BUILDING AN IRON AGE BRITISH CHARIOT

By Mike Loades

INTRODUCTION

In May 2001, I was asked by the BBC to co-ordinate the reconstruction and field-testing of an Iron Age Chariot for a Meet The Ancestors programme. This is an account of that process. It is a personal account that reflects a personal view, born of months of collaboration with a wide-ranging team of experts.

A few months earlier archaeologists had unearthed the remains of a 4th century BC vehicle in a grave at Wetwang, which lies between York and Bridlington in the open country of the Wolds. It is an area well known for its chariot burials. Nearby Garton Station, Garton Slack and Kirkburn have all yielded vehicles in the soil as well as three previous finds at Wetwang.

The plan was to build a vehicle based as closely as possible on this latest find. Of course, the evidence was incomplete and where this was so, we would have to draw on other examples and look for clues in a wide variety of archaeological remains, texts and pictorial representations.

A project such as this has many constraints. Not least of which are a limited budget and deadlines, which come with the necessity to produce a television programme. Add to this the inevitable delays in waiting for the results of conservation and analysis, the other working commitments and holidays of a diverse team, plus the need to arrange to film certain processes before the next stage can be embarked upon and you have some idea of the problems aside from substantial missing gaps in our primary source material.

For these reasons what we have come up with will be imperfect. There will be decisions, which with the wisdom of hindsight or in the light of information still to come, we may think we should have made differently. You may think we should have done them differently in the first place. What I seek to do here is to set out what decisions we made and why we made them at the time. It was a fascinating process and we learned much on the way.

In spite of its pitfalls it has been a most rewarding project. Experimental Archaeology can be such a useful tool in pursuit of our understanding of the past. At its best it can both inform our scholarship and connect us directly to the physical experience of a past age. I hope that we have managed to achieve both these aims and lay a foundation for future scholars and experimenters to build on.

This project couldn't have happened if it were not for the BBC. Television really matters when its resources fund important experiments like this and, in the process help to stimulate interest in the subject. My special thanks must go to our producer, Ian Potts, whose companionship, enthusiasm and insight were as invaluable to the project as his original vision and faith in commissioning it in the first place.

Chariot, Carriage or Cart?

On May 23rd I entered the British Museum with great excitement and eager anticipation. I had come there to see the evidence for the first time. What made this latest vehicle find particularly significant was not only that it added to the sum of existing knowledge but also that the meticulous excavation had yielded dimensions and data hitherto unrecorded.

I met J.D. Hill, senior curator of the department of Pre-History and Early Europe and Tony Spence, who had carried out the excavation. Throughout the project they were generous with both their time and their erudition, providing a benchmark of academic probity against which to check our wilder flights of fancy. Their co-operation and encouragement was unstinting.

They showed me the plan of the dig. It plotted the location in the ground of the surviving metal parts – the terrets, the lynchpins, the iron tyres, the nave hoops, the bits and the strap unions – and a somewhat amorphous stain, which indicated the approximate shape and basic dimensions of the vehicle body. The vehicle, as was common practice, had been partially dismantled for the burial and the wheels lain over the pole, but otherwise many of the components could be detected in their original positions.

Certainly it was a two-wheeled vehicle but was it a chariot? The Oxford English Dictionary defines chariot as a two-wheeled horse drawn vehicle used for ancient warfare or racing. Somehow it didn't look like a chariot – too boxy – and anyway no weapons had been found in the grave and there was nothing to suggest either warfare or racing. Not only that, interred with the vehicle had been a body. The skeleton of which indicated it was that of a woman. It would surely have been far too sensational to suggest that it was a chariot and she some kind of proto-Boudica figure, wouldn't it? There wasn't the evidence. Perhaps it was simply a cart or carriage or a purpose made funeral bier?

A mirror was found alongside the skeleton. Mirrors were important accessories for the afterlife. Perhaps because the afterlife, for those who believe in it, is the continued existence of the soul without the body; whereas one's reflection in a mirror is an image of the body without its soul. In any event the mirror was an exquisite object, re-enforcing the view that this was a high status personage.

The remains of a cleft boar's head, which had lain alongside the corpse, further confirmed that this was a high status grave. Pork was considered exalted meat and the preferred nourishment for persons of high standing embarking on the journey beyond.

The metalwork on the vehicle itself also gave some clues as to status. The horse bits – single jointed snaffles – were of iron, overlaid with bronze sheeting and with a decorated finial on the outside ring of each bit. The iron lynchpins had been dipped in bronze. Most spectacular of all were the terrets. These had iron cores, over-cast with bronze. The over-casting was elaborately formed with chiselled ornament and each terret was studded with beads of coral. These were lustrous jewels indicating a vehicle of immense

prestige. The mere fact that the body had been interred with a vehicle also denoted a person and a burial rite of very high status.

The etymology of vehicle types can be problematic. Distinctions between chariot, carriage or cart can become blurred and each is a ready synonym for the other in everyday speech. Nonetheless we most usually associate the word chariot with war or racing, the word carriage with comfortable travel or parade and the word cart with haulage. Thus the word chosen to describe a vehicle inherently implies its use. This is not always helpful and what we really need is a word that indicates a vehicle's design type rather than a presumption of its usage.

It has become fashionable to refer to all vehicles found in Iron Age interments as carts in an attempt to play down what are seen as the more sensational implications of the word chariot. In particular these Yorkshire vehicles have been called carts because of the box-like bodies hinted at in the soil staining. There has always been a realisation of the inadequacy of the term in archaeological circles but a differentiation from Roman (racing) chariots was sought. However the word cart implies either farm work or the transit of goods. A cart is a lowly vehicle. A cart is not appropriate for a high status burial. This was certainly no cart. Was it then a chariot? Not necessarily, the notion of it being a carriage or a purpose-made funeral bier still had currency.

That was until I sat in the sawdust on the floor of Robert Hurford's workshop. Robert is a wheelwright and the man we had gone to as the principal builder and overseeing architect of our reconstruction. Robert is not only a fine craftsman (he would say tradesman) but also a broad thinker, who was inspirational throughout the project. Anyway, as we were scratching our heads over plans of the burial site, we decided to draw out the plan of the vehicle, full size, on the floor. As soon as I stepped into the rectangular area of the body and sat down, I knew that I was in a chariot. It was all a question of proportion. At once the ratio of my body size to the scale of the vehicle body conjured up the images of iron-age chariots from Iron Age and Roman coins I had seen and the Padua stele. Moreover there was another piece of evidence. We knew the length of the axle.

The grave-pit at Wetwang lay in an area of compressed chalk and was composed of clay, intermingled with flint and chalk gravel. The nature of this soil environment meant that where the wood had slowly decayed and left a void, it had in-filled with fine silt. Miraculously, Tony Spence had managed to locate a number of points on the vehicle where this had happened and take plaster casts. Not only was he able to determine the terminal points of the axle but he was also able to make a cast of a section of it. This revealed that the axle had internal wheel-stops integrally turned to the shaft. This was thrilling, first time information, for a vehicle of this period. We knew exactly where the wheels sat in relation to the body. It was a very wide axled machine, the wheels sited way beyond the edge of the body, offering tremendous stability and cornering. It certainly had the performance potential to be much more than a sedate ceremonial carriage.

Our distinction between chariots and carriages was becoming more blurred if not entirely redundant. Here then is a strong case for expanding our definition of the word chariot to indicate a design type rather than just implying function. After all we do it today with the appellation sports car. We know what we mean by this, it relates to the dynamics of the design but we also know that most sports cars are used for everyday travel. They are not exclusive to the racetrack.

It is a generally held view, sustained by a lack of evidence to the contrary, that Iron-Age Britons did not have a purpose made, dedicated "war-chariot", but rather that, in time of need, they pressed into military service ordinary vehicles. Here then was one such ordinary vehicle but one that had dimensions and proportions consistent with the depictions of war chariots that we find on Roman coins and the Padua Stele.

The Padua Stele is a celebrated Etruscan funerary stone, which shows a relief carving of a 3rd century BC chariot. It is a near contemporary with the Wetwang find. The carving portrays a seated driver and a standing warrior with his spear. It is the most complete and comprehensive depiction of such a vehicle that has, so far, come to light. There are other Etruscan funerary stelae, depicting carriages and other vehicles, but none that match the proportions and dimensions of the find at Wetwang so well as the Padua one. Time and again we came back to it looking for clues.

There are no indigenous depictions of British vehicles at this date, though a number of coins depict a generic "Celtic" type. We had a lot of data regarding what components the Wetwang vehicle was composed of and its dimensions but we still had no real clue as to what it looked like, what was the form of the body and how was that constructed?

The Box

Tony Spence was convinced that the body had solid sides, at least on three of the sides. It was the only plausible explanation for the sharp delineation of the soil marks, which though a little distorted over time, showed clearly where the box had lain. The solid sides would have kept back the infill and thus created the distinct soil markings some 45cm in depth. He also felt that it would have had a solid floor, as opposed to the strap-work floor that we had been considering. This was grist to the mill for the carriage argument but this notion of a sedate conveyance didn't seem wholly consistent with the dynamic "sports car" design proportions that had been revealed in the dust on Robert's floor.

Besides it left a fundamental question unresolved.

Suspension

Anyone who has been in a horse drawn vehicle knows that you get jolted around a fair deal, even on relatively smooth ground. Suspension is all important.

Chariots of the Classical World had strap-work floors, interwoven strips of rawhide, which gave a springy platform to stand on. We see them in the preserved examples of chariots from Egyptian tombs. There is a delightful bronze model of a Roman chariot, found in the Tiber, now in the British Museum. It has a strap-work floor. The bronze model of Emperor Qin Shi Huandi's chariot, found with the terracotta army in Xian, has a strap-work floor. Strap-work floors make sense.

Coupled with this is the fact that so many chariot cultures have devised ways of incorporating a shock-absorbing element into the construction of their wheels. The Egyptians had bifurcated spokes, compliant under load to soften the ride. Chinese spokes had one half as straight dowelling and the other in the shape of an oar blade, creating a compromise between compliance and strength. The Greeks used only four spokes, so that the rim of the wheel was pliant – so much so that they had to remove their chariot wheels at night, lest they take a set.

Suspension is central to vehicle design. What made it even more so in this case was the fact that our vehicle would need to carry either a seated driver or passenger or both.

Chariots in all other cultures are for standing on, not sitting on. Standing has the advantage that you can use your legs as springs and thus, to some extent, counteract a jolting ride. A seated passenger is solely dependent on the suspension of the vehicle if he is not to be pitched to the ground.

When Julius Caesar wrote about encountering chariots in Britain in 55BC, which he did to his astonishment because they had disappeared elsewhere in Europe, he used the word *essedum* to describe them. Clearly the central root here denotes a sedentary mode. This is consistent with the few depictions we have of European vehicles of the period. Not least of which is the Padua stele with its seated driver and standing passenger.

Here was a nettle that had to be grasped. What was it about Northern European chariots that (a) necessitated and (b) enabled the driver to sit?

Sun Tsu, a Chinese military strategist, says in the Art of War: "use the chariot on the plains not in the mountains". This seemingly self-evident military doctrine holds true for most of the great chariot cultures. The Chinese, Egyptians, Asssyrians, Persians and Indians all used their chariots in plains warfare as mobile missile platforms. The Greeks and the Romans used them rather as staff cars and battlefield taxis. However notwithstanding Rome, in Iron Age Europe, the pan-Celtic chariot was used on very different terrain. Chariot remains are found, inter alia, in Northern Italy, Switzerland, Northern France, Spain, Wales, Scotland and, of course, Yorkshire. These are not areas noted for their table flat plains. This is rough country – coarse grassed, hilly, bumpy, boggy, rutted – rough country.

Perhaps this rough terrain is exactly what necessitated a seated driver, he needed a lower centre of gravity for stability. But this would only be possible with an advanced suspension system. There is a model of a chariot in the National Museum of Wales, Cardiff, based on Sir Cyril Fox's 1946 interpretation the Llyn Cerrig Bach find. Superficially it also draws from the Padua stele depiction, insofar as it has side arches. However it has a solid planking floor and no suspension. On such a contrivance a seated driver would bounce like a pea on a drum. We had to have a suspension system to enable the driver to sit.

One evening, the producer of the programme - Ian Potts, and I were having dinner at Robert Hurford's. After much discussion, head scratching and some wine, Robert lit upon an ingenious idea.

