Heavy Transport in Classical Antiquity

Author(s): A. Burford

Source: *The Economic History Review*, 1960, New Series, Vol. 13, No. 1 (1960), pp. 1-18

Published by: Wiley on behalf of the Economic History Society

Stable URL: https://www.jstor.org/stable/2591403

THE
ECONOMIC HISTORY
REVIEW

SECOND SERIES, VOL. XIII, NO. 1 1960

HEAVY TRANSPORT IN CLASSICAL ANTIQUITY [1]

by A. BURFORD

I

THE question of moving heavy loads bears on some aspects of the economic structure of ancient Greek society, and on the way in which it was able to answer mechanical problems. So far this topic has been virtually untouched.

Lefebvre des Noëttes' discussion of ancient harness dismissed heavy transport as a minor issue. It was a rare activity, with little bearing on general conditions and available methods, and an inefficient one.[2] His argument, henceforth the orthodox view, has recently been restated in the *History of Technology*.[3] It maintains that the kind of harness in use in Europe until the tenth century A.D. only allowed the animal to exert a part of his total strength, so that the maximum load which could be pulled by one yoke of animals was about 1100 lb.; and that there was no practicable means known of increasing power by multiple yoking in file.[4] The argument is based on a wide range of archaeological and literary evidence. Taking together the predominance of horse-chariots in decoration, and literary evidence for low loads as a general rule, the orthodox view asserts that ancient transport was permanently hampered by people's inability to remedy a drastic impediment. This lay in the tendency of the throat-and-girth harness to ride up against the horse's windpipe, choking it as soon as it tried to exert its full strength. The harness failed to fulfil its function, which, as Lefebvre des Noëttes says, is to 'permit the complete

[1] This paper is an offshoot of a larger study, of the social and economic implications for Greek cities of building public works.

I am much indebted to Mr M. I. Finley for constant help and advice. I should also like to thank Dr J. Needham for helpful discussion, and for allowing me to quote from the forthcoming fourth volume of *Science and Civilisation in China;* and I am most grateful to Prof. M. M. Postan, Miss R. L. Cohen, Miss J. M. Reynolds, and Mr R. M. Cook, for kindly reading drafts and offering criticism.

[2] R. J. E. C. Lefebvre des Noëttes, *Le cheval de selle à travers les âges: contribution à l'histoire de l'esclavage* (Paris, 1931).

[3] II *The Mediterranean civilisations and the Middle Ages* (Oxford, 1956), ed. C. Singer, E. J. Holmyard, and T. I. Williams. See especially R. G. Goodchild, section 14, 'Roads and land-travel', and E. M. Jope, section 15, 'Vehicles and harness.'

[4] These statements are referred impartially to both horses and oxen; as for the maximum load, there is no reason to believe that either animal did or could achieve much more than this effort. But comparison with modern figures is invidious.

utilisation of the force of all the animals, so that they may work as a team'.[1] The result of this inefficiency was to reduce the power achieved to about one third of that of modern draught animals.[2]

As for multiple yoking, the evidence is scanty, and concerned with extraordinary instances; and on the strength of this Lefebvre des Noëttes declares that 'if the Greeks had known of a method of multiple yoking, other people would have been obliged to adopt it too'.[3]

These reasons are given for the lack of development: the ancient world was uninventive and not interested in improvement, and the use of slave-power rendered technological experiment unnecessary. Lefebvre des Noëttes says that slavery, 'a fatal consequence of the lack of motive power, was the bane of ancient society'.[4] In effect, heavy transport was impeded by bad harness and bad roads; and this in turn impeded the development of better roads and better harness. If there were to be any progress, then one factor must improve first. R. J. Forbes maintains that 'at each stage of technological development the availability of prime movers, such as a type of machinery which supplies motive power for other tools or machinery, is the keystone'. But there was no such development because 'manpower was always readily available in antiquity', and the reason why 'harnessed animals did not largely take over the part played by human labour' is the 'insufficient knowledge of animal anatomy, which caused the ancients to use ox-harness for donkeys, mules and horses too with disastrous effect'.[5]

Occasional doubts have been cast. Fougères questioned Lefebvre des Noëttes' summary dismissal of one piece of evidence for the use of what may be called *practical* multiple yoking.[6] And Sion criticized his selection of the literary evidence for normal maximum loads; he also suggested that transport conditions were in some ways no more backward than in the Middle Ages.[7] As for the draught-animal concerned, J. G. D. Clark remarks that the ox was more important than appears from Lefebvre des Noëttes' discussion.[8] But none of these doubts have prevailed.

II

The chief objections to the orthodox view are several. First, it ignores almost entirely, as I shall point out more fully below, the inscribed building-accounts which yield the most important evidence we have of heavy transport. And

[1] *op. cit.* Introduction.

[2] The normal maximum load of 1100 lb. is derived from two sources. One is a comment of Xen[ophon's] *Cyr(opaedia)*, VI, i 54, written in the fourth century B.C., and the other is a clause in the *Theodosian Code*, VIII, v 8, published in the fifth century A.D. The length of time between these two pieces of evidence lends colour to the idea that transport remained at the same pitch of inefficiency throughout antiquity.

[3] *op. cit.* p. 74.

[4] *op. cit.* p. 174.

[5] *Studies in ancient technology*, II (Leiden, 1955), 78 *et seq.* But if Aristotle was able to write detailed accounts of insects' anatomy in his treatise *De partibus animalium*, it looks as if some people had an interest in the subject. There must in any case have been frequent opportunities to study the carcasses of both horses and oxen.

[6] In his review of the first edition, in *Journal des savants*, CIX (1924), 321, he refers to a fourth-century inscription from Athens which records the use of large teams for moving heavy blocks of building-stone. Lefebvre des Noëttes dismisses it as being too impractical for serious consideration. The inscription is published in *Inscriptiones Graecae*, II (2nd ed.), no. 1673. Further references to this and to other inscriptions in this series will be made thus, IG ii^2 1673.

[7] *Annales d'histoire économique et sociale*, VI (1935), 628.

[8] *Prehistoric Europe; the economic base* (1952), p. 304.

secondly it does not start at the right end of the problem; one should ask, not what limitations were imposed by prevailing transport conditions, but what demands were made upon the means available, i.e. what was in fact transported. My argument runs upon these lines. First, heavy transport was undertaken much more frequently than the orthodox view maintains. Secondly, it achieved its purpose—that is to say, ancient transport though inefficient by modern standards was effective by any standard. Thirdly, draught-animals and not men provided the motive power. The orthodox view is right in maintaining that ancient harness was unsuited to the horse—but this is not relevant to a study of heavy transport because, as I shall demonstrate, the ox was the working animal, not the horse. It is also right to say that no change in method took place throughout antiquity, but to hold this up as a radical fault in the ancient system shows a basic misconception of the nature of technological development, and of the ancients' use of the methods to hand.

