number: "CS7"

title: Case Study 7

subtitle: Interview: A Contemporary Artist-Founder on a Horse: Choices of Materials and Processes

contributor:

* first\_name: Andrew

last\_name: Lacey

bio: Andrew Lacey (Artist, Founder, and Independent Scholar) studied archaeometallurgy at the Institute of Archaeology, University College London (MSc. 1998) focusing on interview techniques for gaining insight into the working practices of London fine art foundries. His work as a contemporary artist is highly experimental; casting all his own work in bronze enables creative interception in all stages of the process, further developing visual and material symbologies that are embodied within the sculpture. His work as an independent scholar is a creative collaboration among conservators, historians, makers, and curators, and explores possibilities of hypothetical facture via processes of experimental reconstruction.

* first\_name: David

last\_name: Bourgarit

bio: David Bourgarit (Archaeometallurgist, Centre de Recherche et de Restauration des Musées de France [C2RMF], Paris, and Laboratory TEMPS-CNRS-Nanterre University) has a background in physics, with a PhD on the physical metallurgy of a specific titanium alloy. Since 1996 he has been a researcher at the C2RMF, where he has been investigating metallic artifacts from almost all periods and regions. His primary research interests are in the technological approach to copper metallurgy, with a focus on the provenance of copper and fabrication techniques. He coedited *French Bronze Sculpture: Materials and Techniques 16th–18th Century* (2014).

abstract: This case study takes the form of an interview with contemporary British sculptor-founder Andrew Lacey. Archaeometallurgist David Bourgarit, who has been intimately involved in the technological study of bronze sculptures from different periods and cultures over many years, engages Lacey on his process in creating *The Anatomy of Bronze* from its initial modeling to the application of the patina.

short\_title: Case Study 7

This case study takes the form of an interview with contemporary British sculptor-%%founder%% Andrew Lacey. Archaeometallurgist David Bourgarit, who has been intimately involved in the technological study of %%bronze%% sculptures from different periods and cultures over many years, engages Lacey on his process in creating *The Anatomy of Bronze* from its initial modeling to the application of the %%patina%% (**fig. 33**).

**Video 3**

The objective is to explore topics that specialists and nonspecialists may wish they could ask the artist or founder directly when studying a bronze sculpture, such as choice versus compromise, or economy and expediency over aesthetic exploration. The recurring question about how a particular process or choice might manifest in the finished %%cast%% probes for explicit descriptions of the kind of evidence these might leave on the cast. The conversation relates to the entire, large version of the figurative sculpture of a horse, but for the purposes of this exercise, the illustrations focus solely on the head and neck. The questions about 3D scanning and printing relate to a separate, reduced-size version of the sculpture that was made during an experimental stage of the entire process.

Andrew Lacey is a sculptor and founder currently living in the UK. He first gained metalworking knowledge through working in London art foundries. He later set up a number of large studios and foundries dedicated to his own sculptural practice, and studied archaeometallurgy at the Institute of Archaeology, University College London. He now carries out research on historical casting practices, often interweaving this historic knowledge into the production of his own sculptural output. It will become clear that while he follows conventional casting methods for some of a work, at times he radically subverts or alters the process to create a material aesthetic that better represents his thinking and ethos.

## 1 The modeling: A drawn-out experimental process

### What are the overall steps you followed to design the model of the horse?

The modeling was a long and frustrating process, as the desired finish needed to be very refined and lifelike. I had already begun modeling the horse in clay and played around with its position but found that, because I was not happy with the way the horse was standing or its overall form, I had to create another version that I could manipulate more easily. I decided to make a rough two-piece silicone rubber %%mold%% of the clay %%model%% with which to %%cast%% a wax model of the horse. This allowed me to try out new compositions, for instance in the position of the legs (**video 3**).

Once I had created the wax model I liked, I had it laser scanned to preserve the greatest amount of information in case the process of making a second, more complicated silicone mold should damage the model.

### How often do you use digital scanning?

Scanning in this way is very new for me, although I had read up on the subject and was fully aware of its progress in the wider industry. It is a common practice today, almost to the point of superseding other, more conventional molding methods. It’s a clean, quick, nondestructive way of capturing a 3D form. All art schools can now afford it (**fig. 376,** **video 3**).