He had noticed that the Padua stele and some Roman coins all represented chariots with double-arched sides. Moreover each of these arches was depicted with a Y configuration inside. This had previously been interpreted as decorative – possibly split hazel wands. "What if", asked Robert, "what if that Y was a rawhide strap and it suspended an independent platform within the main frame? "

Eureka! Here at last was a practical solution to the problem. It had the real potential of working. We cannot know for certain that this is what is being represented on the carving and the coins but it immediately seemed like the experiment worth doing.

Leather slings, supporting a carriage body, are a tried and tested form of suspension – old western Stage Coaches for instance. Additionally there had been a "Celtic" chariot reconstruction in the early nineties by Swiss archaeologist Andres Furger-Gunti. He had based his reconstruction on some 2nd century BC finds in the area of Lake Neuchatel. Chariot finds in that region had revealed the presence of cotter pins – four, one each corner of the platform. Furger-Gunti interpreted these as anchors for leather straps on the main frame, which in turn, supported the platform. After practical trials he concluded that this gave considerable suspension benefits.

We, however, had a find two centuries centuries earlier and no cotter pins were unearthed. Robert's ingenious inversion of the strap suspension system seemed the only way we could go.

It also defused the chariot versus carriage debate. It no longer mattered. If an independent platform were slung from these Y straps, then various types of platform could be interchangeable. What we had effectively come up with was a basic chassis type onto which any type of body could be mounted. We decided that we would try it with an open-ended, open-sided platform as shown on the Padua stele and the Roman coins and also with a three-sided box body as evidenced by the soil differentiation in the Wetwang burial. We had a soft top - hard top convertible. This also gave us a broader range of challenges to test in the field trials.

In its open sided mode, we could test its battlefield applications and with the box body, we could assess its virtues as a carriage. The extended range of these experiments was not intended to presume its original function or the role of its occupant, it was merely intended to test the basic vehicle type in as many ways as possible. Whether the lady in the Wetwang grave ever led her people in anger, we shall probably never know and we certainly can't assume any martial role for her on current evidence.

The interchangeable body approach also offered us the opportunity to make another comparison. We would make the open platform with a strap-work floor and the box with a solid, planked floor. Would the Y strap suspension system be enough on its own or did it need augmentation from a pliant floor in order to give a satisfactory ride?

First, however, we had to convince The British Museum that what we were proposing was a plausible interpretation of what this vehicle might have been like. Initially they were reluctant, which is perfectly understandable since there wasn't any hard evidence for an outer frame from the grave. The soil staining only revealed the internal box. However we were adamant that a practical solution to the problem of suspension had to be tried and the lack of specific evidence meant that we had to look to other contemporary sources for inspiration.

Prior to the meeting Robert had fashioned a little model, incorporating the proposed system. At just the right moment he pulled it from a biscuit tin and the case was won. We couldn't know for certain what the frame of the Wetwang vehicle was like but all agreed that this was the useful experiment to conduct.

The Main Frame / Chassis

The main frame needed to be sturdy. Not only did it have to lash to the axle and the pole but it also needed to anchor and support the arched sides upon which our suspension system depended. The wood selected was ash.

Although the soil markings from the original box had distorted and created a curvilinear stain in the ground, it was felt that the original shape would have been a rectangle and therefore a basic rectangle would be required for the frame in which to suspend it. The boxiness of this still jarred with me, when so much art and design of the period seemed to involve curves.

There was a need to allow for a height clearance between the sides of the chassis and the transverse spars of the platform, which were going to suspend it from the Y straps. Thus Robert shaped the sides of the main frame in an upsweeping curve. This was a most elegant solution, which somehow invested the vehicle with a stylish and dynamic character.

How were the corners of the main frame to be joined together? Robert was convinced that halving joins were the only possible solution to deliver the requisite amount of resistance against the various strains the joints would

come under. This meant that the ends of each side would overlap and protrude at the corners. What then to do with these protruding ends? We couldn't just leave them unfinished on so elaborate and prestigious a vehicle. Robert experimented in giving them some shape but his carving invariably released a form of sculpted animal head. When he tried it differently he simply came up with a different animal.

There were some reservations from the BM. Stylistically, on current evidence, animal heads would be more correct on a Continental carving of this period, although they did become more prevalent in Britain at a later date. Some sort of foliate-like scrolls might have been more accurate. However this wasn't a huge sticking point and we were fighting deadlines. The animal heads certainly had function and we all rather liked them and so Robert's quasi-Celtic bestiary came into being, giving our vehicle life and charm – already a long way from a stain in the ground.

Ash was also selected for the side arches. These were steamed. Robert improvised a steamer with a length of metal tubing, at the centre of which was an inlet for the steam. Billets of ash were inserted and the ends sealed. Once thoroughly steamed, each billet was secured to a metal strip on its outside edge to prevent the grain from lifting as it was bent to shape over a wooden former. Once set to shape the ends were cut to length and tenoned into the side timbers of the frame.

So far, so good but how were we going to hold the whole thing together. After all it would have to withstand a rigorous amount of shaking and torsion as it was bumped over rough terrain. Screws, nails and bolts were out of the question, as none had been found, and no form of Iron-Age glue could possibly be strong enough on its own. It had to be lashed.

The Knot Tyer

Enter Richard Hopkins from the International Guild of Knot Tyers. Richard's skills were to prove invaluable, nearly every component had to be lashed or bound in some way.

Although hemp and flax were both available materials, we decided to use rawhide for most of the principal lashings. This was the practice in Ancient Egypt, still to be seen on surviving examples of chariots from the tombs. It seemed sensible to go with a system that had proved its worth in the field. Rawhide turned out to be a most excellent and versatile material. Applied wet, it would shrink tight and set as hard as iron, pulling the joints together with great security.

A fresh cow's hide was acquired from a tannery, the hair and flesh removed, but still soggy and pungent – very pungent. This "green rawhide", as it is known in this state, was stretched taut on a frame and allowed to dry out a little. Then the laborious business of cutting began. Wet rawhide is a slippery, slithery, stretchy material and it is the very devil to cut it with a straight edge. Richard triumphed to a remarkable degree of success but then he is also a

man who knows how to put an edge on a knife blade that you could shave with!

It was important for the strap-work flooring of the platform that the rawhide had no join, no weakness. A continuous, 430 cm long x 2.5 cm wide strip of rawhide was released from the hide by cutting in a spiral and then stretching it straight.

The internal platform was made from ash and drilled with holes around its perimeter. In order to give it greater strength and, more significantly, to effect a means of slinging it on the Y straps, it had two transverse batons of wood lashed to the underside. The terminals of these batons, where they sat in the slings of the Y straps, were fashioned into yet more bird's heads to augment Robert's bestiary.

The great ribbon of rawhide was passed back and forth through the apertures to make the warp and the weft of the platform. Great care had to be taken to get the tension right, calculating the likely amount of shrinkage as the rawhide dried. Too slack and it would be useless, too tight and it might distort the frame. Richard got it right, producing a platform, which gave both firm support and yet which had just the right amount of give and springiness to counteract a rough ride.

Lengths of rawhide were braided into four strand plaits to create the suspension Y straps. In effect they were actually U shaped straps drawn together at a given point by a toggled piece of rawhide. Thus the lower stroke of the Y embodied a sling at the bottom on which to suspend the platform. In theory the positioning of the toggled join could be moved to create longer or shorter arms of the Y and so have softer or harder suspension.

The Y straps were then lashed to the arches. It was becoming clear that the lashings and braidings were not only elements of essential function but that they also had considerable decorative impact.

Having lashed together the various elements of the body, the next job was to secure it to the axle.

The Axle

The axle had an overall span of 204cm. The cast from the void at one end of the axle, showing the presence of the integral wheel stop, indicated that the axle tapered from a larger mid section out to its terminal diameter of 7cm,. Steve Crummy of the British Museum came up with some computer generated graphic projections based on measurements taken from the grave, which gave us a shape profile. Such an axle needed to be created from an immense piece of timber.

Doubts were cast as to whether such a substantial baulk of timber could be turned using only the primary technology of a pole lathe. Could it have been made in two sections or would that give an inherent weakness to the whole

structure? The only way to find out whether or not it could be done was to try it. So we went to visit Robin Wood – a pole-lathe turner with an expert knowledge of historic turning techniques.

The first thing he told us was that there is no evidence of the existence of the pole lathe before around 600AD. Fortunately the second thing he told us was that the pole-lathe was preceded by another form of reciprocating lathe - the strap-lathe and that there was evidence of turned goods from around this period. Turned items had been unearthed in the excavations at Glastonbury Lake Village.

A strap-lathe is a simple device whereby the work is held between two iron pins, a strap is wrapped around it and it is rotated to and fro by means of this strap. Whereas a pole-lathe can be used with a single operator, the strap lathe system requires one or two additional personnel to pull on the strap. Otherwise it does the same job.

The question then became, could you turn such a large and heavy piece of timber on a strap lathe? Robin was confident that he could and that he would be able to turn it to exacting standards of engineering precision. It was hugely important that we had a precise fit where the axle passed through the nave of the wheel or the wheel would wobble.

The plan was for Robin to roughly turn the piece in green timber, because it is significantly easier to work and then let it dry out, during which process it would deform slightly. Once this process had stabilised, a matter of a few weeks, he would finish off, turning to the precise measurements required. He selected a fine piece of oak for the task and set to work.

Beside the axle in the grave, adjacent to the wheel-stop, a small metal pin was found and traces of organic material. Tony Spence believes that what happened here was that a strip of leather was wound around the axle, packing the small gap between nave and wheel-stop, to prevent end-float and that the pin or nail was used to secure the loose end. In the event, the fit was such that this wasn't required. If such packing did exist, perhaps it is evidence of long years of wear?

Friction was minimised by greasing the axle ends. This was found to be perfectly adequate and when all was done, the wheels spun freely and smoothly on the axle. It is an interesting aside, however, to note that there is evidence for a form of roller bearing on a wagon find dating just a couple of hundred years later than the Wetwang vehicle. The remains of a first century BC four-wheel wagon burial at Djebjerg in Denmark reveal that hemispherical grooves were cut end to end on the inside of the nave bore. Inserted into these grooves would have been lengths of wooden dowel, each of which would have been able to rotate freely.

There was no evidence whatsoever for scythes fitted into the axle ends and there is no evidence for them in any other chariot burials either. The scythes

that so famously adorn Thornycroft's 1902 statue of Boudica on the Embankment are entirely apocryphal.

In making the main frame, it would have been logical to make provision on the undersides of the longitudinal members for the bedding of the axle. However at this stage we were still unsure where to site the axle on the frame. It seemed to lay at the rear of the grave, but then the box body had probably been dismantled to lay over the corpse, so this was not a sure indication of where the axle sat in relation to the body. It also depended on what yoking system we were going to use. The chariot would have to be balanced for the optimum comfort of the ponies. In other words there was the possibility that once we had got it all made and put it to the ponies, we might have to move the axle. In view of this, Robert made independent axle pillows that could be lashed to the main frame and therefore moved as required.

The Wheels

Next Robert addressed the problem of the wheels. Apart from the iron tyres, the lynch pins and two pairs of nave-bands, nothing survived.

Wheels have a number of component parts. In the centre is the nave, through which the axle passes and from which the spokes radiate. The axle is fixed and each wheel turns independently on the axis of the nave. Clearly the nave is subject to a great many stresses and for this reason it is discouraged from splitting by being secured with a metal nave-band close to each end. The nave-bands survived at Wetwang. They were constructed with an iron core and overlaid with copper-alloy. The average internal diameter of each band was 14cm. The distance between each pair of nave-bands was 18cm. We also knew, of course, from the diameter of the axle, that the central bore of the naves must be 7cm. Here, at last, was hard data to go on.

Well almost. These measurements told us fairly accurately the size of the nave but not its form. Robin Wood pointed us in the direction of some finds of around the same period at Glastonbury Lake Village, which were excavated in the early part of the 20th century. Among them had been a half finished nave. Incredibly it measured within two centimetres of the projected length of the Wetwang nave. This became the basis for the shape of the naves that Robert then fashioned from seasoned elm and according to the Wetwang dimensions.

Quite a lot of evidence exists regarding Iron Age wheels, perhaps most spectacularly at Garton Station (Yorkshire), the excavation of which yielded a magnificent plaster cast of virtually the entire wheel, from where the decaying wood had been replaced by clay. It is currently on display in the British Museum. It had twelve spokes. Twelve spokes seems to have been the norm and is what we went for. Although remarkable for its completeness, the Garton Station impression is too distorted to give any detail as to the form of the spokes. Once again we turned to Glastonbury where five actual spokes had survived.