What transport did people require? [1]

No city was self-sufficient. All supplies, of food and materials for ship-building, house-building, and industry—such as wood, stone, wool, metal, and potter's clay—had to be brought in either from the surrounding countryside, or from overseas. Land transport was always necessary in the first case, and often so in the second, since many cities lay some miles inland from their ports. For example, Argos and Corinth are about 5 miles from the coast, and Athens is 7 miles from the Piraeus. We know too that Athens depended on corn imported from Euboea and cities on the Black Sea. Some of this was brought not to the Piraeus but to harbours on the north-east coast of Attica, and came to Athens along the Decelea road, a distance of at least 30 miles.[2] Land communications were obviously good enough, in some places at least, for freight to go considerable distances, in considerable bulk. We hear of another, more occasional kind of transport, when Diodorus mentions a consignment of 5000 suits of armour which was taken from Acragas to Syracuse.[3] This transport would all of it have been carried on by ox-cart, pack-animal, and porter (for short distances).

Heavy transport did not go on every day, but it must have been required occasionally for normal business, such as bringing heavy timbers into the ship-yards. And it was essential to one widespread activity in Greece, public works. This involved moving considerable quantities of building-stone for distances of anything up to 25 miles, and it was an activity undertaken by both large and small cities from the sixth century B.C. onwards.

The building programme of one small city alone shows that the occasions when heavy transport was necessary were not so rare as to be unique in the experience of a whole generation. At the beginning of the fourth century B.C., Epidaurus found itself involved in a long-term building scheme. The healing-cult of Asklepios had become increasingly popular towards the end of the fifth century throughout Greece, so that the Epidaurians thought it worthwhile to enlarge and enrich the sanctuary which was in their territory. We know from the building accounts that foreign workmen (e.g. Argive, Corinthian, Parian, Athenian) contracted to work there, and that various materials such as wood and stone were imported. In this place alone people had to deal

[1] Transport in general has received little attention. M. Rostovtzeff, *Social and economic history of the Hellenistic world* (Oxford, 1941), discusses it briefly, but mainly in relation to Ptolemaic Egypt, not Greece proper.

[2] Thuc[ydides], VII, xxviii 1, cf. VIII, iv.

[3] Diod[orus Siculus], XVI, ix 5.

with building problems including transport for at least a century, during which time they built five temples, a theatre, and various houses for the reception of pilgrims.

Not only was building material moved in large quantities: loads which could not be divided into units small enough for one yoke to move *were moved somehow*. The orthodox view, with the modern idea of a standard of efficiency in mind, dismisses the Greek method of increasing power as unrealistic and uneconomical. Yet the fact that a different harnessing-system was not developed shows that there was no pressing need for improvement. R. J. Forbes says that 'the keystone of technological development is the availability of prime movers' (i.e. the inventions themselves). But the keystone is, surely, the need of a new technological device, for technological development is a practical answer to some particular demand, not a mystical accident.

The orthodox view seems to gain support from a considerable weight of archaeological evidence. But first it is an ill-balanced, prejudiced selection, and secondly, it simply is not in the nature of this kind of evidence—e.g. fine-painted pottery, stone-reliefs from temple- and treasury-friezes and grave-stones, and terra-cotta and bronze models (intended for toys or votive offerings) —to give us information of industrial or heavy transport. The horse was the most decorative, and, as we shall see, the most socially acceptable animal to portray. It is from a few vases only that we know that the same harness was used on mules and donkeys. What most of the pictorial evidence tells us is that horses were harnessed with throat-and-girth harness, two or four abreast, to light, two-wheeled chariots; that they were not shod (a recognized impediment, on which both Thucydides and Xenophon remark);[1] and that this kind of harness remained unchanged until after the end of the Roman Empire. Pictorial evidence for ox-transport is almost non-existent. I know of only the Tourah relief, carved in an Egyptian quarry, which shows three yoke of oxen harnessed more or less in file in order to move a block of stone.[2]

Lefebvre des Noëttes argues from this evidence the predominant and inefficient use of the horse, the non-existence of a sensible way of harnessing in file, and the relative unimportance of the ox. Of the available literary evidence, he quotes, in the first place, Xenophon's description of the Persian Cyrus' experiment. He harnessed eight yoke of oxen to a siege-tower, and the load per yoke was reckoned at 15 talents. Xenophon quotes the normal load for one yoke at 25 talents, which is about 1100 lb., to explain his comment on the ease with which the animals moved the tower.[3] This is supposed to suggest both that multiple harnessing wasted power, and that the generally-accepted load was about one fifth of that carried by modern draught-animals. The second piece of evidence is a passage in the Theodosian Code which is supposed to corroborate Xenophon's observation. The Code, published in 438 A.D, includes edicts against abuse of the Roman Imperial services, of which one was transport. Maximum loads were prescribed for each type of cart, and for a heavy one-yoke cart it was 1500 Roman pounds, or about 1100 lb.[4]

Another piece of evidence is Diodorus' description of Alexander's funeral

[1] Thuc. VII, xxvii 5, and Xen. *The cavalry commander*, i 18, and iv 4.

[2] This evidence is very fully illustrated by Lefebvre des Noëttes, *op. cit.* See fig. 46 for the Tourah relief; oxen are shown in fig. 28, but drawing a *light* cart only.

[3] Xen. *Cyr.* VI, i 52 *et seq.*

[4] R. J. Forbes, *History of technology*, II, 514–515, interprets this passage to mean that eight animals were yoked to the vehicle; but Lefebvre des Noëttes took pains to show that it was a one-yoke cart, with eight animals following, rather on the post-horse principle, *op. cit.* p. 158.

car, which is quoted in full to prove that, because the load involved was ridiculously small in relation to the number of animals harnessed, the harness must have been inefficient. But it is ludicrous even to imagine that one could derive any useful information from the description of a purely spectacular array of beasts, in four ranks 16 abreast, pulling one coffin.[1] Finally, Vitruvius, in his book on Greek and Roman architecture, refers to an invention in the sixth century B.C. for moving heavy blocks, of a wooden frame on wheels to which two yoke of oxen were harnessed (abreast, not in file).[2]

The pictorial evidence is mostly concerned with social and military subjects.[3] The literary evidence is only interested in industrial transport in special instances, or where the evidence consists of domestic or civic records, such as the Theodosian Code or the Mycenaean Tablets.