### Were you satisfied with the scanning results?

The high-resolution scanning was carried out on-site by a specialist from Falmouth University. Acquiring the scans was simple, if time consuming, but it was immediately clear when viewing the initial data that the processing of the computer model would require some significant human interpretation due to shadows from the laser or lack of data where the laser cannot reach, and discrepancies in the overlapping of the layers of scans.

Also, as fine as the laser scan may be, the printed resin version (**fig. 544**) couldn’t fully replicate the fine detail of the original model. We reduced the size of the digital model so as to print a horse standing fourteen centimeters high. This resulted in a compression of the details and thus a superficially tighter shape that lacked the vitality of the original model and felt very artificial. I would still have had to rework the resin print in order to bring some life back to the modeling. It was an interesting experiment, but somewhat disappointing. In the end, it would have been better to model the smaller version by hand.

**Video 2**

I therefore molded the wax model of the horse again with silicone rubber, but this time using greater care and consideration. I was trained to use rubber for molding sculpture early on in my career, and learned how to adapt or cheat because rubber has always been expensive and sometimes time pressures demand quicker methods. I molded the bulk of the horse in rubber. For the tail, which I had cut off of the model for the molding process to get better access to the legs, I used a plaster %%piece mold%%. I had shaped it only roughly since I planned to rework the modeling in the wax, so it did not have much complex detail. The rubber mold was designed in smaller sections that corresponded with the areas to be cast separately first in wax and then in metal—that is, the head and neck, each of the legs, and the body (**video 2**).

### How often do you break down the model into smaller sections, and what would other foundries do?

This is something I do quite often, as it allows me to de-mold the head and neck and start casting before I have finished the rest of the mold for the horse. Again, it’s a cheat; most foundries would complete the whole mold for fear of losing structural or dimensional stability, but since I’m working on something I already intimately understand, I can allow for alterations as I make the rest of the bronze.

### What evidence might we find of this sectioning in the final bronze?

This choice of making the mold in small discrete sections will be invisible from the outside, as I can fix whatever evidence there is. Between each section are thin lines where each part has been %%welded%% together. The pattern of lines in the X-ray will describe the way I planned the mold and therefore how I chose to overcome future difficulties in the casting process (**fig. 545**). Additional lines may be found where wax sections needed to be further cut down, which we see in the joining of the head and neck of the horse.

## 2 Methods used to fill the mold with wax: slush molding and painting

### Turning specifically to wax, what process(es) did you use to produce the wax inter-model?

Making wax sections is generally easy, but the technique changes from mold to mold depending on its design. For example, the head and neck of the horse were made in a two-part mold split in half along its length that forms an open vessel shape (**fig. 21**). It is therefore easy to pour in molten wax and slush it around the inside of the mold (**video 2**). This was also true of the legs and tail. But the body was molded in two large halves divided lengthwise along the horse’s back and belly and designed so that each half would be cast separately. Here I painted wax into the open half mold because that was easier in this case.

### How often do you mix techniques for the same model, and how would other modern foundries do it?

It is quite common for me to use different methods of production for one object, as each specific part of the sculpture presents numerous opportunities for exploration. Other modern foundries would do so as well. Looking at how other foundries’ techniques differ helped me to develop a broad range of techniques for myself.

### What evidence might we find in the final bronze of these different ways of building up the wax?

These two techniques are clearly visible either by looking inside the bronze, if one has access to it, or by radiography. The short and busy patterns of the brush marks are quite distinct from the soft, smooth patterns and surfaces of the slush-molding method, which are often punctuated by tide marks.

## 3 Homemade recipes for casting wax

### What kind(s) of wax do you work with?

I use beeswax with an addition of pine resin and earth pigments. I used to use an industrial wax made of petrochemicals and polymers, which worked very well, but it was expensive. Generally, different waxes are designed to perform different tasks—for example to be malleable when modeling, or to cover sharp ridges when pouring into a mold. Over time and through experience and experimentation I began to design my own wax recipes to produce the physical characteristics I wanted. I use the same basic components but alter the ratio.