The outer part of the wooden wheel is called the rim. It seems that rims were fabricated in a number of different ways. Another East Yorkshire chariot burial, at Kirkburn, had the remains of a wheel that suggested the rim was of a single piece of timber with a scarf join. Robert was eager to try this. It presented a number of technical problems. How, for instance, would he be able to fit it to the spokes, which needed to be set in at an angle and under tension? How would he and how did they create that degree of bend in a piece of timber without the grain lifting? He toyed with a number of ideas, all of which required experimentation and would have proved time-consuming. His favoured theory was that the timber was grown to shape – an ash sapling would be bent and staked as it grew until it achieved the requisite curve. There certainly wasn't time for this. There were deadlines to meet.

In view of the time pressures it was decided to base the rim on the remains of a wheel found at Holme Pierpoint, near Trentbridge in Nottinghamshire. This showed segmented felloe construction, as is still the norm today. A felloe (pronounced felly) is an arc cut from a board of timber. Each felloe abuts its fellow and six of them make up a rim.

We certainly knew the overall size of the wheels, because the iron tyres had survived. They were 90cm in diameter. A size, which seems almost universal to all the many chariot remains that have survived both in Britain and on the Continent.

The tyre (tyer) is prefabricated and forged into a hoop. It is put on hot and as it cools it shrinks and pulls (or ties) all the joints and components of the wheel together. A fine calculation has to be made to create a tyre of exactly the right size. In fact it is made just slightly smaller than the circumference of the wooden wheel in loose assembly. When heated the tyre expands to a greater circumference than this and, on cooling, it contracts to pull everything together.

The moment of putting the tyre to the wheel is a moment of great theatre. A fire is built around the iron hoop and lit. When the tyre is glowing red it is lifted with tongs and then prised with levers (tyre dogs) around the wheel. Sledge hammers assist in tapping it into place. Watering cans then liberally douse it with cold water. The flames, the heat, the hissing and the steam, the urgent knocking with hammers and prising with levers all combine to create a charged atmosphere of creation, out of which is born a wheel.

Linchpins

There were other artefacts that needed to be born of fire and so it was that we recruited Hector Cole, a renowned historical smith to join the team.

For an Iron Age object, there was precious little metal work on the vehicle, but such as did exist was of crucial importance. The great thing, of course, was that the metal parts had survived, so we had actual artefacts on which to base accurate reconstructions.

Hector began by hammering out and forging the iron cores for the terrets, which were to be overcast in bronze, and then set about forging the lynchpins.

The linchpins were of iron, the top third of which had been dipped in bronze. Their form was essentially a J shape. This is not a unique form, it also occurs, for instance, in the Garton Slack burial. However the way in which this type of lynchpin might work has never been adequately explained. A more conventional type of linchpin, effectively a straight iron peg, such as that unearthed at Kirkburn, is easily explained. It passes through an aperture in the axle and, abutting the nave, prevents the wheel from falling off.

A distinctive feature of the J shaped pins is that they are found accompanied in the grave by a separate, small ring. The shank of the pin is flat faced and finishes at its top end with an eye, of the same diameter as the separate ring. There is a slot though the shank, near to the eye end and at the other end it terminates in a bulb. Hector deftly forged these pieces with great precision and adherence to the dimensions and shaping of the originals, taking care to make them handed – one for the left and one for the right wheel.

The British Museum suggested that the lynchpins should pass through an aperture in the axle, in the same way that the straight ones did. This didn't seem feasible, since the size of opening, required to allow the irregular shape of the pin with its expanded bulb on the end to pass through, would have been so large that there would hardly be any axle left at this point. Robert had other ideas.

The linchpins were undergoing conservation until quite late in our reconstruction project. This meant that our information about them changed slightly over the course of several weeks. Robert manufactured a number of prototype solutions – creating executive toys, which we delighted in passing to people saying "can you work out how that goes together?" In the end Robert's solution was characteristically inspirational.

He utilised the extraordinary plastic qualities of wet rawhide and moulded a custom shaped washer. The lynchpin was attached to the washer by a moulded housing, which secured it at the bulb end, thus giving function to the bulb. A thong was passed through the slot. At one end of this thong, the small ring was attached. The other end passed through a second moulded housing in the washer. Thus function was given to the slot and the ring. A slot was cut into one side of the axle and the washer and pin slid in place. By pulling on the thong the linchpin was pivoted and neatly locked into its slot. It was apparent that the curious shape of the lynchpin had a very precise function. The thong was passed through the small ring to secure it in place. It was fiddly to tie the thong off in this position, so it was passed through the ring and tied off on the eye of the pin, which sat proud of the nave and was easily accessible. Thus, it too, had a function.

This solution has not been universally accepted although it has been proven to work in the field. One objection rests on the premise that there could not have been a rawhide washer because no traces of organic matter were found

by the linchpins, whereas they have been detected elsewhere. It is characteristic to find organic traces replaced by iron corrosion products where organics and iron touch in the ground.

Be that as it may, it seems certain to me that J shaped linchpins must have fulfilled their function by sitting in a slot in the axle and that there must have been some means of holding them in place. There may well be other solutions or minor modifications to the one adopted, such as passing the leather thong directly through a small hole in the axle but until it is tried and tested we cannot judge. That, however, is the beauty of experimental archaeology. It is pragmatic.

Pragmatism alone, of course, does not explain every nuance of a vehicle's design. The original architect is also likely to have been influenced by aesthetics and symbolism. So whilst we may have deduced a plausible deployment for this linchpin design, it is nonetheless a design that is mechanically ridiculous. Certainly it was not a technical improvement on the age-old pin style linchpin that simply pegged through a hole on the axle. So what was its rationale?

Robert had noticed that, when laid side by side, these J linchpins recalled an image common in Celtic design. That is a representation of paired dragons; their tails looping away from the centre like the hooks at the base of the Js. It is an image, probably of great iconographic significance, that occurs at the mouth of sword scabbards. Was this same symbolic force being invoked in the design of the Wetwang linchpins? We do not know but it is certainly food for thought.

Bronze

The iron cores of the terrets, which had been so expertly produced by Hector, were taken to Tim Blade, a jeweller who works in bronze, to be over-cast. Bronze is a copper alloy capable of being burnished to a lustrous sheen with the rich warmth of pure gold. It is a material of immense prestige and undoubtedly the bronzed terrets were the most resplendent of all the artefacts at Wetwang. Five were found in the grave and each was faceted with studs of dark pink coral. Tim began by making the two halves of a mould from a compound of beeswax and tree resin. The plasticity of the former and the resilience of the latter produced just the right constituency.

He used a stylus to carve the mould so that it followed the elaborate contours of the originals and added flues to allow the inflow of the liquid bronze. The moulds were placed together around the iron cores and sealed. Then a crucible of hot, golden, molten metal was poured into the flues. On cooling the moulds were removed and the laborious task of polishing and cleaning commenced. Reconstituted coral was used for the decoration.

When completed the terrets gleamed with a vivacity and opulence that proclaimed the wealth and status of their original owner. They were

magnificent jewels, which asserted the elevated status of the person who once owned them.

Subsequent to completing the reconstruction project, further work on the conservation of the terrets has revealed that at least one of the beads was made from moulded, coloured glass. This clearly suggests that the glass bead was a replacement for the coral and that, therefore, the vehicle was one that had been in service for some time and not, as is sometimes suggested for these burials, made especially for the occasion.

Paint

Previous reconstructions and representations of Iron Age chariots have often peddled the view that the sides of the body were made of wicker. This perception is not based on archaeology but on the “romantik” notions of eighteenth century antiquarians who sought to portray the Ancient Britons as simple folk, living a rustic idyll. One look at the Wetwang terrets is enough to tell you that they were not created to adorn a basket!

Already our chariot was looking a more stylish affair than the wicker baskets and heavily planked carts of previous attempts but I felt that we should go further. I felt that we should paint it.

The wood needed some form of preservative. Now we could have simply waxed the bare timbers and it would have looked very fine. Indeed it would have been beautiful with all that polished ash and oak. However I felt that this appeal was to do with our own modern aesthetic and it wouldn’t have shown off the bronze elements to their best effect. They cried out for a strong colour to throw them into relief. Woad was an option – the French still use the exhaust from woad dye-baths as a preservative and fungicide on wooden shutters and doors. Experimentation showed this to be a rather drab and weak colour. Those terrets were telling us that this vehicle should have a lavish splendour.

We know that the Ancient Britons loved colour. So-called “Celtic Art” of later centuries is a riot of vibrant hues. Chariots are known to have been ‘decorated’ objects. Continental examples include studding, ribbing and carving. The terrets needed setting off; they needed the rest of the vehicle to be consistent with their high level of decoration. So why not paint it? So we did.

A quest for suitable colours led me to Clearwell Caves in the Forest of Dean. There is evidence, in the form of stone tools, that mining for pigments had begun there as early as 4,000 years ago. The presence of different iron oxides occurring naturally in the caves has created an extraordinary spectrum of earth colours. Such colours are known as ochres and they emblazon the walls with kaleidoscopic striations of yellows, browns, reds and purples.

Ray Wright, who still mines the caves for colour today, led me on an underground search through the labyrinth of mysterious caverns. It was not an

easy journey, for I was nursing a badly sprained leg – the result of a horse falling on it some days previously – and inching through some of the tighter tunnels was especially awkward. However the discomfort well repaid the effort as we came across seam after seam of the most glorious pigments. Even in the dim artificial light, generated by the lamps on our miner's helmets, there was a richness and vibrancy to the colours. It was like mining precious stones as we chipped the pure colour from the walls and overhangs with picks.

Out in the daylight the colours didn't disappoint. We had beautiful golden yellows, rich, chocolate browns, stunning wine-coloured reds and a most exotic, imperial purple. The pigments were milled to a fine dust ready for dispersal in an appropriate medium.

We considered an oil-based paint as being the best option for protecting the wood from the elements. Linseed, from the flax plant, was widely available in the Iron Age. However we found it darkened the pigments to an extent that spoiled them and, with deadlines to meet, we were also extremely concerned about drying time. We opted for a water-based medium, with the provision that we could then seal it with wax.

In order to give the paint adhesion, tree resin (in this case gum Arabic) was dissolved in water and added to the pigment. This was ground in a mortar until all the granules had dispersed evenly. The shade could then be lightened with ground chalk, as desired. A little honey was added to keep the solution from drying out too quickly whilst working.

Artist and prop-maker, Sally Pack, mixed a wide variety of shades to produce a diverse palette from which to select the final colours. By their very nature of being earth pigments, all the colours and shades harmonised and were naturally complimentary to each other. We chose a shade of the yellow ochre as the main base coat. This was relieved in places by scrolled decoration, which was expertly copied from contemporary Iron Age artefacts by Sally, and picked out in a lightened shade of purple. All the rawhide was painted in red. The gravitas of the dark purple, mixed with a little red, was used for the naves and the yoke. Against it, the glinting splendour of the terrets was shown off to its optimum effect.

Yoking Systems

We had two vital pieces of information about the yoke. Firstly, Tony Spence had managed to identify a section of the yoke, close to its union with the pole, which had left a void. He was able to take a cast of this, which revealed an intriguing contour of what appeared to be notched recesses on the underside. A plausible explanation for these swells was later discovered, when we lashed the yoke to the pole (see Gordion Knot).

Secondly he was satisfied that there had been no movement or disturbance to the artefacts in the grave and that, therefore, the five terrets that were found, lay exactly in the grave, where they would have been attached to the yoke. Terrets are rings through which the reins pass, setting the angle at which the

reins pull on the bits in the horse's mouths. In itself the discovery of five terrets was not unusual. Indeed the five terret system is particularly characteristic of British chariot finds. What perplexed us was that all five terrets were clearly mounted along the yoke in a single horizontal line.

This last was a bombshell. It had previously been assumed that the central terret, always larger than the others, was mounted on the pole, somewhere between the yoke and the body of the vehicle. With this system each of the four reins would pass through its own terret on the yoke and then the two inside reins would cross over through this. The inside reins of a driving pair always cross over, so that when you draw on the reins with one hand, both horses are being guided in the same direction. However with all five terrets being in a single line, this could not now be so. So what was the fifth terret for?