But there is other evidence not used by Lefebvre des Noëttes. In Plutarch's life of Lycurgus, the legendary reformer of the Spartan state is said to have devalued the iron currency to such an extent that one yoke of oxen was required to move ten minae-worth. If one reckons by the so-called Pheidonian standard (i.e. the archaic ratio of iron to silver), ten minae of iron work out at about 3300 lb.[4] Cato, in his agricultural treatise, describes how an oil-mill, probably weighing about 3500 lb., was taken 25 miles by three yoke of oxen.[5] And Pliny, writing in the first century A.D., refers to a Gallic plough drawn by two or three yoke in file.[6] We also have abundant evidence for the use of the ox with the plough. Yoke of oxen were modelled in bronze and terra-cotta, rather less frequently than horses and chariots, but often enough to show that it was oxen which performed the heavy work of ploughing. This is borne out by the fact that, in collections of votive ornaments, the ox usually outnumbers the horse, and that plough-oxen even appear on gravestones of different date, suggesting that oxen were used continuously throughout antiquity for farm-work.[7]

The most important evidence of all consists of building accounts which come from all over the Greek world during a period of about three hundred years. Heavy transport is a recurring item. But this evidence is ignored by the orthodox view, which is yet further invalidated by the fact that, while there is no direct evidence for the use of manpower in transporting building material, we have it stated explicitly in these accounts that oxen were employed for this purpose.[8] The accounts are permanent records, inscribed on large stone slabs (only partly preserved), of expenses incurred in the construction of temples,

[1] XVIII, xxvi–xxvii.

[2] *De architectura*, X, ii 11–12. The question is, whether Vitruvius, writing about the time of Augustus, knew about this invention because it had been so unusual at the time and was remembered as an unique venture, or because it became so useful that the names of the inventors, Chersiphron and Metagenes, were preserved in gratitude.

[3] Some industries are depicted on pottery, notably that of the potter himself, and of metal-workers, on several Attic and Corinthian vases of the sixth and early fifth century.

[4] Plut[arch], *Lycurgus*, ix 1. It is difficult to know to what standard he refers, and what the archaic ratio of iron to silver was. In any case, both Pheidon and Lycurgus are impossible to date securely. But this figure, based on C. Seltman, *Greek coins* (1953), p. 37, must be right within 500 lb. or so, and that is accurate enough to make the point here.

[5] *De agricultura*, xxiii, 3.

[6] Pliny, *Natural history*, XVIII, 173: 'Protelis binis ternisque sic arant—they plough thus with double and triple lines of oxen'. *Protelum* can also mean 'succession', which exactly suits the idea of ploughing with two or three yoke harnessed one behind the other.

[7] There are, for example, two grave-stelai in Smyrna museum showing oxen ploughing. One is Hellenistic and the other is late Roman. I am grateful to Mr R. M. Cook for pointing them out.

[8] There is no evidence at all to suppose that in Greece or Rome there was anything compa-

fortifications and other civic amenities, Materials, the work done, and the labour employed, are listed not in columns as we know accounts but in a narrative form.[1] In some cases they give the names of the workmen employed. But the content of the inscriptions varies from place to place, and from year to year. Items are recorded in working order, and sometimes in minute detail, so that a comprehensive picture can be obtained of the problems which arose.

The earliest known accounts are Athenian and date from c. 450 B.C.; they give a very condensed summary of expenses for quarrying and transport.[2] Then the remaining fragments of the accounts for the Parthenon and the Propylea, between 448 and 432 B.C., record the treasurers' summaries of receipt of income, and of what materials and work this was spent on.[3] The Erechtheum accounts are quite different. Individual labourers are listed by name: they are skilled craftsmen, and the work, of finishing off wooden and marble ornament, is described in detail.[4] At the beginning of the fourth century there are a few brief statements of money and labour contributed towards the rebuilding of Athens' Long Walls, set into the walls themselves.[5] Then at Epidaurus we have the full record of the building of one temple, and incomplete but more detailed records of works carried on later in the century.[6] At Delphi work done year by year on the rebuilding of the Apollo temple is recorded with the minimum detail.[7] There survive from the third quarter of the fourth century at Athens very detailed records of specifications and accounts for work in the sanctuary at Eleusis and in the Piraeus.[8] There is a series of records from Delos, from about 315 to 250 B.C., covering all kinds of expenses, with no distinction between large and small items.[9] Other fourth-century accounts, like those from Epidaurus, have been found at Tegea, Nemea, Troezen, and Hermione in the Peloponnese.[10] Apart from lists of private individuals' contributions to public works, the only other building accounts come from Didyma near Miletus in Asia Minor, in the early second century B.C.[11]

Inconsistent in form and spasmodic they may be, but they provide the most direct evidence we can have of working conditions. I have already pointed out that indivisible loads too heavy for one yoke to move were moved. Blocks weighing 2, 3, or 4 tons are common-place on many building-sites, and some column-drums at Eleusis, by no means exceptionally large, weigh from $6\frac{1}{2}$ to 8 tons.[12] We know from the inscription dismissed by Lefebvre des Noëttes that

rable to a rickshaw-coolie system. Herodotus' statements about the labour employed in Egypt, e.g. the force of 100,000 men who worked in shifts to move blocks for Cheops' pyramid, must be regarded as totally irrelevant to conditions in Greece. The only positive references to the use of manpower for transport are made of the deploying of siege-engines in the field, and of pulling coaches and drays in processions.

[1] For a full discussion of the characteristics of ancient accounting, see G. de Sainte-Croix, in *Studies in the history of accounting* (1956), ed. A. C. Littleton and B. S. Yamey.

[2] IG i^2 336.

[3] IG i^2 339–352 and 363–65.

[4] IG i^2 373–4.

[5] IG ii^2 1656–1664.

[6] IG iv^2 102–120.

[7] *Fouilles de Delphes*, III, v, 19 *et seq.*

[8] IG ii^2 1665–1685.

[9] IG xi^2 142 *et seq.* The series is continued in *Inscriptions de Délos*, nos. 499–509.

[10] IG v^2 6 and IV^1 481, 823, 742.

[11] *Didyma II- die Inschriften* (Berlin, 1958), ed. A. Rehm, nos. 20–47.

[12] J. Stanier, 'The cost of the Parthenon', *Journal of Hellenic Studies*, LXXIII (1953), 68–76, reckons that the average weight of these drums, intended for the porch of the Telesterion at Eleusis, was about $7\frac{1}{4}$ tons. Measurements given by F. Noack, *Eleusis, die baugeschichtliche*

these blocks were moved a distance of 22 miles from the Pentelic quarries to Eleusis by teams of oxen, ranging in size from 19 to 37 yoke. (Lefebvre des Noëttes assumed that the column-drums only weighed 1 ton each.) Moreover, a survey of the kind of stone used in temples and other buildings shows that transport was by no means prohibitive to one's choice of material. For example, it seems likely that imported stone, possibly from Corinth, was used in the temple of Zeus at Nemea, about 20 miles inland from the Corinthian quarries. The inscriptions tell us that Corinthian stone was used in the sanctuary of Asklepios at Epidaurus; and, to reach the sanctuary, people had to take the stone first to the Corinthian port of Cenchreae, then ship it from there to Epidaurus, and carry it 7 miles inland from there to the sanctuary. It is clear from the accounts that the small towns of Hermione and Troezen, in the south of the Argolid, also imported stone. In fact local stone was only used in places where it was known to be suitable, i.e. at Corinth. It is quite likely that poros-limestone, similar to the Corinthian stone, could have been quarried near Epidaurus. But the difficulty of transporting stone from the known source at Corinth was not so great as to oblige the Epidaurian building-commission to look for local material.[1]

It is precisely this evidence which the orthodox view neglects; and unless one considers heavy transport in its context, together with the evidence, it can only appear exceptional and irrelevant.