### Does evidence of the kind of wax you used show up in the final bronze?

When the %%investment%% mold is eventually broken off the cast, occasionally you can see some very interesting areas of color on the surface that was in contact with the wax. These are caused by the inorganic earth pigments in the wax, which are deposited on the ceramic shell during the de-wax stage (**video 11**). Some of this coloration might just stain the %%core%%, and it is possible that future conservators could retrieve this material. Unfortunately, as all the wax is melted out and fully burned out during de-waxing, all of the evidence pertaining to its organic chemistry disappears with it.

## 4 Separately cast sections rather than cast in one shot

### Why do you cast in separate sections, and how do you choose each section?

Originally, I was taught to bring all the wax sections together so that they could be cast as one object. This has some benefits: when a wax is made in this way, you can immediately see if there is anything wrong. For instance, is the shape or geometry of the body correct? Are the textures and modeled areas of the surface continuous and harmonious? My practice has developed in a different direction.

On the one hand, I know my own sculptures intimately—the surfaces, the movement, the energy, et cetera. Therefore, there is no need for me to put the whole structure together in the wax, as it is already understood. On the other hand, I work by myself and there is a limit to what I can physically handle. There are related limiting factors. For instance, the crucible I use holds sixty kilograms, so there is no point in making a wax section that would require more metal (wax is one tenth the weight of bronze). The kiln is front loading, so when setting out the %%pour%% (organizing the layout of the casting equipment), I find it difficult to lift a red-hot mold that weighs more than I can comfortably carry—maximum thirty kilograms (**fig. 546**). On reflection, the entirety of the studio is designed around these limitations, which in turn directly influence how I make sculpture. The surprising aspect is that I do not limit the scale of the final bronze sculpture. If I’m working on a very large sculpture, I simply break the form into pieces I can deal with and rebuild it in bronze. I just have to be confident of my engineering skills.

### How do you choose where to section up the wax to create what we might call a casting plan?

Just to be clear, “%%casting plan%%,” in my mind, relates to the organization of the sections to be cast—that is, how the model is divided. This could just mean that the top of the head is removed or that the whole model is cut into smaller sections. It might also relate to the organization of the %%sprues%% in terms of designing the direction and flow of the metal.

Prior to molding, I study the sculpture for some time. You have to imagine that you’ve already made the sections, then take them apart and reassemble them in your mind, seeing what the issues would be, then try a new configuration to resolve each problem in turn. By using my imagination, I can explore numerous possible dissections until I have what I consider the best casting plan for the sculpture at hand.

My reasoning for making specific dissections is threefold: namely the “economic line,” the “assembly line,” and the “aesthetic line.” The “economic line” is the shortest line or dissection needed to remove one section. This may mean that it is better to move the line slightly higher or lower in order to shorten the length of the cut. The length of the cut will be proportional to the length of the weld. The “assembly line” considers what happens if a line goes through difficult-to-reach areas. In considering how the sections will go back together, I assess whether I can physically get the welding torch and filler rod in at the right angles to make a continuous join. Lastly, the “aesthetic line.” When making a dissection line I always avoid areas that are detailed, complex, and in frontal zones. This means, for instance, never making a line that crosses facial details or follows the direction of the modeling, so that the eye is not disturbed. If a join must cut across the torso, which is inevitable, utilize the rib cage or muscle structure to disguise the weld %%seam%%.

### What further evidence of such sectioning may show up in the bronze?

Most of the evidence will be found on the inside of the bronze, since the outer surface is worked over to disguise the seams. After many years, the bronze may corrode differentially in these areas, and the joints become visible. Otherwise, as mentioned earlier, one can detect joints in X-rays. Thin gaps or thickening from joints between the various sections will tend to indicate how I decided to break the model down for casting. The brush marks are visibly different from the slushed sections of wax, and often the direction or orientation of these marks will be strikingly different. If you compare the inside to the modeled texture or form of the outside, you’ll start to see what issues I’m trying to resolve and in turn understand something of my thinking process.