We debated a variety of theories and it wasn't until we began the horse-training programme that we settled on a solution to try. More of that later. For the moment we at least knew the spacing between the terrets. Unfortunately the yoke was detached from the pole and lying on its side, so we couldn't know exactly where it attached to the pole, although we did have a maximum measurement for the length of pole to axle. From this evidence we had to decide on exactly what system of yoking to employ.

Some writers, historians but not horsemen, refer to chariot yokes as sitting on the horse's withers. The withers are a bony protuberance which form the high point on a horse's back just over the shoulders. There is no muscle here and the area must be kept free of weight, pressure or abrasion. A yoke must sit either just in front of this point or just behind it. When in front it is called a neck-yoke, when behind, a dorsal-yoke.

The difference is subtle but important. Although both types of yoke appear to be sitting on the horse's back (not along its neck as the term neck yoke may mislead you into thinking), they require completely different harness arrangements.

Neck-yokes are found with Egyptian chariots, where examples of virtually the entire system have survived in tact as well as a host of supporting pictorial evidence. Here the neck yoke is augmented by saddle forks – inverted V's – the apex of which binds to the yoke. A broad strap passes from the base of each tine of the fork and lies across the junction of the animal's chest and throat. This is essentially to keep the forks in place, most of the draught coming from the juxtaposition of the forks with the horse's shoulders. Even so there is some tractive pressure at this point and, although this part of the horse is still fairly well muscled, neck yokes are better suited for light vehicles such as the Egyptian chariot. Having said that, it is worth noting that where there is neither concern for animal welfare nor a requirement for pace beyond a slow plod, neck yoke systems are still employed in parts of the world today for drawing small farm carts, bearing unreasonable loads.

It is worth noting here that ordnances in the Theodosian Code of 438 AD regulated the maximum permissible loads of various vehicles. The angaria, one of the largest vehicles in service for instance, was limited to a load of around 492kg. We should be careful not to consider this out of context – size of vehicle, size of horses and intended gaits etc – but it is an indication of an awareness of draught efficiency relating to load and proto-concerns about animal welfare.

Given where the breastband / throatband lies, it is desirable that it is kept in place and that the yoke does not lift it up. For this reason neck-yoked vehicles, most usually, have the wheels at the rear of the chassis, the weight of the driver and passenger, being thus forward of the axle, keep the yoke pressed down in position.

Circumstantially, we had reason to suppose that the Wetwang vehicle might have been a neck yoke system. It had a very long pole (289cm from chassis to yoke), suggesting a more forward yoking point and the axle seemed to be at the rear of the grave. Moreover the most informative contemporary illustration we had to go on, the Padua stele, appeared to have a yoke that was sited in front of the withers.

Against this was the fact that there is no evidence for saddle forks, either at this excavation or any other in Britain. Well, no conclusive evidence. There are some bronze artefacts, unearthed at Llyn Cerrig Bach, which I think require further investigation. Llyn Cerrig Bach is an Iron Age site which delivered a variety of objects, many of which can be associated with a vehicle. Among the finds were these bronze cylinders, more or less in the shape of a waisted cotton reel and a hollow centre. They resemble, almost identically, similar harness accoutrements found on Egyptian chariots. Both on surviving vehicles and in depictions, these objects sit at the point where the neck fork joins the yoke. Equivalent items also occur in depictions of neck yoke chariots from other cultures. I believe there is a clear connection between objects of this shape and size and the functioning of a neck-yoke system.

However that line of enquiry will have to wait for another day. There is no real evidence for saddle forks in Britain and even though the vehicle on the Padua stele appears to have a neck yoke, no saddle forks are discernible. It is possible that there was some form of neck-yoke system around the 3rd century BC, which didn't utilise the adjunct of saddle forks but we had no clues to work out how such a system might operate.

Besides there was the issue of animal welfare. Although our vehicle was by no means heavy (c 200kg), it was certainly more substantial than an Egyptian model. Previous experiments with neck-yokes, which though they have had no deleterious effects on the horses, have nevertheless, used saddle forks and very lightweight chariots over even ground. To have used neck-yokes without saddle forks, with our slightly heavier vehicle, laden with two occupants and using the very small ponies that we did, would have risked causing the horses discomfort. It was therefore decided that we should use a dorsal yoke.

A dorsal-yoke is held in place by a girth, passing under the horse's belly. It is not dependent on the weight of the pole bearing down. The great advantage of this is that it allows the axle to be moved forward and, thereby, the weight of the vehicle to be balanced and lifted off the horse's backs. Our other reason for opting for a dorsal yoke was that there was some clear evidence on which to model one. What appears to be a dorsal yoke had survived, in remarkable condition, from the La Tene period excavation at Lake Neuchatel. On this example the yoke arches were very broad, offering a comfortable dispersal of the load on the ponies' backs.

The Yoke

Lake Neuchatel lies in the cradle of the Swiss Alps near Fribourg at a point of crossing between the Rhine and Rhone valleys. It was at the heart of the iron-age culture known as La Tene (c 500BC – 0BC). In the 1870's, the eastern end of the lake dried out and horde after horde of precious objects were discovered there. Stylistically distinctive these and later finds have characterised what is known as La Tene art.

Among them was a yoke and horse skeletons were found with it in the grave, so we know that it was intended for equine use. It is unique in this respect and has a number of features suggesting practical function, which were of interest to interpret. There were slots for the terrets, a distinctively shaped topside and pommels at each end.

Robert carved us a copy of this yoke, taking account of measurements from our ponies, out of a beautifully grained piece of ash. It was a masterpiece, a sculpture with elaborate and elegant contours.

The next question was how to affix it to the pole. Perhaps the plaster cast of that little section of the Wetwang yoke, with its seemingly notched underside, held a clue.

The Gordian Knot

It seemed obvious that however we did it, some form of lashing would be involved. Here we were reminded of the Gordian Knot. The Gordian Knot was the fabled knot securing the yoke to the pole of the royal chariot of the Kings of Phrygia. It sat in the acropolis of the town of Gordium (in modern day Turkey). The prophecy was that whosoever should loose the knot should become lord of Asia. The puzzle was supposedly so intractable because it was a form of Turk's Head knot, in which you can see neither the beginning nor the end of the tying.

Legend has it that Alexander smote it with his sword and so fulfilled the prophecy. That is according to later Roman writers. However two of them, Arrian and Plutarch give credit in their stories to an earlier account by Aristobulus, who was a contemporary of Alexander. According to Aristobulus, Alexander " undid it very easily, by simply taking out the so called "hestor" or

pin of the wagon-pole, by which the yoke fastening was held together, and then drawing away the yoke."

I had seen other evidence for a pole-pin – in Britain. When visiting Cardiff to inspect the Llyn Cerrig Bach artefacts, I was shown the pole-sheath from that find. It is currently in conservation and therefore not on public display. The pole-sheathe is a metal sleeve, which sits over the end of the pole, strengthening it at the point of its intersection with the yoke. No pole-sheathe was found at Wetwang, although another East Yorkshire site – the Charioteer's Barrow at Arras – can boast of one. Both the Welsh and the Yorkshire sheathes have delightful upsweeping curves, suggesting a characteristic shaping here, presumably to frustrate the lashings from slipping forward. Both of them also have apertures, consistent with the use of a pole-pin.

So it was that I persuaded Robert to make us a hestor, even though he remains convinced that it is not necessary. He believes that the central terret can fulfil the function of a fixing point alone. And, of course, he may be right. He generally is about these sorts of things. I, however, still think there is a strong case for it.

Richard selected a fine hemp fibre cord to tie the knot with, mindful of my injunctions that it should have some decorative qualities. He felt that he could do a neater job with this than with rawhide. I had visions of a continuous tradition of "Celtic" knotwork , as proliferated in stone carvings and later manuscript art, mirroring the interwoven intricacies of the knot at Gordium. Richard showed me some of his knot-tying pattern books and I was very struck at how the expanded patterns for some knots evoked precisely the sort of knotwork one encounters in "Celtic" art.

Prioritising practical function, Richard took turns around yoke, pole and hestor this way and that, ending up with a most pleasing ravel of twine to which he added decorative Turk's Head knots fore and aft. The stepped configuration of these lashings might well account for what appeared to be the notched contour revealed by the plaster cast of this central section of the yoke. The swells of rope, creating a solid and distinctive outline and dense mass of matter, are just as likely to have left a void in the ground where they decomposed, as would have been created by the yoke itself being shaped in this way.

The hestor was a tapered peg and so it could now be used to tighten up the knot and hold everything securely together. A few taps with a mallet and the hestor was wedged tightly home, bringing the cords under tension. It also served the rather important function of stopping the whole thing from pulling off the end of the pole.

The Pole

A small section of the pole, towards the yoke end, had also left a discernable void in the grave. Conservation on the tyres further revealed an organic band,

indicating where they touched the pole and confirming that they were laid on top of it. These clues, combined with the shape of the floor of the grave and the possibility that some of the larger pieces of stone in the grave may have been supports for the pole, were taken together by Stephen Crummy at the British Museum and were the basis for his “best fit” computer 3-D reconstruction. This gave us the angle of elevation of the pole and thus an approximate size for the ponies. They were around 11 hands!

Iron Age equines were certainly much smaller than modern day horse breeds. It has taken over two millennia to get the “genetically modified” diversity of horses that we have today. During the Iron Age they were essentially using wild, native breed stock. Although probably selectively bred for temperament and other qualities, significant changes to the overall size of the species had not yet been effected.

Riding horses of the period would more likely to have been around 13 hands and a size range of ponies between 11 and 13 hands is consistent with the evidence of horse remains from Iron Age sites throughout Europe. Although very small, we were confident that a pair of 11 hand ponies would be adequate to pull a chariot of this size; how effectively was the point of the exercise.

The size of the ponies had a significant bearing on the design of the pole. Hitherto it has been conventional to represent the pole of an Iron Age chariot with a “dog’s leg” bend at the vehicle end. This allows the pole to step up from the height of the platform to the height of the horse’s backs. There is no evidence for such a bend and it presumes a need that is only there if larger horses are used. Robert was able to avoid both the technical and stylistic conundrums of serpentine bends by shaping the pole in a continuous curve. The diameter of the wheels was a known factor and thus the height of the axle, to which the pole adjoined. With 11 hand ponies, all that was required was a most gentle upward curve of the pole and the necessary elevation was achieved.

The length of the pole was another matter. We had opted for a dorsal-yoke system, partly because the ponies were so small and we were sensitive about the weight bearing requirements of a neck-yoke. Now a dorsal yoke system requires quite a lot less length of pole than a neck-yoke system, so there was a consequence to our decision. Also, with the dorsal-yoke system we were going to bring the axle forward to balance the vehicle. Because the pole joins the axle, it too moves forward when the axle does and so again, you need less length of pole.

Assuming that the pole remained attached to the axle when it was placed in the grave, then it extended from the very rear of the pit to in front of the yoke line. If that was so, then it was a very long pole and almost certainly indicative of a rear axle, neck-yokes and possibly of larger (therefore longer) ponies.

We therefore had to ignore the suggested evidence for the length of the pole. We made one to fit the circumstances of our axle position, the length of our

ponies and the choice of dorsal-yoke. In all other respects we adhered to the dimensions of the grave find, without any intentional deviation. In the matter of the pole, however, we did not.

Training the Ponies

The Chinese developed shaft harnessing in the 2nd century AD and then the rigid collar in the 5th century AD. These are the systems for driving horses that are still in use today. Driving horses under a yoke is a very different matter altogether!

An essential element of the driving collar is that it has straps attached to it, called traces, which extend back to attach to the vehicle body. It is by means of these traces that the vehicle is pulled along. Traces give traction. Incidental to this is the fact that traces, like shafts, also have the effect of keeping the horses' hindquarters in. In a yoke system there is nothing to stop them swinging out.

I had first hand experience of this a few years ago in Egypt. A replica of Tutankhamun's chariot had been reconstructed and I had gone out there to test its effectiveness as a mobile platform for an archer. This was for a documentary about the horse in war. The Egyptians had sourced two driving horses for us but they had not trained them to drive under a yoke. The result was that their hindquarters swung out and the whole yoking system nearly broke apart on our first attempts. We only had a day to get something working, so at anything other than a sedate walk, we had to compromise by attaching false traces.

We knew that getting the horses properly trained was key to the experiment, so we went to see Tony Smart. Tony trains horses for films and T.V. He has rearing horses, falling horses, horses that play dead and horses that knock doors down. He understands horses.

