riveted together, starting with the thumbs, then the thumb side of the knuckle plate, and lastly the little finger side of the knuckle. With the riveting complete, he can sew the rest of the lining leathers to the gloves. Keegan Ingrassia asks about the use of leather tabs to secure the palm, rather than a leather strap. Mac illuminates that this is pretty much the normal thing, except for mid 15th C mittens. Xtracted asks for close-ups of the stitching to the gloves, and Mac sketches up a diagram of how he did it, including a cross section. Tom B inquires about the particular properties Mac looks for in the leather used for each of the different applications, and Mac shares his thoughts, closing with a mini-rant: "one has to be wary of falling into the classic reenactor's trap of "pedigree vs. properties". Vegetable tanned leathers will not give you the characteristics you need. If you can't get what they actually did use, you have to substitute something behaves similarly, and not something else that they would have had but didn't use." JAR asks about different types of leathers, such as kangaroo or bison. Mac fulfills a promise to the folks over at Metlab to get them a pic of the armor as soon as they could, so it could be added to their newsletter. (See cover image) He does a quick assembly, even though some items are not entirely done, and it just as spectacular as one would imagine. He then gets back to working on the helmet lining, first working up the templates over several drafts. Once the pattern is finalized, he builds up the layers of batting, then pins, and bastes them into place. His final trimming is according to a cunning plan that involves angling the edges of the batting to provide space for the seam allowances and reduce bulk. The pieces are sewn together and turned. A quick reality check is done, to see if the liner will fit properly: They do. The pieces are quilted, and eyelets added for the drawstring.

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Mac finishes the eyelets, and whip stitches the individual pads of the liner together on the insides and outsides. After all the segments are sewn together, he turns up the raw edges and whipstitches them down. One last fitting check before he sews it in... All looks good. He provides step-by-step photos of the sewing process, attaching the liner to the leather strip that's fastened to the inside of the helmet. Rene K's twisty rivet caps are added to various spots on the helmet, and the finished helmet is shown off in some lovely pics. Now the plate work is under control, Mac fixes a little niggly detail that caught his eye a few weeks ago: there's an issue with one of the tassets and the strapping, as they aren't sitting close to the fauld. When the lower half of the buckle is undone, the tasset hangs properly. But how to fix it? More bend in the buckle frame. Using a hand-vice (with tape on the jaws to protect the finish on the buckles), he adjusts the curvature of the buckle. This process is repeated for all the tasset buckles. Mac chats about the need for suitable laces – currently textile tape or leather lace are the top contenders. (Extant example photos are included) Jason Grimes thinks it may be silk, and provides some links. Mac believes they were leather, as there's some supporting images in Jost Amman's Ständebuch -- in the Nestler, guys are clearly making leather laces with metal tips. Sean M provides some data on silk points being upper class, and leather ones being the cheap ones. He points out some sources for braided cotton (Historic Enterprises), and waxed linen (Medieval Rats) and leather points with brass aiglets (The Tudor Tailor). R. Kohlstruck provides some photos and details on how he makes laces with points, which Mac finds very helpful. Mac then ponders how the mail brayette will be suspended and how that will interact with everything else, and looks at historical examples for some guidance. A shaped belt appears to be the best option, and he makes up several different versions, tweaking the pattern each time. He sews up a mock-up of the belt and sends it off to his August Patron for him to try on. Next on the list is spurs. He links to his Pinterest album of 15C spurs: (<https://www.Pinterest.com/macshop/spurs/>). Tom B provides some links as well to the Royal Armory collection, and calls out an example on display in Leeds. Mac seizes upon one of the styles, and asks if anyone knows how to rig such a spur, as it has more strap fittings than he knows what to do with.

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Mac shares his source for the material he'll use for the final belt, which is 'monster strong.' (Unbleached 14 oz. Coarse Linen WLG 101, from Wm. Booth Draper). He then admits that he has a copy of Iliane and Fred Funken's Arms and Uniforms, the Age of Chivalry (Part 3, pg. 37), which shows the particular kind of spur he is pondering. Wade Allen provides links to some spurs he has, and expresses his sorrow he hadn't known about the question of spurs the prior week when he could have brought some examples along on his visit. (S-19, S-34, S-56, S-7). Tom B also finds some sources in the Thun Skizzenbuch and other sources, which he shares, and also creates