## 5 A sprueing system adapted to each section

### What does the sprueing system look like? Do you prefer “top fed” or “bottom fed”?

In casting up the various wax sections, I used two very different methods of sprueing, “top fed” and “bottom fed.” This is simply because some sections present better opportunities for one method over another. For example, the head, legs, and tail can be considered irregular cylinders. By pouring a plaster core into these and placing feeds (the sprues used to direct the bronze into the mold) at the top (**video 2**), they make for very straightforward castings. The panels of the body, on the other hand, are sprued up while still in the mold so as not to cause any distortion in the geometry of the wax. They can be sprued up from the top, but this tends to cause overheating and excessive %%porosity%% at that location. By bottom feeding them, the flow of metal is less turbulent and the heat is dispersed throughout the mold.

### Is this common practice among founders?

I think most founders take such an adaptable approach when presented with different forms to cast. And really, that’s only logical. Why enforce unnecessary complexities onto an already difficult task?

### How does evidence of the sprue system show up in the final bronze?

In the interior of this bronze sculpture you should see some evidence of the different sprueing choices, but reconstructing the way a bronze has been sprued based on remaining sprue stubs, residual flow patterns of the dross, or oxidized metal in the cast surface (see **fig. 154**, [I.3](#I.3)), et cetera, would be difficult at best. And of course, if I had chosen to place the sprues on the outer, modeled surface of the wax then no evidence would be left after I reworked the locations of the cut-off sprues to blend in with the surrounding areas (**fig. 88**).

## 6 Core supports

### What technique(s) do you use to keep a core in position?

I have developed the habit of using carpet tacks as %%core supports%% (**fig. 547**). I used to use stainless steel rods, but they are expensive and can be difficult to get hold of. Carpet tacks, on the other hand, are very cheap and sold at any hardware store. The design of the tack is also perfect for the task. They are thin with sharp points, perfect for piercing the wax, and have flat heads, which assists in their removal after casting.

### How do you choose where to place the pins?

I tend to arrange them in the wax with a degree of symmetry. This means that if any of the %%core pins%% get broken off during the breaking open and removal (de-molding) of the mold I should know roughly where they are. I also place them in areas that are easy to %%chase%% in the bronze, such as higher, rounded parts of the form. I tend to avoid putting core pins near faces or front-facing areas as these require more chasing later, or in hollows and crevices that only superficially conceal their presence.

For larger and more open wax sections I allow the ceramic shell to coat the outside and inside of the mold continuously. This means that the core is ceramic, too, and is locked in place by its full contact with the edge of the outer mold, and then a smaller number of core pins are needed.

### How does evidence of the core pins show up in the final bronze?

Externally, it’s very difficult to observe any evidence of core pins, as they are either welded over and chased clean, or excess material around the hole is hammered in and chased. On rare occasions I have lost track of a broken core pin that remained firmly locked into the surface of the bronze and showed itself by staining the patina red with rust; obviously this had to be removed. The interior of the bronze will clearly reveal either holes where the core pins have been removed or the tips of pins that have broken off and remain lodged in place (**video 11**).

## 7 Different core materials depending on the location in the statue

### What material(s) do you use as core?

I was taught very early in my career how to make cores from a simple mixture of plaster and sand. Over time, experience has taught me that almost any inert grain or powder will work just as well as sand. This opens up many opportunities for experimentation, but also frees me from needing to buy prohibitively expensive commercial core materials. Also, no matter where I find myself in the world, I can now always find materials that will work for this purpose. Currently, for small bronzes I have used clay, which is the easiest material to find globally. I mix clay with inert powders and a tiny amount of plaster.

In the case of the horse head, I chose to make the core out of plaster for the nose up to the level of the eyes, as this shape is very difficult to get air-dried, and ceramic shell for the more open area of the neck, as from this point air could easily be blown into the hollow form. Using both methods of coring ensured that the combined core would be perfectly dry and also as lightweight as possible for handling and firing.

### Does the core leave traces on the finished cast?

I usually remove as much core as possible, but often some small fragments of material may be left inside. In the case of the double core method, a thin line or minimal %%flashing%% would be visible inside the bronze where the two cores meet (**video 11**).