As suggested by the angle of elevation of the pole, we needed ponies of just 11 hands. Tony already had one, Fudge, a Dartmoor cross. She was soon joined by another called Nugget, a Section A Welsh pony, who stood about an inch taller. The fact that we ended up with a rig that worked is in no small measure owing to the fact that the ponies underwent a prolonged training programme.

Tony got them used to working alongside each other by long-reining them and then, to get them accustomed to driving under a yoke, he made some conversions to a modern exercise cart. The shafts were exchanged for a pole and a tubular steel yoke was attached. With some makeshift harness and thick padding beneath the yoke, this was enough to get them going, while waiting for the actual chariot and harness to be made.

At first they were driven in the exercise cart using false traces – that is ropes passing from the yoke to the cart. Unlike actual traces these had no function in pulling the vehicle but they did substitute for the second function of

preventing the hindquarters from swinging out. Only when Tony was satisfied that the ponies were adjusted to the harness and running straight were the false traces removed.

Another aid that was incorporated in the training was a strap that joined the girth straps of the two ponies. This helped to keep them together at a point immediately under the yoke. It was critical that they didn't move apart at this juncture. If they had it would have changed the horizontal position of the yoke on their backs and caused them discomfort. This small aid was retained throughout the training and the trials.

The training progressed with encouraging results, although the ponies had a tendency to lean and were not standing up straight and pulling as efficiently as they might. Tony had an idea to correct this. It was an idea that offered us a plausible solution to an enigma that had been troubling us from the start.

Terrets

You will remember that there were five terrets found in the grave and that what perplexed us was that all five terrets were clearly mounted along the yoke in a single horizontal line. Two horses only require four reins and so what was the fifth terret for?

Was it simply a device to assist with the lashing of yoke to pole? It is certainly possible. Was it purely ornamental? There is good reason to believe this also. The Ancient Egyptians had the symbol of Horus, the sun god, mounted on the centre of their yoke and modern "chariots" still embody this tradition, such as the silver lady on the bonnet of a Rolls Royce.

Yet another theory was that it indicated the capacity of the vehicle to be drawn by four horses. Four horse chariots, known as quadrigas, occur in Greece, Rome and China. With these systems, only the two centre horses are under the yoke. The outspanners are simply rigged in with leather harness. Five terrets sit on the yoke and the two outer horses each have a terret mounted on a surcingle over their backs. The inside reins of the two yoke horses pass through the centre terret and the rest of the reins have a terret each.

Against this is that there is no evidence, either literary, pictorial or archaeological for four horse chariots in Britain. Only two horse-bits were found in the grave, though, of course, the fact that a vehicle has the capacity for four horses doesn't mean to say that four had to be used. It would still work with two for everyday purposes. More damning though was that the horse-bits had an additional feature. Though in every other way like a modern, single-jointed snaffle, which is what we used, the bits in the grave had a small knop on each of the outer rings. This unexplained feature – could it also have had a function? – was incised with decoration in the form of a swastika like motif. It is interesting to note that the same motif occurs on the Battersea shield and may therefore have significance in dating that other magnificent item. For our purposes, though, the presence of ornamentation suggested

that this element of the bit would have been on show, which it would not have been if flanked by two other horses.

Bearing Rein

And so to Tony Smart's discovery. An essential element in keeping the horses straight under the yoke was to keep the carriage of their heads up. If a horse drops its head as it turns, there is a tendency for the hindquarters to swing out. The bearing of the horse has a significant impact on the way it moves.

A similar, though not quite the same, effect can be seen in bipeds. Stand, facing forward with your head up. Keep your head up and look behind you. You will remain standing up straight. Now drop your chin to your chest and look behind you. You will probably find that your hindquarters swing out!

If the ponies hindquarters swing out it is a disaster. Instead of running straight ahead they are at an angle of up to 45° to the yoke. They are therefore pulling against each other instead of with each other. The yoke will become skewed and uncomfortable and the ponies will become agitated. They may jib and bite at each other. The strains on the yoke and its union with the pole are likely to become so severe that it all breaks apart. It is imperative that the ponies are kept straight.

Tony adjusted the carriage of the ponies' heads by attaching what is known as a "bearing rein". It fixes from the inside ring of one pony's bit, back through the centre terret and then ties on to the inside ring of the other pony's bit. Adjusting this to the optimum length, so that the bearing of the ponies is controlled, without impeding their free movement is, of course, the art of horse-mastery.

It was possible for this bearing rein to pass round only one branch of the centre terret but a neater solution was found by employing the hestor. We had debated whether to site the hestor in front of or behind the yoke. With it located behind, however, we had the option of passing the bearing rein around it, thus giving the hestor additional function. The arch of the terret prevented it from rising up and its outer branches set the angle at which it ran to the ponies' heads. It worked but is probably not the last word on the purpose of the mysterious centre terret.

The Horse Harness

One of the problems that faced the harness makers, Tonya and Miriam from Shamley Saddlery, was that we were dealing with a pre-buckle technology. This meant that everything had to be either sewn to size or, where adjustability was desirable, fastened with thongs.

The bridles were kept as simple as possible - cheek straps, a nose band and throat latch – which is all that was required to position the single jointed snaffle bits like those found in the grave. We used modern equivalents for the

bits, since there was going to be no difference in function in having replicas made and it was a way to save time and money.

It was also important that the bits were the right size for the horses' mouths, so exact replicas would not necessarily have been appropriate. By the way, the size of bits found in graves is not a sure indication of the size of the horse, as you can get small horses with wide mouths and larger horses with narrow mouths.

We used leather for the bridle and the reins. My feeling is that all the harness would probably been of rawhide. It is such a strong and serviceable material and still widely used for bridles in Spain and the Americas. Moreover the implication of the incised lines on the harness on the Padua stele is that this represents braiding. Rawhide harness is typically braided to make it more supple. Again it was a question of cost and time and by this stage in the project we needed to come up with something quickly, so decided upon oak tanned leather.

Tanned leather would have been available to 4th century Britons. An Iron Age shield of moulded leather was found in a bog at Clonbrin, County Longford in Eire, for example, and the very word tanning stems from the old Celtic word tan, which means oak. Other processes such as curing the skin by rubbing it with animal brains to retard putrefaction and increase flexibility may also have been known. Only time will tell how long the dried rawhide that we used for the lashings on the vehicle, will last in a pristine state. It certainly seems very stable in its fully dried state and the hope is that our painting of it will have further sealed it against damp.

The Yoke Harness

Similarly, tanned leather was used for the yoke harness. Again it is my belief that this probably should have been rawhide. There were four main elements to the yoke harness – pads, surcingles, breast-bands and cruppers. The principal function of this harness was to keep the yoke in place. The breast-band, of course, also assisted with draught.

The pads, which cushion the weight of the yoke on the ponies' backs and prevent chafing, were made with stout leather and backed with sheepskin. Sandwiched in between was a thick piece of felt. Originally it may have been stuffed with horsehair. The pads were made quite a bit broader than the yoke in order to resolve another puzzle - how to attach the terrets to the yoke and how to attach the yoke to the pads?

The yoke from Lake Neuchatel, on which we had based our reconstruction, had slots in it where the terrets sat. Conservation of the Wetwang terrets revealed traces of organic material on the un-bronzed, iron bar at their base. This indicated that a leather strap passed over this bar and that the whole was then pulled down through the slot. The question was, what then happened to the ends of the leather straps?

I experimented in my shed with bits of wood and leather until I hit upon the idea of bifurcating the straps fore and aft, cutting a keyhole slot at their extremities and attaching them to the pads by means of wooden toggles. In this way both the terrets and the pads were secured to the yoke with a single and discreet fixing.

An improvement was to drive wooden wedges into the underside of the yoke slots, between the splay of the straps, and so bed the terrets firmly in their custom shaped recesses. They thus sat up proudly with just the right amount of play. In the event of the ponies bolting there could be quite a bit of strain on the terrets in trying to pull them up. A more rigid fixing could fail in such circumstances, whereas this system had a springiness and flexibility suited to the task.

We may conclude from this, as from the lashing of the main frame, that many of these constructional solutions cannot just be ascribed to the limitations of a primary technology but that they are the best solutions for the job they had to do. Strength through flexibility, like a sapling. We may wonder at the ingenuity of our Iron Age forbears.

The next challenge was how to attach the yoke to the ponies. Obviously some sort of girthing system was required but the contours of the Neuchatel yoke were hinting at something quite specific. Where the broad sections of the yoke arched over the ponies' backs it had a central ridge and at its outer edges it had a turned up lip. Together these features created channels, which seemed perfect for retaining straps of leather. So we made a surcingle, literally an over girth, which divided as it lay over the yoke and the two resulting straps sat in the gullies of the yoke contours. This held the yoke down securely onto the pads and offered an element of resistance against it twisting forward or back.

Mindful that no buckles could be used, the surcingle was done up and adjusted by means of passing one end through a slot in the other. The loose end was attached to a length of hemp cord that then tied with a cinch knot around the pommels at either end of the yoke. It was a quick and easy release system that made sense of the particular features of the yoke.

Thus secured, some of the draught is effected by the yoke acting directly on the pole. To take up the main strain of the draught and to prevent the yoke from being pulled back, a breast-band was also attached. Evidence for a breast-band is clear on the Padua stele and other depictions. As with the pads, we lined it with sheepskin to render it more comfortable for the animals.

On the inside it was joined near to the lower edge of the pad by means of sturdy thongs. How though to attach it on the outside so that it could be easily fastened/unfastened and had an element of adjustability? Fortunately more clues were at hand from the dig at Wetwang.

Strap Unions

Two strap unions had been found. They were found, one on each side, near the ends of the yoke and in front of it, towards the ponies' heads – just where we needed a fixing for the breast-band. Strap unions are commonly found in this position but the form of these was distinctive and, so far, unique among Iron Age finds. They had been cast in bronze and were studded with coral beads – on both sides. The fact that decoration occurred on both sides was especially puzzling. Surely if, as was suggested by its shape, it was for joining two straps then this double faceted decoration didn't make sense. One side would be hidden and possibly rub against the animal's side.

Before addressing this problem I should mention that a third strap union was also found, lying on the floor of the grave beneath the lady's knee. It was of a familiar type, as seen in several other excavations and had no decoration on its reverse side.

If it had been one of a pair, then we might have assumed that it had something to do with the harness, perhaps gathering together the loose ends of each pair of reins, but it was not, it existed in the grave on its own. This is curious. There is no doubt that had another been present, it would have been detected.

The presumption, at the moment, is that it may have been part of the lady's personal accoutrements, perhaps some form of belt fastening. It seems odd though that a fastening of this type, altogether more robust than those at the yoke end and of a style usually associated with horse harness, should adorn the woman herself. It is a puzzle we shall have to leave for another day.

Meanwhile we had to apply ourselves to finding out how the strap unions at the yoke end might have functioned. Tim Blade made replicas. As soon as I showed one to Tony Smart he immediately recognised it as a form of harness fitting that is still occasionally used in Spain. It was ideal for its purpose. One end was attached, by means of a loop, to the outside edge of the pad and the other clipped on, by means of a very simple push, hook and pull procedure, to another loop fitted to the end of the breast-band.

An important advantage of this system is that it incorporated a determinable method of adjustment. The surcingles, of course, didn't need subtlety; they simply had to be pulled up tight. Whereas the breast-bands needed to be just right, neither too tight nor too loose and might well require a quick alteration after setting off. By putting twists in either or both the loops the tension on the breast-bands could be adjusted easily and effectively. A 25cm loop of 1cm diameter cord can be shortened by as much as 5cm just by putting turns in it. This gives a good degree of fine tuning and would explain why there is decoration on both sides of the strap unions – it would depend on how many turns were taken as to which side faced outwards.

It was a very quick release system. The strap union could be unhooked and the cinch knot of the surcingle untied in a matter of seconds. A team of ponies could be replaced in next to no time and certainly a great deal faster than it would take to change a team in modern harness.

All of this made sense of the clues – the position of the strap-unions in the grave, the pommels on the ends of the yoke and the channels across its top. My only reservation was that it looked untidy, which didn't seem to fit with the general economy of design and neatness elsewhere and the delicate elegance of the finely crafted strap unions seemed incongruous juxtaposed to the spaghetti of so much hemp cord. Perhaps we should have made the loops for the strap unions out of relatively thin strips of coloured rawhide. It is difficult to see what, other than hemp cord, we could have used to tie off the surcingle. A rawhide thong would have been too stiff and a leather one would surely have bound together too tightly and have been difficult to undo.