a google photos album of them. Wade shares his insight that the spurs depicted are sitting very far down on the foot, and considers that perhaps they really are worn lower than he would tend to think of spurs sitting. Tom B. concurs that the image seem to show the spurs almost at the bottom of the foot, and wonders how the rondels would affect walking. Sean M asks about the manner that Mac is sewing his eyelets, and asks if he's doing a more simple or a complex, modern tailoring technique. Mac decides to work up some test pieces to see if there's a difference in performance. Tom B and Wade continue the spur discussion, talking about location. Wade pledges to do some testing with his spurs to see how they work, and Mac asks him to get some measurements while he's at it. Wade follows up, and provides some specific photos for Mac, linking them in so they can be viewed full size. Mac requests images of spurs that can be dated to the 1470s or thereabouts, declaring that spurs appear to be the red-headed stepchild of arms and armor. Tom B. provides a link to the spurs that the Met has online. Mac starts working on templates for the spurs, using the casts of his August Patron's legs. Wade provides a link to a pair of spurs (S-56) and discusses their specific measurements and the taper of the stalk. Mac works up a prototype that seems to be working nicely. He works on sewing for a day, creating a vest-like garment for the mail sleeves to be attached to. Mac has a growing notion that his spur idea may be designing him into a corner. He sketches out some new shapes that fix the issue of whether or not he can file the crest line he intends to have, once the neck is welded on. Moving the crest line up a bit and attaching the neck entirely in the lower face may well solve the problem. He provides step-by-step photos of his work on building the spurs.

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Mac makes some in-progress design changes to the spurs, changing the termination of the comb and the stop where the arm meets the ring. Mac comes to his senses, realizing that it's absurd to work on the rowel boxes without having rowels at hand. So, he starts work on them. Jigsaws are NOT the best tool to cut these out. An hour plus with a barrette file, and they start to take on some shape. They then get made a bit thinner and pointy-er. Next up: Spreading the legs of the rowel boxes. Heat applied with a torch, he pries them apart with a chisel. After pinching them closed around a mandrel made of the same stuff as the rowels, some heat application relaxed the metal around the mandrel. This didn't quite get the required results, so Mac temporarily rivets the assemblies and works them down with a torch and hammer. Next, the thickness of the legs of the rowel boxes is reduced to make the arms more graceful. A bit of grinding and filing brings the bosses to a conical shape. He sets in the rowels, and spends some time furthering the finish. He also makes the conical bosses yet more pointy. Chris Gilman tosses in some very bad armoring puns. Mac shares his tentative sketches of the fittings, noting that he should have included the fittings in the initial sketches. Wade provides a link to some random bits of spurs that aren't associated with the actual spurs any more. As some of them are on their sides, they may serve as good examples of thickness. Gaukler provides some photos as well, and offers to take measurements. Mac makes up a prototype, and quickly realizes that the hook is too long, the body is too long, the loop is too short, and is bent the wrong way, which makes little sense to his brain, but the source material is clear on. Wade agrees that the design runs counter to the way one would think, and provides some details on how the ends die out. Mac shares photos of prototype 1 and 2. Johann ColdIron confirms that having fittings that would fail under extreme circumstances would be helpful, as he's gone for a ride when his spurs caught on something.

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Bartholomew says he knows someone who has a laser shop that could make all the parts. Wade marvels that this is truly a new world, where real-time updates of measurements from original pieces from around the globe can be obtained while working on a project. Mac works up a third attempt on the hooks, and after some rough shaping and profiling and hours of filing, they're done. The fittings are polished and bent. The hooks are closed over a strip of 12ga stock to make the spacing for the leather. He attempts a second 'draft' of the buckle mounts. Thinning out the material that will be turned over the bar of the buckle is a bit tricky. This second attempt he grinds and files, rather than forges. In doing so, he realizes: *"I'm sure that forging is the right way to do it, but in retrospect I think I need to do that before making the "tail" for the loop. That way I would have had something to hang onto, and could have done the operation hot. Next time."* The fittings and rowels are gilt. Mac goes back to Sean M's reference to page 164 of Crowfoot, asking some clarifying questions. He transfers his attentions to the points for the laces, sharing a first and second attempt. He admits he needs a clever idea on how to stuff the fibers into the cone as he closes it, as his thumbnails aren't really up to the task. Andrew Bodley suggests trimming the tip into a point and using white glue to form a point. This is in line with some ideas Mac was pondering, but he