## 8 The investment: key for a good-quality and clean cast surface

### What kind of investment do you usually use, and how do you prepare it?

The first studio I worked in used ceramic shell, albeit in an ad hoc way. Rather than having large tanks of liquid ceramic shell to dip the sprued wax models into, we would make up a tiny bowl of material that we painted onto the wax, which would then be coated in a fine fused ceramic grain. This sequence was repeated several times to build up the desired thickness of the ceramic shell. Small models were easy to cover that way, whereas large sculptures had to be painted one area at a time until the whole was covered. Either way, using ceramic shell in a manner outside of the industrial norm proved flexible and affordable. Ceramic shell offers great surface detail and is much lighter for handling, whereas even small molds made in a plaster-based investment can be heavy, and larger molds are so weighty they require the use of hoists, and de-waxing is very long and time consuming. The de-waxing and firing times for ceramic shell are very short, in contrast, meaning that I do not need as much fuel.

### How did you work out your current method of investing the horse?

My recent experiments in re-creating one of the Rothschild Bronzes ({Lacey 2018}) have revealed how much care and attention are needed in applying the first layers of investment. This I already knew, but I found that I could use a historic recipe of fine clay mixed with ground inert powders for the first coats and back them up with ceramic shell (**video 2**), or just use ceramic shell for the less detailed parts (**fig. 7**). This made for very lightweight molds that captured detail accurately, but were easier to remove from the bronze than ceramic shell. The clay layers are also cheaper than the zirconium silicates typically used for the initial layers in ceramic shell investments. It was through these experiments that I developed a method of investing the horse that worked best for me.

### Do other art foundries act likewise?

For contemporary foundries this approach would be disastrous, because they need a degree of repeatability. My method is very sensitive, but requires time to adjust mixtures and apply initial layers.

### Does the investment material show up in the finished sculpture?

These new mixed techniques that I’ve been exploring with historical materials will rarely leave a trace on the finished bronze. Possibly some of the fine particles may remain lodged in crevices. Potentially, chemical analysis could pick this up.

**Video 11**

## 9 Choice of alloys

### What alloys do you use? Do you have any preferences? Why?

Throughout my career I have used numerous bronze alloys (for more on bronze alloys see[I.2](#I.2)). In the early days, leaded gunmetals were common, easy to obtain, and generally compliant to work with. Over time phosphor bronze (Cu90Sn10 with phosphorus addition for de-gassing) took over, which is very clean and with a low viscosity, meaning that it casts beautifully. Silicon bronze (Cu94Si4Mn1Fe1) became ubiquitous in the late 1990s among foundries due to its great ductility and mechanical strength. It could be welded nearly flawlessly. In recent years—partly related to my historical research, but also to cost and/or the desire to control the color of the alloy—I have gone back to creating bronze alloys from raw ingredients or by recycling scrap bronze, usually from old industrial components and leftovers from previous casts. To do this I have learned how to deal with some of the more troublesome aspects of alloying. Particularly when using scrap metals, one has to be much more attuned to what happens in the melt. The surface of liquefied silicon bronze is a perfect mirror, but that of scrap bronze will have plenty of dross or slag on top and needs refining, adjusting, and cleaning.

### Do commercial art foundries often experiment with alloys as you do?

I think that my long-term habit of material exploration and curiosity about historical and archaeological materials and technologies—and prescientific ways of making sense of the material world—has enabled me to deal with unknowns with moderate success, but as with the investment, this approach would be disastrous for commercial foundries.

### Why do you try to avoid zinc in the alloy?

Whatever alloy I work with, I try to reduce the amount of zinc because zinc tends to make welding more difficult, and often causes porosity and occasionally differences in metal color that are exacerbated when the patina is applied. Zinc vapor is also terrible to breathe in: it can cause a strong fever and chills, all of which I have experienced in the past.

### How do you deal with differences in alloy composition in separately cast sections?

In the example of the bronze horse, several mold sections might be cast in small batches from the same crucible load (**video 11**). Typically a week or two would pass before I cast the next batch. Inevitably, by using refined scrap bronze to cast the body and legs you will see an overall shift in composition due to continued reuse of the scrap and segregation of the alloy. For the sections that required fine chasing, such as the head and neck, I created an alloy of 90 percent copper, 10 percent tin—similar to the one prescribed for cannons and sculptures in Italian Renaissance treatises—which is receptive to sharp tooling such as %%chiseling%% and %%engraving%%. As long as the combination of alloys does not negatively affect the patina or the physical/mechanical properties of the sculpture, these differences in elemental composition do not concern me.