III

The ox was the first animal to be yoked, and it retained this significance throughout antiquity. Hančar's account of the horse in early societies shows that oxen, sheep, and pigs had a greater economic importance. The ox was domesticated long before the horse, and even in areas where the horse had his natural habitat cattle predominated.[2] It may be argued that oxen, as well as sheep and pigs, were kept in far greater numbers simply because they were more edible than horses. But the greater distinction between the ox and the horse is one of slow strength as opposed to speed. When it came to the point of harnessing animal-power for agricultural work, as in Sumeria, the ox was not only the most obvious draught-animal to hand, but also adequately if not eminently suited to working with a yoke and plough—and so it continued to be.

In those parts of the world to which the horse was not native—the Near Eastern and Mediterranean countries—it only appeared after the art of riding had been usefully developed, and consciously imported. No horse-remains have been found in Crete before c. 1700–1600 B.C., and none in the Early Helladic settlements (pre-1900 B.C.) of mainland Greece. The horse, whose essential quality is speed, has always possessed glamour, an aristocratic mystique. Its prestige value has never, certainly in antiquity, been outweighed by its

Entwicklung des Heiligtums, I (Berlin and Leipzig, 1927), 126, show that the difference between the smallest and the largest drum was about 1½ tons. (Pentelic marble weighs about 2.70 tons per cubic metre.)

[1] Diod. IV, lxxx 5–6 says that a temple built by the Sicilian town of Engyon was expensive because there was no good local stone, and material had to be brought from a quarry about 12 miles away. So that the cost of transport was a matter of concern here. But Selinus used two quarries, for the same kind of stone and during the same period, one of which was twice as far away as the other.

[2] E.g. of animal-bones found in an early Bronze-age settlement in the European steppe, 30 per cent were cattle-bones, and only .5 per cent were horse-bones. See F. Hančar, *Das Pferd in prähistorischer und früher historischer Zeit* (Vienna, 1956), p. 54.

utility. When war chariots were introduced in the Near East, people were probably as much impressed by their psychological effect as by any practical advantage they afforded. The late use of horses is also indicated by the written evidence. There is no mention of them in Sumerian texts c. 3000 B.C.;[1] the earliest occurs in Assyrian texts c. 1700 B.C. The Mycenaean tablets also speak for a late date—it is said of ideograms that 'some commodities which are themselves innovations in LM II' (i.e. well after 1600 B.C.) 'such as horses, chariots... require new symbols'.[2] That the horse did not replace the ox in farm-work is suggested by the fact that oxen outnumber horses in agricultural contexts. The tablets only mention horses in connexion with war-chariots, but oxen are specified as 'working oxen'.

The distinction, of the horse as a luxury, and the ox as an economic necessity, comes out clearly in the Homeric poems and in mythology. Horses are part of the Homeric hero's essential equipment—it was socially necessary to ride out to battle, even if one did dismount for the actual business of fighting.[3] Then there are Achilles' horses, which have the power of speech, and which weep for the death of Patroclus in a highly sensitive and aristocratic way. But although the horse appears frequently as a fabulous beast in myth and designs for sculptures—as the winged horse Pegasus; as the Centaurs, half man and half horse; as the Libyan horses, renowned for their remarkable speed and size; as the embodiment of Athena in her horse-taming capacity [4]—it is the ox which is closely associated with the economic and religious life of ancient society. The great sea-god Poseidon is most often represented by a bull. Gold statuettes of calves or bulls were worshipped by the Philistines, and offered in the temple of Artemis at Ephesus by Croesus of Lydia; and in the Homeric poems the standard of wealth is oxen, not horses.[5] Their value is attested by the eighth-century poet Hesiod, who rates oxen above wives in his discussion of the essential features of a farming household.[6] And Archilochus, writing in the early seventh century, speaks of the 'curving-horned working ox' as part of the establishment.[7]

A more striking example of the ox as a popular standard of wealth occurs in the name given to the third of the reformer Solon's four class-divisions at Athens in the early sixth century. This class was called the zeugite-class: *zeugos* is generally taken to mean 'a yoke of oxen', so that a zeugite was someone who owned about as much land as required one yoke of oxen to plough it, and who thus owned one yoke.[8]

That horses were not common either before or during the classical period is suggested by another political distinction, that of eligibility for service as a

[1] The onager, an equine animal, was harnessed at this time (or even earlier), significantly with ox-harness.

[2] M. Ventris and J. Chadwick, *Documents in Mycenaean Greek* (Cambridge, 1956), p. 42.

[3] It may reflect the author's uncertainty as to the proper use of horse-chariots on the battle-field, i.e. he may have been living in a comparatively horseless age and recalling a distant 'heroic' past. See M. I. Finley, *The world of Odysseus* (1956), p. 48.

[4] The horse was associated with Athena in a Corinthian cult, discussed by O. Broneer, 'Hero-cults in the Corinthian agora', *Hesperia*, XI (1942).

[5] It is probable that the talent, the highest denomination in the Greek monetary standard, was equated to one ox. And the Latin *pecunia* is derived from *pecus* meaning 'cattle'.

[6] *Works and days*, 11.405, 435, and 689.

[7] Fragment 39, ed. Bergk.

[8] A. Andrewes, *The Greek tyrants* (1956), p. 87, suggests that all Solon's class-distinctions were taken over from a military classification, and that 'zeugite' means 'yokefellow' in the infantry-line, i.e. a hoplite. But it seems more likely to have been an agricultural classification, since farming was a more regular occupation than war.

hoplite or heavy-armed infantryman. The basic distinction between democracy and oligarchy cut across society *below* the horse-owning level; the Spartan oligarchy depended on citizen-hoplites, and the lower-class zeugite was admitted to the rank of hoplite in the Athenian democracy. Only the aristocrats owned horses, and this is why horse-riding and chariot-driving (together with other social habits of the aristocracy) appear so frequently on Attic black- and red-figure vases. The second social class at Athens was the *hippeis* or Knights, cf. the *hippobotai* or horse-grazers of Euboea, and the frequency of 'horsy' proper names in Thessaly, the domain of horse-riding aristocrats.[1] The prestige attached to horse-owning is perhaps best illustrated by Alcibiades' speech in defence of his extravagant conduct. He recalls how he entered seven chariots in the race at Olympia, and won first, second, and fourth places. This weighed with his audience, the popular assembly of Athens, because the city also derived glory from its citizens' Olympic victories.[2]

The orthodox view is right in assuming that the horse was choked by its unsuitable harness. But the horse chariot was not intended to be an efficient and sensible means of transport. The aim was to have a fine show of horses rearing and struggling, and drawing a ridiculously light load as fast as possible.[3] In any case the horse would have been too precious, too lightly built, and too nervous for heavy work. I have found only one example of a working-horse, in a list of contributions for building in the third century B.C. at Callatis, on the Black Sea.[4]