wonders how it was really done. John Vernier suggests using an awl of some sort to poke the thread into place, or a harness needle held in a pin vise. He also recommends hide glue. Mac's experiments with titebond glue don't really provide good results, so he says he'll try hide glue next. John also suggests the use of punching the cones and adding in a rivet to help hold the laces in place. The discussion turns back to the sewing of the eyelets, and that following the written directions in Crowfoot results in a very different looking eyelet to the diagram that's provided. Sean provides a link to some 16C eyelets in the British Museum, and mentions that the brook on the brigandine fragment from Schloss Tirol has some close up color photographs from the 16th C and 17th C. Mac reports back on his experiments: The hide glue doesn't seem to work well on nylon, but might do better with natural fibers. He tried using thread to bind up the ends, and that seems to work relatively well but is excessively tedious. The switch to .016 brass seems to be a good one for points of this size, behaving better under the hammer. The tolerances are found to be way too tight, and Mac can't resort to whiskey, only cussing. He reduces it from .437 to .420, and that seems to work better.

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Arrakis suggest a method for thread wrapping that might help, which Mac will ponder – another time. He's given up on the wrapping for now, and has been cutting the tapers with a hot knife. He provides some detail photos of some of his testing on sizing the brass bits. Tom B asks about the chamfering and beveling process Mac is using, asking if it's just hand filing while the brass is still flat. Mac replies that it's done after shaping the cone up, but before opening it to receive the tape. He gives it a quick spin against a well-worn 80gr disc. Sean M provides some exterior links to some eyelets. Mac makes Yet Another Tool, this time out of drill rod, to create a widget to stuff the cording down into the brass points. This is all tedious and time consuming... but necessary. To give himself a bit of a break, he returns his attention back to the vest that the mail sleeves will be attached to. He spends a day experimenting with various ways to sew eyelets, then proceeds to sew them on the vest. He moves the mail sleeves from the mock up to the final garment. Jenzinas asks whether Mac is sewing his eyelets from the front or back, then shares that when he makes eyelets, he does them first from the outside, then roughly between each stitch, again on the other side, generally 8 inside and 8 outside. Mac marvels that there are so darned many ways to make eyelets. Mac sews on the second sleeve, then addresses a problem with the first one, eventually cutting it loose and re-sewing it. It is suggested he embroider his maker's mark on the finished vest. Now it's time to tackle the belt. The sewn item has eyelets added to it. Despite his prior post indicating a non-tabbed final template, the one he's shared has front tabs. Tom B inquires as to the thought process for the change, and asks about the techniques for sewing the mail to the belt. Mac replies that he returned the tabs to the design for two reasons: 1, to get the laces down below the belt to make use of the support, and second, because it's closer to what he has found in historical examples. Mac takes a break for a fortnight to do some home improvement projects, but reports that the mail has been sewn to the belt. Sean M. provides a link to Dave Thatcher's silk odoshi, which might be a good option for the points, and also a link to the work of Isis Sturtewagen.

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Mac has some confusion about the pricing on the Dave Thatcher site, and after contacting the merchant, gets an answer. He turns his attention back to the gloves, and shares an important danger in using a glover's needle for sewing the gloves to the lining leathers (other than stabbing one's self and bleeding all over the project) – cutting one of the threads that holds a seam together. He found that this had occurred somewhat by accident, and takes steps to remediate the problem. He looks over other things that may need fixing, as his August Patron and costumer will be arriving on the morrow. If all works....

Round one of the fitting goes well except one BIG problem: The backplate doesn't fit up at the shoulders. Without the doublet, it's acceptable but not good, but with, it's a no-go. He removes the backplate and spends 12 working hours roughing out a new back. The helmet lining is also found to be a little thin at the sides, and too deep to set the helmet at the right angle and eight. He makes a new lining using four layers of batting instead of three, and is about 5/8ths shorter from top to bottom. The backplate issue is summed up by Mac's optimism about how much he could reshape the body. His Patron has a round back, and this had to be reflected in the shape of the armor.

Randal Moffett mentions an issue he's been having, and how thinking of Mac's difficulties helped him resolve to rework the problem piece. Mac provides some key pointers on avoiding cracks:

- Put off cutting the corner until the hammering is done, if you can.
- Take care not to have even the slightest hint of overcutting in an internal corner
- Leave the corner a bit round, if it will look ok that way. Otherwise, leave it round as long as you can before squaring it up.
- Use a fine needle file to remove the arrises from the corner. That's where cracks start.