### Do the compositional differences show up on the final bronze?

The surface of the sculpture should not reveal any differences in composition; ideally it should look as if it was cast in one pour. The joints will have been skillfully concealed through welding and resculpting the metal in those areas to make the surface look continuous. More time is taken to build up the patina so that the differences in alloy are disguised. It would be difficult to discern the compositional differences visually. However, if you used a handheld XRF [surface elemental analysis] to make a compositional map of the sculpture, the different alloys would show up immediately. One would have to sample quite a few areas to do that. On the basis of the data gathered, it might be possible to hazard a guess at which batches or panels were cast together, in what order, and maybe even the orientation of the sprue system in a given piece.

## 10 Gas furnaces versus charcoal hearths

### What kind of furnace did you use for the horse?

It’s a homemade affair, essentially a simple box of bricks. I have tried many forms of construction, materials, and dimensions over the years and found that reflective kiln brick (designed to reflect heat) held in a drum works perfectly well. There’s a small aperture at the bottom for gas to enter and a cement lid on top with a hole in the center. Gas is fed into the furnace from a hand-built torch, powered by propane gas that heats a clay graphite crucible. There is no great science or magic here; it just has to heat up the crucible as fast as possible. It is a tool that needs no adjustments or sensitive management; just turn it on and leave it alone.

### Do you use the same furnace for all of your castings?

No. For casting some of the small and more detailed sections I use an open charcoal hearth that contrasts greatly to the gas furnace I just described. I use a crucible no more than fifteen kilograms in capacity, in a bed of charcoal. The temperature of the charcoal can be far higher than that of gas, and the bed itself has different heat zones, meaning that you can be far more sensitive or exacting—for instance switching from oxidizing to reducing environments, accelerating the temperature or dampening it down to hold when waiting for the right time.

### Do commercial foundries use charcoal hearths?

I don’t think so. In contrast to a gas furnace, the hearth is full of “magic” and requires dedication and time to fully master. The hearth offers so much versatility, but from a commercial perspective it is something of a liability financially, as it requires someone to tend to it constantly.

### Can the type of furnace or hearth you used be inferred from the technological investigation of the finished bronze?

I cannot imagine that much if any observable evidence is left in the bronze. There is a technique that examines the gas trapped in porosity held deep within the body of the bronze, and in theory this gas could hold information on the type of furnace used, but it is a very complicated and delicate process.

## 11 Welding like crochet

### What are your considerations when assembling the cast sections?

I come from a long line of tailors, and there is something in the way a suit is built that echoes in the way a bronze sculpture is constructed. In both fields you work with a number of sections or panels that need to be joined together in a way that conforms to and describes the contour of the body or sculpture. Usually this works perfectly well, but occasionally you have to cut vents or seams into the bronze to better align the sections. I think this is when I started to think about how larger and more complex forms could be created in bronze.

### How are the separated sections assembled?

I always weld the cast sections together using an inverter TIG welder (**fig. 548, video 11**). When using different alloys for the various component sections, tensions can form in the bronze: the art here is to join the sections to avoid “hot tearing” and porosity. With refined scrap, this can be very difficult because you never entirely know what you’re dealing with, but I have learned that rather than applying more and more heat to the bronze panels, a gentler approach works better. The movement between the arc of the weld and the filler rod is also hugely important. The action looks more like crocheting: small circular movements that hook into the cooling parts of the weld literally stitch the bronze together. Typically, I use a silicon bronze welding rod to join the cast sections. It works very well, but you do have to plan where the weld line goes more carefully when using varied metals, as each of them (and the weld metal) will react differently to patination.

### Is TIG welding common in most commercial art foundries?

Yes, it’s the simplest way to join sections of bronze together, especially as most art foundries use silicon bronze for casting, and it welds with ease using this method. The other method commonly used is MIG welding, in which, instead of using short, thin metal welding rods, the handset has a continuous feed of wire. This is ideal for joining larger, heavier sections of bronze, but it lacks the finesse required for detailed work.