So that it is the ox whose capabilities must be considered with regard to harness and the power available. We have already seen that Xenophon and the Theodosian Code establish a maximum load of 1100 lb.; but Plutarch suggests a normal load about three times as heavy, and Cato's oil-mill produces a load of about 1100 lb. per yoke—but here some form of multiple yoking was used, and this, according to the orthodox view, should have reduced the maximum power of each yoke. So that what should have been a lower effort achieved the same as that claimed by the orthodox view for a maximum effort.[5]

Which is right? And if one figure is right does this mean that the others are wrong? Evidence for the speed of working oxen provides about the same degree of variation. Pliny says that a fair day's work for one yoke is to replough one and a half acres with a nine-inch furrow, which comes to about 11 miles.[6] Cato allows expenses for six day-wages, that is, presumably, two days' wages to each of the three yoke-drivers; in which case, if the whole journey was 25 miles long, then 12 or 13 miles were covered each day.[7] But it took two and a half to three days to take the column-drums 22 miles from Mt. Pentelikon to Eleusis, though the delay may have been due to some other now unknown and unimaginable complication.[8]

[1] Hippodameia, Hippodromos, Hipparchos, Hippokles, Hippolochos, Hipponikos, Hippon etc.

[2] Thuc. VI, xvi.

[3] A comparable practice is the use of the bearing-rein on carriage horses. This made the horse hold his head up, preventing him from pulling properly with the head down, because it looked better.

[4] *Revue archéologique*, LXXXII (1925), 258.

[5] *Lycurgus*, ix 1. The figures for Cato's oil-mill are taken from C.A.Yeo, 'Land- and sea-transportation in imperial Italy', *Transactions of the American Philological Association*, LXXVII (1946).

[6] But of course the distance covered depends upon the quality of the soil. See Pliny, *Natural History*, XVIII, 178.

[7] See n. 5.

[8] See below, and the table.

It is thus futile to try to make out a standard rate of efficiency for ancient transport. First, the evidence does not allow it, and secondly it is much more likely that people adapted the means available to the demands of the moment. It was to no one's advantage to work according to some abstract standard of speed or load, nor were commentators interested in any but the particular instance they had in mind. Thus Xenophon's comment refers to an experiment with army baggage-animals, so that the standard he quotes may be a military one; while the Theodosian Code seeks to impose a limit on loads for the protection of state-roads and transports. Neither refers to private or business methods.

Nevertheless it seems likely that an approximate measure was understood by the word *hamaxa* or 'waggon-load', much as we talk of a 'load' of hay. The word *hamaxiaios* is used to describe stone blocks large enough to impede a Spartan attack on Athens in 403 B.C.;[1] large wooden beams stored for use in temple-repair;[2] squared blocks for patching fortifications.[3] And at Epidaurus 'waggon-loads' of wood are supplied at various prices.[4] So that heavy transport was a vital enough issue to have given rise to a little technical language of its own.

IV

The practical importance of the ox is relevant to the whole question of harness. The adequacy or otherwise of ancient harness depended on the animal harnessed. The yoke is peculiarly suited to the ox, as it is not to the horse, since the horse's neck provides no ridge of backbone and muscle for the yoke to rest against when the animal pulls forward, so that the harness slips back and drags the throat-strap up in front, off the horse's shoulders onto its windpipe. Successful harness for the horse was invented when its anatomy received special study—and this can only have happened when the ox was too rare or too slow for the needs of the moment.[5] The Chinese invented the breast-strap harness as early as the fourth century B.C.

Its efficiency is attested by the *Mo Tzu* book in which a linch-pin is described as being capable of assuring the transport of loads of 1½ to 3 tons. This harness which we see in all Han representations was strong enough for one horse to draw the stoutly-built Han horse-bus with six or seven passengers, at a time when Roman carts were still drawn by a yoke.

The Chinese also developed the prototype of the modern horse-collar, from necessity—this time to meet a threat to security. Dr Needham suggests that this development took place on the edge of the Gobi desert in northwest China, where in the fifth century A.D. people required speedy and dependable transport in the face of nomad attack. The breast-strap harness was not tough enough to bear the strain of pulling loaded carts at speed over soft, sandy surfaces. So the waggoners reverted to the old, unbeatable ox-yoke harness. A felt collar was substituted for the ox backbone hump, and the shafts of the vehicle were now attached directly to the yoke, which now rested not on the horse's unresisting

[1] Xen. *Hell[enica]*. II, iv 27.
[2] IG i² 314.
[3] IG ii² 463.
[4] IG vi² 108 and 109.
[5] The ox was not rare in the Han period, but the horse was certainly more common than in the west.

neck, but against the collar. Frescoes showing this development have recently been studied in Wei and Thang cave-temples in this area.[1]

Other people in antiquity, e.g. the Greeks, did not have to solve this particular problem; they were not faced by any difficulty which could be overcome only by inventing different harness. As V. Gordon Childe said, 'technological progress depends not only on an accumulation of useful knowledge, but also on a multiplication of wants'.[2]

When did the Greeks find it necessary to employ devices for heavy transport? Occasionally, as I have suggested, for moving heavy ship's timbers, for oil-mills, grindstones, and military equipment such as battering-rams and catapults (in the Hellenistic period); but more frequently for building materials. Another fairly regular demand on heavy transport would have been made to move ships along the Diolkos at the Isthmus of Corinth. Not much is known about this, except for a few yards of the paved roadway itself. This has grooves about a yard apart cut in it to accommodate cartwheels.[3] Ships could thus be wheeled across on a cradle of some kind and so avoid the long voyage round the Peloponnese when travelling east or west. Warships may have been pushed across by their crews; but on the other hand, both these and merchant ships which had small crews could have depended on teams of oxen harnessed in file.

The devices used for heavy transport were ox-teams and waggons of some kind. I have already mentioned the inscription of payment to ox-teams for moving the Eleusis column-drums. An honorary decree c. 330 B.C., spoken in the Athenian assembly for a Boeotian, provides another striking instance of the use of ox-teams: Eudemus of Plataea was honoured for having provided '1000 yoke' to transport material for the theatre of Dionysus and the Panathenaic stadium in Athens.[4] If the literary and epigraphic evidence is taken altogether, it gives us proof of the use of oxen from the sixth to the second century. Vitruvius supplies it for the sixth in his mention of the devices for moving heavy blocks invented by Chersiphron and Metagenes, when they were building the Artemision at Ephesus.[5] Plutarch's *Life of Pericles* and the inscriptions provide the rest.[6] Oxen are not specified in all the accounts, but they appear often enough and over a wide enough range of time for it to be feasible to argue their use generally. The specifications for repairing walls in the Piraeus in 337/6 B.C. include careful directions for transport—'They are to unload the material for the work, bringing each stone to the place ordained by the contracting-officials, wherever there is a way of approach for a yoke of oxen'.[7] In the second-century accounts at Didyma, there are payments for the use of draught animals specified as 'ox-yokes'.[8] Other animals are rarely specified, e.g. mules are mentioned once in the Didyma accounts.