Perhaps all the harness would have appeared neater if we had coloured it the same and rendered the sheepskin backings less obtrusive by covering them with fine leather. However, by this stage, we had run out of time and the day had come to put the ponies to the chariot. After walking them up and down Tony's yard a couple of times, it became immediately apparent that we needed crupper straps.

Backing Element

Once in motion, how do you stop the vehicle from running forward, when the ponies either slow down or stop. This is called the backing element. The theory had been that the surcingled yoke would have taken all the strain. In practice, however, even just walking down the yard, we found that the yoke moved and rode up in front of the withers, when the ponies stopped. At speed this would have threatened discomfort to the ponies, loss of control and strains on the yoke, which could have caused it to break. It was imperative that the yoke stayed in its fixed position.

Modern carriages have brakes and harness systems with elaborate breeching to deal with this. The old neck yoke system, as used by the Egyptians, had a most ingenious answer to the problem. Here the yoke was kept in place, just forward of the withers by weight. This was effected by having the axle mounted at the rear, so that the weight of passenger and driver pushed the yoke down onto the animal's backs. Attached to the yoke were wooden forks, which sat over the ponies' shoulders and into which they leant to provide traction. A loose leather strap passed from the base of one tine, under the horse's belly, to the base of the other. It was a loose strap, not a tight girth. When the vehicle slowed or stopped it pushed forward on the yoke, which in turn changed the angle of the forks so that they pulled this loose strap tight under the belly. In this way the chariot was brought to a halt.

All this is well and good but didn't apply in our case, since we were using a dorsal yoke. How could we anchor this in position? We had to have something to stop the vehicle pushing the yoke forward and so opted for cruppers. That is leather straps, which have a soft loop at one end that slips over the pony's tail and sits in place at its base. The opposite end passes under the yoke, then comes back on itself over the yoke and ties off with a thong and hole

system, which allows it to be adjustable. These crupper straps arrest any forward movement of the yoke.

Cruppers are not evident from contemporary illustrations but then the one that is clearest with regard to harness, the Padua stele, seems like it is representing some form of neck yoke system, which wouldn't require one. Moreover, lying where they do, along the top of the animals' backs, cruppers would not necessarily be evident in depictions. We found that cruppers were a practical necessity and that they worked. It may be that should any evidence for cruppers become apparent in the future, it may be taken as an indication of a dorsal yoke system.

The First Trial Run

In order to get on with the first trial run at Tony's yard, we improvised with modern cruppers and took the chariot into his field. The ponies seemed comfortable with it at first, laden with just a driver but as soon as it was boarded by a passenger, it became clear that there was too much weight bearing down on the yoke. The ponies dropped their heads, which prevented them from going on as well as they might.

To compensate for this we kept our weight as far back as possible on the platform. This caused further problems. Although I could stand securely on the platform when driving alone, I found that there was not enough room to do so as a passenger. In order to stand and keep one's balance it is necessary to spread the legs fairly wide and flex the knees. It is a very small platform and with Tony, as driver, sitting his weight back over the axle, there just wasn't the space to allow this. We obviously had to move the axle forward. So after just ten or fifteen minutes of trying it out, we, frustratingly, had to call it a day.

I stripped off the lashings, securing the axle and the axle pillows, and put them into soak for an hour or so. The next day Richard Hopkins arrived and commenced the task of lashing the axle in a more forward position – a few inches in front of the centre line. The rawhide had quickly returned to a supple, malleable form and the job was completed without any significant problems. With the axle in this new position, the chariot was so well balanced that it was possible for two people to stand on the platform and the yoke to be supported by a person, using just their index finger.

Even so, I was still concerned about the viability of standing as a passenger. By the time we had finished it was dark and there wasn't going to be another opportunity to try the chariot again until the Field Trials day proper. I therefore asked Richard to fashion me a rawhide strap, which lashed to one of the suspension arches. The next time I rode in it was going to be in front of the cameras and I was going to attempt to throw javelins. The strap seemed an obvious precautionary aid.

Construction of the Box

As well as testing the chariot with the open, strap-work platform, you may recall that it was also our intention to try it with a closed sided box with a solid floor. This was based on the evidence of the soil stain at Wetwang, which indicated solid sides, on at least three sides of the box. We cannot know if this arrangement was typical of all British chariots or peculiar to East Yorkshire, where similar evidence exists at the other excavated sites.

The interest lay in comparing the sort of ride we would get with a sprung floor and a solid floor. Was the strap and arch arrangement of the suspension system sufficient in its own right or was the sprung floor an essential component for the vehicle to travel over rough ground at speed? But first we had to build it.

Robert cleft some fine oak boards for the job, splitting it so that its medullary rays showed as a beautiful decorative grain on the panel faces. The boards were just 1cm thick in order to maintain lightness. How though, should the structure be joined? We wanted to avoid the heavy carpentry and 19th century joinery techniques embodied in the 1946 reconstruction of the Llyn Cerrig Bach chariot in Wales and metal brackets were definitely out of the question

Our clues came from Bronze and Iron Age timber house structures in Eastern Europe. Here archaeologists have found the remains of wall corners where the board walls have been slotted into grooves cut into upright posts. Robert turned four uprights, their form influenced by bronze finials occurring on Continental wagon finds, and cut grooves into them. These and the floorboards were set into an ash frame. Then the sideboards were slotted into the grooves. The whole was sewn together with rawhide lacing.

There was ambivalence about whether there should be three or four sides. We decided to leave the front open, since this would allow maximum freedom to hold the reins at an appropriate height and it was also the logical place for a driver, already holding the reins, to mount the vehicle. Some additional structure was required to support the front uprights and Robert augmented them with little strouters. The box was mounted on transverse spars, with swan necks that sat in the loops of the suspension straps, in the same way that the open platform did.

Although we were all delighted with the paintwork on the rest of the chariot, the swirling grain on the oak panels of the box seemed too beautiful to hide. The box was therefore waxed rather than painted, save for a scrolled motif than ran around its sides.

We now had two alternative bodies, a box and a platform that could be easily exchanged by hooking them into the suspension straps of our basic chassis. Well fairly easily. There was one more element required.

Underbraces

In order to prevent either body from swinging around too much and to minimise tipping on mounting, some form of bracing was required underneath. Another job for our knot tyer, Richard.

He devised a criss-cross system of eye-spliced ropes, attached to the main frame by means of rawhide cuffs. Each diagonal of the four underbraces passed through a loop fitted to the underside of the transverse spars that supported both the platform and the box and then tied off, via the eye-splice of its opposite number. This system also allowed the tension to be adjusted. It may sound a little complicated and, lying on one's back beneath the chariot, trying to work out which end went through which loop, it was.

Field Trials Day

The Field Trials took place on November 2nd. Owing to delays and setbacks, our schedule had been revised on several occasions. This was our last chance as the following day one of the ponies, Nugget, was off to rehearsals for a production of Cinderella that she would be appearing in. Mercifully it was a glorious day. Crisp and bright, with a diffused early morning mist, the light dappled through the autumnal colours of the trees. Colours that harmonised splendidly with the soft earth hues of our chariot.

The terrain was grassland with the going medium to soft. It was essentially flat country with a few slight gradients. The grass was long and the surface was fairly rutted and bumpy, with some quite severe hollows on some of the tracks.

I began by standing on the platform to drive. Until I had tested the suspension on this terrain, I couldn't be sure that it would work sitting down. By standing I, at least, had my legs for springs. It was a smoother ride than I had imagined possible. I tried it at walk, trot and canter. There were no problems and the ponies went on beautifully, keeping straight and going off on the same leg.

Next I tried sitting down. On evidence from Roman coins and the Padua stele, it seemed that it was common practice for the driver to sit. I sat at a slight diagonal, with my right shoulder leant against the right forward arch and a foot braced against the upright of the opposite arch. It was extremely comfortable and secure. The strap-work platform eased the ride considerably and I could actually see the Y straps doing their work, their forks oscillating in and out as they absorbed the jolts. This was very exciting.

Another factor that had been a concern with regard to sitting down was the ability to see where one was going. I had a clear view and this confirmed the rightness of using 11 hand ponies. If they had been a couple of inches taller, then vision would have been a problem. Besides as soon as we saw them harnessed to the rig, we knew that this decision had been correct. They were in proportion to the vehicle. Larger horses would have looked wrong. Our little ponies worked tirelessly throughout a long day and were still full of go at the end.

My first passenger was Julian Richards, the presenter of the Meet The Ancestors series for which this programme was being made. The ponies made no protest at this extra weight, proof that re-balancing the vehicle by moving the axle forward had been a wise decision, and we cantered up and down an extremely rutted track several times for the cameras. Julian even managed to stand up for a little way, hanging on to the strap, which Richard had provided. The suspension system was proving of extraordinary merit.

This was followed by interviews and posing for still photographs, while the ponies had a rest and then we were off for more driving. This time I was dressed as an Ancient Briton, complete with comedy wig, for the reconstruction sequences. My friend, the actress Liz Keats, rode as the passenger in the guise of the lady who had been buried with the chariot at Wetwang.

We walked, trotted, cantered and galloped over quite rough ground, that included a few alarming pot-holes. The chariot continued to perform brilliantly. After a while, though, I felt the need to shift position, simply for a change and so that I didn't get too stiff. A foot naturally found its way to resting on the pole. This recalled an idea we had had earlier but hadn't put into practice.

The Newbridge Chariot – a tangent

At about the same time as the vehicle at Wetwang was being excavated, another chariot burial cropped up. This one was at Newbridge on the outskirts of Edinburgh. At the time of writing we are still awaiting conservation of the soil blocks that were lifted and who knows what secrets they have to reveal. However I was fortunate enough to visit the excavation site at the time. The archaeologists, led by Stephen Carter of Headland Archaeology, had scraped away to reveal the original cut of the grave. Unlike other chariot burials, where the vehicle is dismantled to be placed in the grave, this one, seemingly, had been interred intact.

The cut of the grave followed the contours of the vehicle with immaculate precision and what I saw on my visit was like a life-size jelly mould of an Iron Age chariot. Its proportions were very similar to Wetwang but of particular interest was the cut in the ground just in front of the main body. It came forward in a V shape.

A number of Continental wagons have a pole which divides and comes back beneath the body as two struts, forming, with the axle, an A frame support. It might have been something like this. Then again it could have simply been two supporting wooden struts extending from the front of the body to the pole. How I longed for such as these to rest my feet on. They would have been perfect because I could have braced against them, whereas the pole wasn't really suitable. It was at the wrong angle and, at speed, one's foot slipped off.

There was certainly space between the front of the vehicle and the rear of the ponies. Their hocks had plenty of clearance and, provided that it was at a very shallow angle, such a support would not have got in their way. Even if not of

wood, a similar device from either rope or rawhide would certainly have been a benefit in giving a more variable driving position for sustained periods.

Back to the Field Trials

After lunch it was time to throw some javelins. We weren't making any presumptions about the original intended function of the Wetwang vehicle, but our interchangeable platform system gave us the option to test its potential as a battlefield weapon.

Julius Caesar in his Gallic Wars wrote of British chariotry " they begin by driving all over the field and hurling their javelins". Now, admittedly, Caesar was writing a few hundred years later than when the Wetwang chariot was built but it seems reasonable to suppose that what he encountered was the perpetuation of an established martial tradition. Chariots were used in this way on the Continent at the Battle of Telamon in 225 BC. On this occasion some sources suggest that there were as many as 20,000 combined forces of cavalry and chariots.

Hector Cole had forged me three fine javelin heads and I had fashioned their tapering shafts and a form of quiver, which strapped to the side of the chariot. A thong at the mouth of the quiver pulled it tight, to prevent the javelins rattling too much when in motion but it pulled loose in an instant to ready them for withdrawal. Ian Potts had drawn some Asterix-like Romans onto cardboard targets, which we staked out at 10 metre intervals. Tony Smart drove the chariot and we were set to go.

Tony drove the chariot at a fast canter about 12 metres distant from the line of Romans and, to my great delight, I hit every target. We repeated the run several times. Obviously when throwing a javelin with intent to kill, it needs to be thrown with full force. This is where the strap handhold, Richard had made for me, came into its own. I found it invaluable in stabilizing after hefty throw. Although it may be that with sufficient practice (I had had none) one might be able to dispense with this aid. I had more than enough time to draw my next javelin and prepare the throw. I could certainly have managed a line of closer spaced Romans.