### How does the welding show up in the final bronze?

As stated earlier, in an ideal world, the finishing should make the joints invisible from the outside. If you are trying to assess the location of the joints as part of technical analysis, any differences between the body metal and the weld metal will be clear with XRF. This assumes that one can take enough readings around the sculpture, but you should be able to discern from the data not only the separate cast sections, but also the layout of the weld seams. Using X-radiography, the section joints will appear as fine pale lines, occasionally with fluid shapes defined by the filler welding material.

## 12 Chasing: different from one edition to another

### How important is chasing for you?

I like chasing, and strangely it’s something I’ve always enjoyed, which is not the norm. It’s a hard and very physical process (**video 11**). Most commercial foundries aim to reduce the amount of chasing needed by trying to cast bronzes that require little after-work. This also increases efficiency and, thus, profit. As I am principally concerned with the casting of my own work (I don’t cast the work of other artists as commercial foundries do), I can judge how much extra effort I wish to put into a particular bronze. More importantly, I do not consider the artistic process as ending with the initiation of the pouring. Most artists hand over the model and after that point have little part its creation; they only see it as the final bronze. Whereas I often wish to extend the modeling or enhance a certain aspect of the sculpture well after it is cast. That’s why I don’t produce %%editions%% of identical casts. I see them as prohibiting artistic expression. I like to be able to alter each cast in different ways, all the way through the process.

### Do you use electric tools?

I do use electric tools, for example grinders and pendant drills, but mostly I use hand tools like %%punches%%, chisels, and files, the majority of which I have made myself to suit my needs (**video 11**). My use of hand tools is not out of a sense of tradition or to uphold craft values. I’m very physical and love to express this through the bronze, and these tools allow me to communicate with the metal in an ongoing dialogue. That invigorates me, and hopefully both the sculpture and I have a near-tireless energy for such work.

### How does chasing show up on the finished bronze?

On this sculpture, most of the tool marks are very fine and nearly impossible to see. Around the eye, for instance, I used them to refine the shape and sharpen the form without leaving marks (**video 11**). That said, the surfaces of most of my bronzes might be littered with marks made on the original model, as well as punch marks and traces of chiseling, texturizing, and burnishing. I enjoy this process and use it a lot to bring the surface to life. Raking light, which is easy and practical with a flashlight (or with the more sophisticated photogrammetry methods), shows up the surface topography and is a descriptive way of understanding the discrete deformations made by chasing. If the surface of the bronze is distracting because of a thick or colorful application of patina, the chasing may be obscured. One could take an impression of an area with silicone rubber in order to reproduce the tool marks for study.

**Video 16**

## 13 Patina: unique for each edition

### What place does patina have in your creations?

I love patina more than chasing because it offers so much scope for exploration (**videos 11, 16**). I was trained to create very fine and highly repeatable patinas—the patinas produced by most commercial foundries. Over time this approach began to hold me back, and I needed to bring the energy of the model and its translation into bronze into closer alignment. Again, the feeling that the creative process does not stop when the modeling is finished is paramount!

### How did you patinate the horse?

I started with a black followed by brown using ferric nitrate, deep black using oil and flame, then white with titanium dioxide, and lastly mottled grays with complex layers of chemistry. Sometimes it’s easier to begin exactly where you do *not* want to end up—that is, with the traditional black or brown patina. By starting with such a contradiction, I then feel my way by deliberately destroying that patina with the application of another. I repeat the process until I reach a point of equilibrium or expression that starts to speak of the object or whatever it is that I feel is in the sculpture. Sometimes the process never ends and I melt the sculpture back down.

### Is such a series of back-and-forth trials your modus operandi for patination?

Yes, I often start with an idea for the look or the finish that I want to achieve, but after starting down that route, the feeling and direction for the sculpture shifts. You need to go beyond the surface of the bronze: What is it that a particular sculpture wants to become? It’s not always obvious, and this process tends to be a reflection of oneself, entirely introspective. I guess, when I find what is needed in the patina, I usually find some resolution for the bronze and ultimately in myself.