Now for the evidence concerning waggons. The fact that Vitruvius, a contemporary of Augustus, records in detail the invention made by Chersiphron in the sixth century B.C. suggests that his method, of suspending a block in a

[1] *Science and civilisation in China*, IV (Cambridge – in the press).

[2] 'Magic, craftsmanship, and science', *Frazer lecture* (Liverpool, 1950), p. 9.

[3] Thuc. II, xciii 1–2 implies that the Diolkos was not in existence in the fifth century, but Strabo, VIII, ii 1 takes it more or less for granted. For recent reports of the discovery of the Diolkos, see N. Verdelis, *Mitteilungen der deutschen Akademie in Athen*, LXXI (1956), and *Illustrated London News* (19 Oct. 1957), and O. Broneer, *Antiquity*, XXXII (1958).

[4] IG ii^2 351.

[5] See p. 5/, n. 2.

[6] Plut. *Pericles*, xii 6–7.

[7] IG ii^2 244.

[8] *Didyma*, 40–41.

wooden frame, on pivots, and harnessing oxen thereto, went on being used widely in the intervening period. But Plutarch's list of the various craftsmen involved in Pericles' public-works programme includes 'waggon-builders' (as well as 'yoke-breeders' and 'drivers'); and the Propylea accounts record payment for loading stone onto wheeled vehicles.[1] Much of the other evidence —such as the record of payment 'for the hire of teams' for repairing the Long Walls in Athens in 395/4 B.C.—tells us nothing about the size of loads, the number of yokes, or the kind of vehicle used. But two fourth-century inscriptions from the Argolid give between them evidence for the use of ox-drawn waggons. At Hermione, a 'yoke-owner' receives pay for transport from the harbour to the town, and at Troezen payments are made for 'waggon-loading of stone'.[2] If waggons were used, then oxen pulled them.

The problem of vehicles is related to the question how far 'standard' or 'maximum' loads were thought of. Such standard as was implied by the term 'waggonload' would naturally fluctuate according to the demands of the moment. The really stable measures were those for grain, wine, and commodities measured in baskets, flagons, or the amount a man could carry on his back. But no standard, and no vehicle used for light transport, would be fit to take the abnormal loads dictated by any building-specification. They must have required special roads and waggons. There is little to show what provisions were made, apart from those recorded in the Eleusinian inscription.

Scholars have often assumed that column-drums were rolled along behind animals whose harness was fastened to pivots in the central cuttings on the horizontal surfaces of the drum. In most cases the lifting-bosses projecting on the round surface would have been rather an impediment, besides which the drum would have chipped, and on a downhill slope would probably have broken the animals' legs. Nor would one have moved *squared* blocks in this manner. Rollers provide a simple means of moving large blocks for very short distances. Obviously this method was used on the site and on quaysides—payment was made at Epidaurus for two kinds of 'rolling', on and off, where a quayside context seems likely.[3] But the Eleusis-drums were moved on waggons; wood and rope were brought up from the Piraeus shipyards, four coils of rope were cut into lengths for traces, axle-blocks were purchased, and heavy beams, of the kind which bore the weight of a ship's anchor at the bows, were also provided. So that something larger and stronger than an ordinary waggon came of it. Where such weights (7 or 8 tons) were involved, something had to be done about the road-surfaces; iron (i.e. tools) was supplied for 'road-making', which probably meant filling in holes and removing boulders. The Greeks could make good roads when occasion demanded, as is shown in the Panathenaic Way in the Athenian agora, the paved track down from the Pentelic quarries, the Sacred Way at Delphi, the Diolkos, and in the cities of Selinus and Acragas in Sicily. The Didyma accounts record roadwork at the quarries; Plutarch mentions roadmakers among the other workers on Pericles' scheme, and they also appear in the Propylea accounts; and Diodorus says that roadmenders went with Alexander's funeral-car on its way from Babylon to Egypt. But despite this evidence for roadmaking, it should be pointed out that the Eleusis-drums were moved in August, when there was least likelihood of mud on the roads.

[1] Pericles' building programme was begun in 449 B.C. with the Parthenon, and went on after the beginning of the Peloponnesian war in 431/0, and his death in 427, until 407 B.C., when the Erechtheum was completed.

[2] IG IV[1] (742.8 and 823.55.)

[3] IG iv[2] (103.46 and 84.)

There still remains the question of harness. Some method of harnessing in file must have been used. But there is virtually no archaeological evidence for this, the literary sources deal only with exceptional cases, and the inscriptions only make it clear that it was done somehow. Lefebvre des Noëttes dismissed Cyrus' experiment with his siege-tower as proving nothing beyond the feebleness of ancient methods. Eight yoke, says Xenophon, were drawing less per yoke than each its normal load. But Lefebvre des Noëttes seems to miss the point, that Cyrus was surprised by the fact that they drew the tower more easily than one yoke its normal load. This does not necessarily imply therefore that motive power was reduced in proportion to the number of yoke used. The vehicle is described as an 'eight-poled' cart, which has been interpreted as meaning that one yoke was attached to each pole, so that there were 16 animals abreast. But I would interpret 'pole' not as a shaft, but as a 'yoke-bar'.[1] It would be awkward to attach eight drawing-shafts to the front of any vehicle, however wide (See fig. 1). The tower was 18 feet high, and to accommodate its crew of 20 men (on three floors) a frontage of about 20 feet would have been ample. But eight yoke abreast would need a frontage of about 40 feet, allowing 5 feet for each yoke. Apart from this structural difficulty, harnessing 16 animals abreast for battle seems a most unstrategic proceeding. What easier than for the enemy to pick off an animal or two in the middle of the line where they could not be quickly dragged out of the way, or to kill them all? Then, as in all wars before 1939, baggage-animals must have been very precious, so that if the animals advanced in file the risk was greatly reduced.

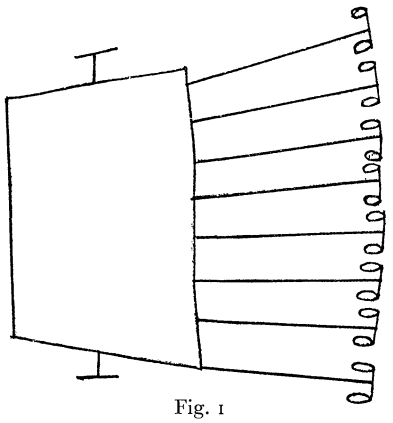

Fig. 1

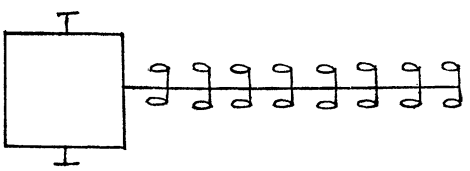

Fig. 2

Even if the system used in this instance was something like this (fig. 2), it does not mean necessarily that it was or became generally known and widespread. All it suggests is that, in cases of necessity or interested experiment, a method of yoking in file could emerge.[2]

V

Were people economical in their use of draught-animals? The evidence suggests that they were not. Alexander's coffin was drawn by 64 mules. One would have done if there had been a shortage; but the funeral-car was especially magnificent, and 64 beasts were needed to make a show. Cyrus' siege-tower could have been pulled by five yoke of oxen, but here as in the case of the funeral-car the context is a military one, so that there would have been no lack

[1] This adds but one more to the various meanings of *rhumos*.