Our next test was also based on an extract from Caesar. "They jump down from the chariots and engage on foot. In the meantime their charioteers retire a short distance from the battle and place their chariots in such a position that their masters, if hard pressed by numbers, have an easy means of retreat to their own lines." In other words it was used as a kind of battlefield taxi. How easy would this be? Clearly the situation in which a warrior had to be rescued meant that he was in the thick of the fighting and a chariot could hardly draw up and stop to allow him to climb aboard. It must be done on the move. Furthermore he would be encumbered with his weapon, a long spear or sword and his massive shield.

We set the scene with me talking to camera and armed with sword and shield. On a signal Tony set off, wheeled around and came cantering past. It was

rather like catching an old fashioned London bus. I passed my sword into my left hand, which also held the shield grip and reached for the suspension arch as a handhold. It was quite a step up, although the rear cross member of the main frame offered a convenient footplate and, once you have the handhold, momentum is generated which helps you spring aboard. The instant Tony felt my weight connect, he accelerated the ponies and we sped away at a gallop.

It was natural to remain in the crouch as we changed pace – there was no point in trying to stand – and I was simultaneously able to stow the shield. Its oblong curve sat, as if made to measure, on the necks of the transverse spars, which supported the platform and hooked it into the Y straps. This wasn't premeditated; it is just where it went naturally and is exactly where we see it on the Padua stele, with its distinctive central boss and axial extensions. There is tremendous satisfaction, a resonance, when one chances, in action, on an image that recalls exactly that which one has seen in a primary source.

This exercise also gave us the bonus of witnessing Tony's superb driving skills. When he wheeled around behind me, he did so at the canter and with a very tight turn. It exemplified the astonishing stability and manoeuvrability of this magnificent vehicle and endorsed Caesar's observation that the Ancient Britons were "able to control the horses at full gallop and check and turn them in a moment."

Running the Pole

Another extract from Caesar's account of chariot warfare in Britain states "they run along the chariot pole, stand on the yoke and get back into the chariot as quick as lightning".

It had been my hope that I would get to try this. I felt reasonably confident about standing astride, one foot on either pony's back, though running the pole did appear to present some awkward problems. The reins, crossing over to the driver's hands were in the way and as one put one's weight forward along the pole it would increase the load on the yoke significantly. The ponies were likely to react violently to this and, with their unfettered hindquarters, liable to kick up. Training and practice could possibly have circumvented some of these problems but the fact of the matter was Tony felt that I was too heavy to try it on such small ponies.

His larger horses are trained to accept a rider standing on their backs in the manner of the "Roman ride", so it wasn't a question of not thinking such a trick possible, simply a question of animal welfare. So although a little disappointed, I felt that the decision was right. That is not to say that it wasn't done, I'm sure it was. It merely indicates that their ponies were trained over a long period to accept this and that they did not have the same level of animal welfare concerns that we, quite rightly, have today.

It does of course beg the question as to why did they do it? The commonly accepted presumption is that it was an act of bravado. A display of prowess to intimidate the enemy. Chariots, as well as having a function as mobile missile

platforms and battlefield taxis were also powerful instruments of psychological warfare.

Psychological warfare played a big part in the “Celtic” mindset. Warriors would coat their hair with a paste of lime and water, turning it white and enabling them to draw it up in spikes – the original punk rockers? It made them look very fierce, exaggerating and imitating the fight or flight aggression display typified by a dog’s hackles rising on its back. This, together with the practice of painting themselves blue with woad, gave them the appearance, not of men, but of strange and terrifying beasts.

Their hero culture promoted the cult of individual prowess and individual valour, so very different from the team unity of the Roman war machine. Individual warriors disported themselves before a battle with taunts, challenges and acrobatic displays. Running the pole was but one example of this.

Chariots make a great deal of noise. The wheels, with their iron tyres, clatter and rumble, especially over stony ground. There is the pounding of the horses’ hooves and there is the loud creak of wood and leather. It is the creak of giant trees groaning in a storm. The creak is a wonderful, mellow sound when it comes from just one chariot. Imagine five hundred chariots, that is a thousand thundering, snorting horses and a thousand rattling wheels together with five hundred lashed, wooden frames straining at their joints with a reverberating moan. This, together with the cries and howls of the warriors, would be a terrifying din. A clamorous roar to strike fear in the enemy’s heart. Moreover the chariot was a weapon of terror, a weapon of hit and run. It was also the weapon of the elite, the sign of a high status warrior. It was designed to daunt its foe. To all this we might add the chilling sight of the severed heads of enemy captives, bloody, their eyes glazed, and their features frozen in an expression of fear, which were suspended from the vehicle sides.

Livy, writing of the battle of Sentino in 295BC cites that the Romans “were terrified by a new method of warfare”. The Gauls had arrived in chariots and “great was the noise of the horses and the wheels and the Roman mounts were thrown into panic by that fearful din to which they were unaccustomed.”

Trials with the Box

I have spoken of war because it is germane to some of the tests to which we put our chariot. However I must remind the reader that we cannot assume a martial role for the vehicle in the Wetwang grave. Nor, indeed, can we totally dismiss it given its evident suitability for the task. But what of the solid sided, planked floored box that we had built as an alternative to the sprung floor platform. How would that perform in comparison? With the winter sun threatening to draw the day to an early close, we exchanged the platform for the box. The results were unexpected.

I threw a couple of animal skins on the floor, anticipating a need for enhanced comfort and climbed aboard as a passenger with Tony driving. It was

surprisingly comfortable. The Y strap and arch suspension system was more than adequate. Perhaps the strap-work floor had been unnecessary after all. I had been expecting a much more bumpy ride but it wasn't. It was a very smooth ride.

Although the box was small, it provided sufficient space for two people to sit in. We sat diagonally one to the other. In this way we distributed the load evenly and achieved maximum legroom. This meant that the passenger sat in the corner, leaning both against one side and the rear panel of the box. For a passenger seated on the floor these relatively shallow sides were actually at a very agreeable height to lean against.

If the box were only three sided, then I am convinced that we were right in making the front the open end. The additional comfort and security of the rear panel for the passenger more than compensated for any imagined difficulty in climbing aboard. The broad cross member at the rear of the main frame, provided a perfect step and there was no impediment whatsoever to stepping from there into the rear of the box.

As to whether the front was open, I am less sure. I think it perfectly feasible that it could have been a four-sided box. Mounting from the front for the driver could have been achieved via the pole and a front panel of just 45cms would not have affected the run of the reins.

Nevertheless there are no real advantages in having a board at the front. I doubt whether it would have made much difference as a splashguard. The main frame itself sat relatively high to the ponies' hocks and most of the mud spatter went beneath the vehicle. At the gallop the occasional divot flew up but such errant clods would probably have flown over such a low defence anyway. In support of an open front, I would cite the benefit for the driver of being able to change position and angle by allowing his legs to spill forward of the main frame. The open front theory also ties in best with the soil evidence where the north front side was not quite so clearly defined, indicating that it was probably open.

Encouraged by the stability of the ride, I decided to try standing up. The sun was sinking ever faster and Ian still wanted to film me in my Ancient Briton gear driving the box with the lady aboard, who, incidentally, stepped into the rear of the box wearing a full-length dress with no apparent difficulty. I therefore only had a few moments to experience standing in the box but did so at walk, trot and canter. I would have liked longer to make a considered comparison between it and the strap-work platform but I think that there was little or no difference. I could stand up perfectly well at all gaits.

I found this astounding. Perhaps I was simply becoming more practised as the day had progressed. It is certainly not an easy thing to do on either platform or box but the point is that it could be done. The floorboards of the box were sturdy but slender; they too imparted a fair degree of pliancy and springiness. Had the strap-work platform been a complete red herring? I think the answer

has to be yes, although without it we would not have been able to make the comparison.

Summary

So that is what we did and why and how we did it. The perceptive reader will already, in his mind's eye, have made many improvements. Good. That is how it should be.

Without doubt the most significant feature of our reconstruction was the arch and Y strap suspension system. It proved itself to be extremely effective and offers a plausible explanation for the arch and Y configuration depicted on Roman coins and the Padua stele. It facilitated the ability of the driver and passenger to sit and to travel over rough country at speed, which, in turn, supports Caesar's use of the word *essedum* to describe British chariotry.

If we were right in this interpretation of a suspension arrangement, then it signals a vehicle of immense sophistication, considerably evolved from the 'standing only' chariots of the Ancient World. The "carts" of Celtic Europe have often been thought of as inferior to the prestigious and majestic conveyances of Egypt, Greece and Rome. Now this view may need to be revised. European chariots were more advanced in their design and altogether superior machines.

The great advantage of being able to sit is that, provided the suspension system allows it, you are more stable and more secure and can therefore travel over much rougher terrain without fear of mishap. Your lower centre of gravity not only assists your security but also contributes to the vehicle being more manoeuvrable. It becomes an all terrain vehicle, capable of negotiating the undulating hill country of Northern Europe and not restricted to use on the plains.

We cannot know from the evidence of the Wetwang grave if this is exactly how this particular vehicle was constructed but, if it was not like this, then it surely must have had similar features providing an equivalent function.

A new discovery, which is clear from the evidence of the grave, is the configuration of the five-terret system. All five terrets lay in a horizontal line along the top of the yoke, not, as previously believed with the central terret sited further back along the pole. The five-terret system is unique to British chariot finds and the interpretation of it has implications for our understanding of how Iron Age, British yoking systems operated. It may well be that there was a distinctly different yoking system that we have yet to comprehend.

Although what we came up with, in regard to yoke and harness, worked on a practical level, there were nonetheless some contradictions, which beg further inquiry. We had to compromise on the length of the pole. If it was as long as the archaeologists believe, then we are missing something. The yoke that we used was based on one found at Lake Neuchatel in Switzerland. Would a similar one have been typical for East Yorkshire? The Neuchatel yoke didn't

have a provision for the central terret; we modified our replica for that purpose. There must be a tidier way to attach surcingle and breast-band and what about the role of the hestor and the bearing rein?

I think that the bearing rein has been an important and valid discovery. Of course the rig would basically work without it but it delivers an improved performance from the ponies and gives a credible, practical function to that central terret. I find it hard to believe that the central terret was just for decoration or simply a lashing point for yoke and pole. Everything else we have discovered indicates objects of a purposeful design.

Working in conjunction with that central terret was the hestor. It provided a convenient pillar for the bearing rein to pass behind, tightened up the Gordian Knot and was a fixing point for the yoke. On the very last run of the day, it broke. We had noticed that it had worked loose a little earlier and, in haste, had thumped it back again by fist. This was obviously insufficient and, in working loose again, it had broken. This told me two things.

The first was that it was providing a useful function. To break it must have had strains upon it. Without it, therefore, there would have been every possibility that the yoke and lashing could have worked their way the few inches to the tip of the pole and come adrift. Unless there is a vertical peg passing through the pole to anchor the fixing, the yoke and pole must be joined with a fairly substantial recessed joint. We have no evidence for this, though we do have evidence for the existence of pole-pins.

Secondly our fractured hestor indicated that its design was not quite right. Aesthetically it stood out too much, eclipsing the splendour of the central terret and distorting the proportions of the line of the yoke. It needed to have been far more discreet. There would have been no difference in function if it had stood no taller than the apex of the terret. As for strength, I suspect that its diameter was about right and consistent with the size of the opening on the Llyn Cerrig Bach pole sheath.

However this latter was an oval hole and we had used a tapered cylindrical peg. If our peg had been of oval section, it would have had greater resistance to snapping and would have been much less likely to work loose. Moreover with an oblong section peg, it would be an easy matter to drill a small hole in the end that protruded below the lashings and secure this with a wooden pin or thong to prevent it from lifting. Intriguingly there is just such a peg among the finds from Glastonbury Lake Village. There is nothing to link it with a vehicle but it is oval in section, tapering and is perforated with slot shaped hole at the narrow end. At its top end there is a smaller, oval hole at right angles to the slot. Out of context such a peg may interpreted as having a variety of functions, but I think it would make a jolly useful pole-pin.

Robert's solution for securing the lynchpins seemed to me to work very well but we must acknowledge that there are reservations in academic circles as to exactly how they fitted. Conservation work on the lynchpins still continues

and may yet throw up further clues. We have a working solution but the quest goes on to find an alternative arrangement.