### Patination is such a jealously guarded secret of art foundries. Do you know of other practices like this?

There is another way of thinking about this. Instead of considering that individual areas of activity, like patina or mold making, are more shrouded in secrecy than others, in reality the entire foundry system is governed by secrecy. Although most foundries are, at least superficially, open to visitors and clients to discuss their work, there are always layers of activity behind the scenes that operate discreetly and privately, out of sight. This behavior leads to the evolution or invention of novel practice in all areas of the foundry. It is, after all, these unique inventions that give each foundry its commercial and artistic edge. Secret methods also enter the foundry when new workers or practitioners arrive from other foundries. If their methods are better than what is currently practiced, their ideas will readily be adopted. For researchers of technologies used in the arts, this is a wonderful phenomenon because these secret methods often leave evidence on the bronze that can act as a signature of an individual maker or foundry. If you follow this evidence, sometimes you can map out how ideas—or secret practices—have either been spontaneously invented or migrated and evolved from foundry to foundry.

### Do you think we could find out how you patinated the horse by carrying out the kind of investigation recommended in the present volume?

One can only imagine the depth of chemical layering that forms on the surface of a bronze like this. Sometimes it appears that the chemical solutions begin their own complex set of interactions that carry on for days after the patina is applied. Chemical analysis of the surface should reveal, if not a specific recipe, the possibility of an approach by the maker that is distinct and purposeful.

## 14 Process duration

### What insights can you offer regarding of the time involved for the various steps of the process?

I can give you an outline for the working times or durations used in this casting process, although there is no such thing as a generalized time frame. And some steps relate to drying or cooling times where there is nothing to do but sit and wait.

The first stage of the process was to make a two-part silicon rubber mold from the original model, backed with plaster mother molds. This took one day to complete, but three hours of this related to time allowed for the rubber to cure. Next, I made the wax %%inter-model%%, which took one and a half hours to pour four layers of wax, the first starting at 95°C and the last ending at 65–70°C. It required a further one hour for the wax inter-model to cool down enough to be removed from the mold. The wax needed reworking to remove any imperfections such as holes and delaminations. This took around two hours.

Designing and attaching the sprue system and adding the core pins to the wax inter-model then took one hour. I poured a plaster investment core inside the wax inter-model, which took about thirty minutes, but again some of this time was just preparation and cleanup afterward: the actual pouring of the plaster took a mere ten seconds.

Applying a ceramic shell investment to the sprued wax took two and a half hours to apply for ten layers. But one needs to count a further two and a half hours between layers to ensure that each one was dry, so it took three days to complete. De-waxing is a relatively fast process, taking only twenty or thirty minutes, but because I used a plaster core rather than ceramic shell, the mold needed to be fired in a kiln at around 500–600°C for a further hour and a half. The wax reclaimed after de-waxing weighed four and a half kilograms. The weight in wax is multiplied by ten to calculate the weight of bronze needed: I had to melt forty-five kilograms of bronze to fill the mold. Both my gas and my charcoal furnaces take an hour and a half to get up to temperature. Once liquefied, it took only thirty seconds to pour the metal into the mold. I tend to leave the bronze cast to cool for three or four hours before breaking it out of its mold.

The initial %%fettling%% of the bronze cast took two hours, while the fine detailed chasing took another four hours. Finally, the patination process took one hour, but often this stage is revisited over the following days to see if any further chemical changes have occurred, in which case I usually redo the patina until I’m satisfied.

## 15 Closing observations

By following Andrew Lacey’s artistic and foundry process in making *The Anatomy of Bronze* from start to finish, what has become evident is that although he was trained in London’s contemporary art foundry scene, his decision making, material considerations, and aesthetic values differ greatly from those of most commercial art foundries. He has developed a deeply idiosyncratic methodology. This may be due to a number of factors. He works in isolation in his own studio/foundry and is therefore not constrained by the need to collaborate with other practitioners. And thanks to his academic research, he very deliberately interweaves historic and contemporary methods of making. While conscious of costs, he is not under the tight economic constraints that most art foundries are. He is driven primarily by artistic expression and also likes the intellectual challenge that comes from investigation of materials and processes. Finally, his sculptural output and the methods behind it are clear extensions of the same artistic expression.

## Further resources

<https://andrewlacey.com/>