[2] Heavy transport may, as I have suggested, have played a small part in ordinary business. But it was essentially an unusual activity.

of baggage-animals. In the Eleusis inscription, the size of team for a single load ranges from 19 to 37 yoke (for which, see the Table). It is inferred, by taking the average as 28 yoke, that power was wasted—i.e. the team pulled a weight of about 7 tons which is half the weight that 28 × 1 yoke should have been able to pull, even according to the orthodox view. On the other hand, the difference in size of the teams is not commensurate with the variation in weight of the column-drums. And according to the orthodox standard 19 yoke at full strength could have pulled about 10 tons.

Drum	Date of month	Days taken	Size of team	Total of yoke-days	Pay per yoke per day	Total to each	Total price
1	—	3	+31?	+93?	4 dr. ½ ob.	12 dr. 1½ ob.	+390? dr.
2	—	3	33	99	(,, ,, ,, ,,)	(,, ,, ,, ,,)	404 dr. 1½ ob.
3	—	3	33	99	(,, ,, ,, ,,)	(,, ,, ,, ,,)	404 dr. 1½ ob.
4	—	3	32	96	(,, ,, ,, ,,)	(,, ,, ,, ,,)	392 dr.
5	—	3	30	90	(,, ,, ,, ,,)	(,, ,, ,, ,,)	367 dr. 3 ob.
6	—	3	i)28 ii) iii)31	90	(,, ,, ,, ,,)	(,, ,, ,, ,,)	367 dr. 3 ob.
7	—	3	i)27 ii) iii)30	87	(,, ,, ,, ,,)	(,, ,, ,, ,,)	355 dr. 1½ ob.
8)							
9)	10th	2½	i)40 ii)45	107½	(,, ,, ,, ,,)	(,, ,, ,, ,,)	438 dr. 5¼ ob.
10)							
11)	12th	3	?	?	?	?	?
12	15th	?	?	?	?	?	?
13	17th	?	?	?	?	?	?
14	20th	?	?	?	?	?	?
15	23rd	2½	24	60	(,, ,, ,, ,,)	(,, ,, ,, ,,)	245 dr.
16	26th	3	20	60	(4 dr.)	(12 dr.)	240 dr.
17	29th	3	19	57	(,, ,,)	(,, ,,)	228 dr.
Returned to quarry							
	—	3	37	111	(,, ,,)	(,, ,,)	444 dr.
18	—	3	32	96	(4 dr. 1½ ob.)	(12 dr. 4½ ob.)	408 dr.
19	—	3	28	84	(4 dr. 3½ ob.)	(13 dr. 3½ ob.)	385 dr.
20	—	3	24	72	(4 dr. 2½ ob.)	(13 dr. 1½ ob.)	318 dr.
21	—	3	28	84	(,, ,, ,, ,,)	(,, ,, ,, ,,)	371 dr.
22	—	3	30	90	(4 dr. 1 ob.)	(12 dr. 3 ob.	375 dr.
23	—	3	31	93	?	?	?

The figures in brackets do not appear in the inscription, but are deduced from the total payment. i), ii), and iii) represent the first, second and third days of the journey.[1]

The question is, could a smaller team have moved a drum, or was 19 the absolute minimum (owing to the complications of multiple harness)? It is quite possible that here again there was no shortage of draught-animals; that fewer could have been used if fewer had been available; that the whole system was much less rationally worked-out than Glotz allows in his study of the inscription.[2] Glotz assumes that the large team of 37 yoke was needed to take a damaged drum back to the quarry, about 700 metres up. But, firstly, 37 yoke would not have been necessary for the whole journey, across the plain; and

[1] This table is derived from G. Glotz, 'Un transport de marbre pour le portique d'Eleusis', *Revue des études grecques*, XXXVI (1923), 26–45.

[2] *Ibid.*

secondly, some of this number may have been going back to the quarry in any case. A possible explanation of the variation is, not that 19, 28, or 37 yoke were needed to move the drums in the first place, but that if 19, 28, or 37 yoke turned up (in answer to a general appeal made perhaps by the officials in charge of the work), they were all put on the payroll. All comers were given a share in the exercise.

But here, as in all building-operations, there was some regard for the economics of the affair. The drivers were paid at an established rate per yoke per day, according to a decree of Lycurgus, the financial genius of mid-fourth century Athens;[1] and the officials had to keep an exact account. Thus the administration had a very good reason for being interested in the organization of transport. This is clearly shown by the inscription recording instructions for wall-repairs in Athens—the officials organized the unloading of stone at places 'where there is room for a yoke of oxen to come up' to the wall.[2] The problems were thought out realistically by the organizers, and it therefore seems hardly likely that they were unaware of the powers of an ox-team, or of what a block of specified measurements might weigh.

As to economical administration, it is difficult to see whether there was ever a fixed scale of charges for transport, because the evidence does not supply enough details. At first sight it looks as if the varying sums paid for transport at Eleusis (where the 'standard' rate varies within one month for the same job), at Epidaurus, and at Delphi—all during the third quarter of the fourth century—have none of them any relation to another. At Eleusis the average cost was about 295 dr. to take one drum 22 miles; at Epidaurus it cost about 3400 dr. to transport stone for the interior of the Asklepios temple all the way from the Corinthian quarries to the sanctuary, whereas it cost 1775 dr. to bring 71 Pentelic marble blocks 7 miles up from the harbour; at Delphi it cost 420 dr. per block to go 7 miles from the harbour to the sanctuary, 1770 feet above sea-level. There is no relation between the prices for the transport of poros limestone (at Delphi and at Epidaurus, for the temple-cella) [3]; but the cost of transporting Pentelic marble works out at about $1\frac{1}{2}$ dr. per mile per ton at both Eleusis and Epidaurus; and this may be a result of Lycurgus' decree regulating transport-charges.[4] Or perhaps conditions were so similar that expenses (which perhaps included insuring the stone against fractures en route?) simply happened to be the same. Otherwise, prices must have been dictated by the needs of the moment, and by a number of general considerations. Thus no administration could afford to pay more than it had at its disposal; no contractor could expect to be paid more than the administration could afford, and the cost of maintenance for driver and beasts was an unavoidable expense, whether or not they had been employed; no one could do the job more quickly than anyone else, because all were subject to the limitations of the ox—its strength and its speed. Furthermore, the administration's understanding of the transport situation is shown by the safeguards against fraud. Contractors and drivers were discouraged from holding up their beasts and so defrauding the administration by a system of fine for delay (the man who received 1775 dr. at Epidaurus was fined 1080 dr. for delaying). To this extent the speed of an ox mattered, to

[1] This decree has not survived, but reference is made to it at the beginning of the section dealing with payment to the teams in IG ii^2 1673.65.