Despite my minor reservations about details of the harness, I think we demonstrated how well a team of ponies are able to go on under a simple yoke system, provided that they have been properly trained. It is technically much more difficult to drive such a pair, without the 'modern' paraphernalia of collars and traces, but there is no actual limitation on what can be done. They can be driven at all gaits and turned at very tight angles. The horsepower of 11 hand ponies proved more than adequate for the task and were capable of a decent turn of speed. Such a team would have the tractive power to pull around a ton, although there is quite a severe limit as to how much weight they could comfortably bear on their backs.

Limitations of budget and time meant that we only had one day for field trials. There is so much more to be tested. Now that our chariot has proved its worth on reasonably rough ground, we need to test it on even harsher terrain, to take it to the hills and see how it performs on steep inclines. Caesar again: " even on a steep incline they are able to control the horses at full gallop". We need more driving time with the box in order to evaluate it fully and to experiment with some slight changes to the harness system. We could have facsimiles of the horse-bits made up. J.D. Hill describes them as the finest so far discovered. What of that finial on the outside of the bit rings? Was it purely decorative or, with replicas to experiment with, might we deduce a function for it? The "Meet The Ancestors" chariot now exists, so hopefully money can be found in the future and the work can go on.

Was it a chariot?

And so finally we return to the question posed at the beginning. Was it a chariot?

There is a natural reticence on the part of academics who feel that the word chariot automatically connotes a use in war. Such an association, coupled with the fact that there was a female skeleton found in the Wetwang grave, immediately conjures up images of Boudica, who lived some four hundred years later. Certainly Boudica, like her contemporary Queen Cartimandua, was in a tradition of strong female leaders and, given the status of her burial, it seems most likely that the lady of Wetwang was of royal or noble birth. But here the connection stops. There is no direct evidence to associate the lady in the Wetwang grave with war. No weapons were found in the grave.

On the other hand the vehicle find at nearby Kirkburn had a magnificent mail shirt adorning the corpse. We may therefore assume that this was the grave of a warrior. The vehicle was of similar dimensions to that at Wetwang and similar vehicle finds elsewhere have also revealed martial accoutrements in the grave – swords, spears, shields etc. So it is not wholly unreasonable to associate a vehicle of this size and type with military activity. Our field trials with the reconstruction prove that a vehicle of these dimensions and

proportions was ideally suited to the kinds of battlefield manoeuvres and applications described by Caesar in his Gallic Wars.

The important thing here is to establish the vehicle type without making unsupported assumptions about the role of its female incumbent, although if she were a Queen or leader, it is not so very far fetched to imagine that she travelled or paraded in the type of vehicle that might be pressed into service on the battlefield. That doesn't make her a warrior, just a leader.

But what of the evidence for a solid sided box? Doesn't this suggest that we might more properly describe the vehicle as a cart or carriage? Our field trials suggest that there is nothing that could be done on an open sided platform that could not have been achieved on our three-sided box. The possible exception being the mobile rescue, although I suspect that with a little practice this could also have been achieved. The box itself is not a clear indicator as to use.

I think that we can dismiss the word cart as too lowly for such a prestigious vehicle and carriage is somehow too grandiose for something so sparely designed. Moreover the word carriage surely implies purpose made seating arrangements for the passengers. The fact that you can sit on the floor is not the same as saying that it had seats. To install raised seating, as some have suggested, would ignore the benefits of comfort and stability that stem from being able to maintain a low centre of gravity on this low platform vehicle.

If we wanted to imply that it was used only as a means of travel, and we have no more evidence for this than we do for it being used in war, we might use the word trap but this is a word more usually associated with a vehicle that is pulled by a single horse or pony.

So, of all the words available to us, I feel that chariot is the most apposite to describe this light, wide axle, low chassis, two wheeled, pair drawn vehicle. It is a word that encapsulates both its design dynamic and its elevated status. We must be cautious not to ascribe to it an implicit use in war, though, as we have seen, it is apt for the task. However chariots are chariots in other contexts too.

During the Warring States period a Chinese Emperor's status was calculated on the number of chariots he had. It was also the vehicle he paraded in, underscoring that prestige. That this was a vehicle celebrating its owner's status can be in little doubt.

Chariots were also used for racing, most notably by the Romans. Although we have no accounts or archaeological evidence for the Ancient Britons using their chariots for racing, who can doubt that they did? The vehicle that we reconstructed is a veritable racing machine. It may not have been its principal function but, throughout history, man has raced anything suited to the task.

Another use for chariots, which we see in the Ancient World, is as a mode of transport for hunting. There are the famed Assyrian bas-reliefs, now in the

British Museum, which depicts Ashurbanipal shooting lions from his chariot with a bow and there is an Egyptian wall painting, which depicts a huntsman in his chariot, going after water buffalo with a long spear. The ferocious wild boar was a principal quarry for the Ancient Britons. One cannot but help think what an eminently suitable conveyance the Iron Age chariot would make for the hunting of these beasts with spear and javelin, although, of course, this is just my fancy. There is no record of such usage.

Whatever they were used for, and they certainly had the potential for various applications, British chariots, such as that found in the grave at Wetwang, are an exciting and rewarding subject for study. The work has only begun.

POST SCRIPT

The chariot was presented to the British Museum. On the day prior to the broadcast of the programme we combined this presentation with a little publicity for the Press cameras. I drove the chariot around the BM forecourt and a picture of the chariot, with me in yet another ill-advised wig, appeared in the Times the following day.

Not only did this offer me a second opportunity to assess the chariot's performance but I was able to do so with a different team of ponies. Nugget had been sold and Fudge was lame, so we had to scout around for another pair. We found them through John Carter, a longstanding doyen of the driving world. They were both Section A Welsh cobs and were a very zippy little scurry team – a grey called Joey and a bay by the name of Freddy.

I had one afternoon to acquaint them with the chariot and they took to it remarkably well. Although used to crowds at big competitions, they were not used to the sights and sounds of an urban environment and so we thought it prudent to have some blinkers made for their bridles, even though these were slightly anachronistic.

Joey and Freddy were largely unfazed by the crowds and echoing confines of the museum forecourt, though they did become somewhat restive when required to stand still for any length of time while a small regiment of cameramen flitted and buzzed around them. It was much better to keep them on the move and I trotted and even cantered them around a very confined space, testing the chariot's turning circle to the utmost. It really is a rig in which you can turn very sharp corners indeed.

After the morning's proceedings, however, the hestor had worked loose again and there was a great deal of play in the union between yoke and pole. A few days later the strains on this union were put to an even greater test. I drove the chariot, through morning rush hour traffic, from the British Museum, along Shaftsbury Avenue, round Trafalgar Square (twice) through Admiralty Arch

and thence up the Mall. From there we went along Constitution Hill and finally around Hyde Park Corner (twice!).

The reason for this lunatic escapade was that The Evening Standard wanted to do an exclusive item on the chariot and thought that pictures of it caught up in the London traffic would be amusing and eye-catching. They sent a reporter, Harriet Arkell, to travel as my passenger. The great thing about this excursion, from the chariot team's point of view, was that it was an excellent opportunity to try out the box.

We made fast the Gordion Knot and the hestor, set the box in the suspension loops and pressed Freddie and Joey into service once more. Not only were they relatively inexperienced with this type of rig but, as rural ponies, they had never before experienced heavy traffic. Harriet was clearly, and not unreasonably, fearful but she nevertheless steeled herself and mounted the box, settling herself against the sides in a corner.

I opted to stand for the entire journey. The principal reason for this was that because Freddie and Joey were about a hand taller than Fudge and Nugget, I was unable to see so well sitting down. It was not just a question of seeing where you are going but of seeing how the reins were lying. Without traces it was essential to have exactly the right tensions on the reins in order to keep the ponies straight. I could see this better standing up.

Mindful of how Freddie and Joey would behave in the traffic, I decided to take a bold approach. One of my favourite insights into riding and horse lore comes from an incident at the Olympics in the 1950's. A show-jumping competitor's horse went lame and he was lent another horse by his hosts. For days before the event he was seen to be walking it up and down steps, into marquees, where people were holding receptions and downtown in the traffic. "what are you doing?" inquired his hosts, "don't you want to get some jumping practice in?" The competitor replied " I know he can jump, otherwise you wouldn't have lent him to me. What I need to do is get the horse to trust me, so that he'll do what I ask of him".

It seemed to me that if these ponies were green to the sights and sounds of the city and to busy traffic, then they would be frightened. But if I seemed confident to them and treated this as an everyday event then they might put their trust in me. I therefore urged them on briskly as we exited through the great iron gates of the British Museum courtyard. Fortunately there wasn't too much traffic to start with and we clattered along at a very fast trot. I must confess to running a couple of red lights, in order to keep the ponies going and give them no time to think.

By Shaftsbury Avenue the traffic was starting to build up and we did have to come to a standstill amidst impatient motorists and motorcyclists. But the ponies had started to settle and were grateful of the rest. When the lights went green and the traffic surged forward, we were able to keep pace with it by trotting on smartly and so, although we were a distraction, we were not an

obstruction. In fact cheery taxi drivers hailed us, announcing that they had seen the programme.

Although the ponies were beginning to settle to the traffic, Joey developed an aversion to man-hole covers – you wouldn't believe how many man-hole covers there are along Shaftsbury Avenue and the Haymarket! We ran a rather ziz-zag course.

And so on to Trafalgar Square. My passenger was still rather tense but managed a smile for the cameras as we passed Nelson's Column. I inquired after her comfort and she said she was finding it a surprisingly comfortable ride. Certainly I had no trouble at all in standing up all the way. The suspension straps were doing their job and I think I would, cautiously, argue that the solid box was actually a better option than the strap-work floor. I only wish we had been able to do more trials with the box on rough terrain.

As we went up the Mall it became clear that the hestor was working loose again and the yoke was starting to yaw. I stopped and knocked the hestor back in an attempt to tighten up the pole knot but its efficacy was short lived. We pressed on along Constitution Hill and onto Hyde Park Corner itself. It was the height of the rush hour. We managed the two circuits required by the photographers (they were paying for this after all) but it was with great relief that I finally drew the team to a halt just inside the gates of Hyde Park. Another circuit would have seen disaster. The knot had now worked extremely loose and there was far too much play in the yoke. The more it moved, the more it made the ponies uncomfortable and the more they agitated. The more they agitated, the looser the yoke became.

So the journey proved a triumph for the box and Robert's suspension system but signalled very clearly that any future experiments must address the fastening of the yoke to the pole. This is crucial work yet to be done.

GLOSSARY

Bearing Rein — A strap that is used to set the horse's head at a certain angle, which has an effect on how it carries itself and moves.

Body — The main part of the vehicle. Also referred to as the chassis or the main frame.

Box — A box structure, which is suspended within the frame of the body and upon which the driver and passenger ride.

Breastband — A strap which passes from one side of the yoke to the other and sits over the animal's chest. It prevents the yoke from slipping back and assists with pulling.

Crupper — A strap that passes from the yoke to the animal's hindquarters and lops over the tail. It prevents the yoke from pushing forward when the vehicle slows or stops.

Felloes — The component parts of the wheel rim.

Girth — A strap, which passes under the horse's belly and keeps the yoke in place.

Hestor — A wooden peg, also known as the pole-pin, which helps in attaching yoke to pole.

Linchpin — A peg-like device which holds the wheel securely to the axle.

Nave — The hub of a wheel. Also known as a stock.

Nave band — A metal hoop that is fixed to either end of the nave to prevent it from splitting.

Pad — A stuffed leather pad, which sits on the animal's back and cushions it against abrasion from the yoke.

Platform — A flat base with no sides. It has a springy floor of interwoven rawhide strips and can be used as an alternative to the box.

Pole — A beam that attaches the body and axle to the yoke.

Rim — The outer part of a wheel. It is composed of sections, known as felloes.

Surcingle A type of girth strap, which passes over the yoke as opposed to a normal girth, which attaches at the outside edges before passing under the animal's belly to hold it in place.

Terrets Rings, fixed to the yoke, through which the reins pass. They go from the bit in the horse's mouth, via the terrets to the driver's hands.

Traces Part of a modern driving harness. Traces attach from a rigid collar around the horse's neck at one end and to the body of the vehicle at the other. They had not been invented in the 3rd century BC.

Yoke A shaped piece of wood, joined to the pole, and which sits over the horse's backs. It links a pair of horses together and is the means by which the chariot is pulled. A dorsal yoke sits just behind the withers, whereas a neck yoke sits immediately in front of them.