Mac gets the new backplate smoothed out and ready for the next fitting. The new one is deeper and rounder, starting right at the waist. The August Patron posts to let everyone know he's just arrived back in the UK with most of the armor, after the second fitting.

"There are no mistakes in armoring... only opportunities to rebuild the parts and correct the things that have been nagging you all along."

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The August Patron shares, when asked by Dr. Charlemagne, that his initial conversations with Mac started back in 2001, and were influenced by the now infamous A13 in the Wallace Collection. He then found an article in the library of the Royal Armories that referenced the statues of St. Wolfgang and suggested to Mac that St. Florian might be suitable artwork to follow. There was another piece that he was interested in, but could not find any solid images of: St George from the Order of the Swan Chapel. Mac updates us on the project: The new backplate fits well, and he expects to get back to work on it after Pennsic. It will need to be hemmed, fluted, hardened, ground, polished, blackened and assembled. The rest of the armor fits in two 30 gallon plastic Husky boxes from Home Depot. Sean provides a link to an eyelet from the Lengberg finds, that does not have a rim, just spokes. Mac finds the video very useful, and says it's a must-watch for anyone interested in costuming.

(<https://www.youtube.com/watch?v=LGg8xbUVXT4&feature=youtu>)

Tom B. finds a photo of the St. George statue, and shares it. The actual statue is quite small. After some much needed Post-Pennsic rest, Mac returns to the project. He hems the backplate and begins fluting, but cannot share photos as his camera has given up the ghost and gone to electronic la-la land. Bracing commences, and heat treating follows. He installs part of the old lifting fixture from the cuirasse onto the back plate and makes sure it all fits in the kiln. (Another project joins it in the kiln – a new set of bib lames for Toby C's old close sallet. The details of this project are discussed on another thread:

<http://forums.armorarchive.org/phpBB3/viewtopic.php?f=1&t=186492>) The backplate is hardened at about 1480°F and quenched at 100° F. A problem is found with the temperature controls on the range, and he finds readings at double what it should be. The final tempering is finished the following day. Some minor issues of warping are addressed with vigorous application of C-clamps. The poor old camera is briefly resurrected, such that Mac is able to take some photos of the backplate bracing and tube lifting point. He gets into the initial grinding, and shares update photos. He experiments with driving in his mark before heat treating. Sean points out a missing element of Mac's bracing, which he sheepishly admits he should have done, and is glad Sean called him out on it. A rough grind is complete on all of the backplates by September 5, 2017. The following day he gets in some more hours of grinding, and takes some time going back to the hard disc to get rid of some wavy spots in the flutes. It's a step back, but should minimize the surprises that might reveal themselves in the final polish. The flutes are worked with 80 and 180gr disks, and then worked over with a 7 M AL Scotchbrite wheel.

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When Mac goes to the black emery on a sisal buff, he discovers that the Scotchbrite has left a lot of deep scratches, due to bits of metal clogging the wheel and leaving their own scratches. He turns to his 220 gr set up wheels and goes over the entire thing with those. Work is paused for a visit to the Philly Art Museum, where he and Dirk Breiding discuss matters concerning the display of Will's old armor, examine a new bascinet acquisition, and generally shoot the breeze about armor. Upon returning to work, Mac continues the slow and painful process of bringing the backplate up to the finish level of the other pieces. He provides comparison photos of the new vs the old: the increased depth of curvature and curved path of the new fluting give it much greater life. The old

plate suffers greatly in comparison, to the extent that Mac says he can barely stand to look at the old one now. He gets in contact with Metlab and schedules the blackening. Tom B. asks some questions about the changes. Once the blackening is done, he reassembles the armor. It takes him less than two hours to make the new shoulder straps, but somehow manages to spend much of the day putting it together, almost in denial about being at the end of the tunnel. The armor fits well into the previously purchased tubs when the breast is placed into the back with some fabric between them for padding. Next comes the question of GETTING IT THERE... and there's discussion about the best carriers and shipping costs involved.

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Mac reports that FedEx's online help was Less Than Helpful, and the local office says it will be more than \$1,100 to ship. His current plan is to send it as baggage with a friend who is traveling to England anyway. From September to November, the thread goes quiet, until the August Patron posts that the project is complete and the final parts arrived in England on October 31st. This ends a project that started some 16 years prior. He announces that a June 2018 photo shoot will be occurring, and will share the images with Mac when that happens. Everyone is ridiculously excited. Mac writes out the instructions for putting the armor on, and sends them to his August Patron for comment. [end]