[2] IG ii^2 244.

[3] The high cost at Delphi can perhaps be explained by the steepness of the road which even after modern engineering rises sharply once it has left the coastal plain.

[4] Though why should this operate at Epidaurus, unless the contractor were himself an Athenian, and insisted on getting an Athenian price?

both contractor and administration. Its slowness was an accepted limitation—and it went on being accepted well into the Middle Ages.[1]

Transport-contractors never formed joint-stock companies. There is no evidence that draught-animals were maintained either publicly or privately for heavy transport alone, and there is no likelihood that this was so. For normal purposes there were porters, packmules and donkeys owned or rented on a small scale by slaves and freemen. The Eleusis inscription shows that two, three, or four men worked together to transport a bulk of material, which suggests that no one had more than the minimum resources. It was not these professional, small-time carriers who undertook transport contracts for public works, because they had neither the resources nor the social position necessary for organizing transport on a large scale. Obviously Eudemus of Plataea was a big man, socially speaking[2]; and it is possible that the social prestige gained by this kind of work was more important than the financial profit, if any. Even at Corinth, there would only have been occasional need of transport on a large scale, although the quarries supplied stone for other places.

Transport contracts were by no means specialized: sometimes the contract stipulated transport alone, but often it involved quarrying and construction as well. There is a clear distinction between those who did large-scale transport and the odd-job men who moved ladders, fetched beams, and carried white-wash buckets, though the bulk of the material varied from item to item—at Epidaurus, a man received 5 dr. for one load, and 175 dr. for another load of the same kind of timber. In another record, one man brought 6 waggon-loads, another 25, and someone else 40. If there were no professional heavy-transport contractors, then this variation in the size of job may well be due, not to differences in resources or social status, but simply to one man's having more time to spare from his usual occupation. And people who undertook transport contracts were unprofessional in the sense that they could not rely entirely on their own resources. For one thing, sea-transport was often involved, and for another, no one owned many draught animals.

Who was able to provide them?

Glotz has suggested that Attica was very poor in cattle, and that (for large-scale transport) Boeotia supplied the draught-animals. As for his first point, the importance of the ox to ancient society is obvious from its use for ploughing; and it seems unlikely that Attic agriculture ceased at any time to depend on the ox for this purpose. In fact the evidence suggests otherwise. Apart from the bronze and terra-cotta figurines mentioned earlier, we have written references. Records of the property of men convicted of sacrilege in 415 B.C. include a pair of working oxen [3]; Xenophon speaks quite casually of 'the yoke' of oxen fetching stone for the city's defence [4]; so the people who provided draught-animals were the farmers; the 'yoke-owner' of Hermione must have been a farmer—there would be little or no demand for professional carriers in so small and uncommercial a place. Transport contractors depended on local oxen, brought along by the farmers when work was slack. This is suggested first by a late fourth century decree from Teos, which established the liability of private

[1] R. S. Lopez and J. W. Raymond, *Medieval trade in the Mediterranean world: illustrative documents* (1955), no. 177. Here, an ox is said to have taken 25 days to go from Azov to Astrakhan, whereas a horse took 12 days, but with a lighter load.

[2] It may also have been considered good policy for the city of Plataea to enjoy this kind of personal link with Athens.

[3] W. Kendrick Pritchett, 'The Attic stelai II', *Hesperia*, XXV (1956), 255, no. 6 l.68.

[4] *Hell.* II, iv 27.

slaves and draught-animals for public service.[1] And, secondly, it is clear from the date of the accounts that the Eleusis drums were transported in a slack (from the farmer's point of view), as well as a dry period, between the corn-harvest and the grape-gathering.

Glotz presumably bases the assumption, that Boeotia was the main source of draught-animals, on one inscription, the decree honouring Eudemus.[2] But, in the first place, Eudemus himself cannot have owned 2000 oxen (no estate could use or feed so many), and secondly, if he had possessed the animals he would be hardly likely to drive a herd of 2000 beasts 30 miles from Plataea to Athens for a job not lasting more than a month or so. And it seems strange that 1000 Boeotian farmers should all have rallied to Eudemus' support for a job in Athens.

There are two possible explanations. Eudemus' promise consisted not of a limited transport-company of 1000 yoke, but of money, either to pay 1000 yoke-owners gathered together for the job from Attica, Boeotia, or elsewhere: or to pay for 1000 yoke-days. The second and more likely explanation means that the job would only have required a few score oxen if they worked in rotation. The dated part of the Eleusis inscription suggests a similar arrangement. The teams started from the quarry at two- or three-day intervals, so that by the time the second team had reached Eleusis, taking three days on the journey, the first team could have returned to the quarry ready to collect the third drum: so that 90 or 100 yoke would have done.

Eudemus' motive was to gain profit not on a commercial basis but by doing Athens a favour. In return for 4000 dr. towards war-expenses, and 1000 yoke-days' worth of transport, he received the highest honours the city could grant—a gold crown, official recognition of himself and his family among the city's benefactors, the right to buy property in Attica, to fight in the army, and to share the responsibilities of Athenian citizens (i.e. pay taxes).

Was his motive very different from that of transport-contractors in more normal circumstances? The frequency of heavy fines for delay indicates that often there was little left of the contract-price which could be counted as profit. I have suggested that the social standing of the organizers, i.e. the contractors, was fairly high. This would accord with the idea that heavy transport was organized on a more or less voluntary basis; and that the owners were willing to join in transporting building-stone for their own city's temple or defences, or for the sanctuary of a cult in which they felt a particular interest.[3] Cities usually had to depend on foreign skilled labour to some extent, but the transport of material could be done by any citizen with time to spare, under the direction of a contractor or official with some experience of loading heavy blocks on to carts. Contributing money towards the cost of public works became a common practice in Greek cities from the fourth century onward. People felt themselves honoured by being inscribed as minor benefactors of their city; and sometimes contributions were made in kind—e.g. labour, materials, or draught-animals.[4] So that contributing service as a haulier could

[1] *Supplementum epigraphicum graecum*, II, no. 579. See M. Rostovtzeff, *op. cit.* p. 182 and n. 45.

[2] *Ancient Greece at work* (1926), p. 259. He cites no evidence in support of this statement.

[3] A day-wage of 4–4½ drachmai was much higher than the wages earned by skilled craftsmen; but it was only temporary, and irregular at that. Whether or not the driver of the beasts owned them or hired them from someone else, any money he received for this kind of transport would be *in addition to* his usual income.

[4] Many inscribed records of this kind of contribution have survived. The Athenian material has been collected and published by A. Kuenzi, Ἐπίδοσις (Diss., Berne, 1923), but it has not been available to me.

be considered a part of this social practice. But of course it was service for payment; though the pay would not have been regarded by the farmers as a major source of income, but as a bonus.[1] Except that the rate is much higher, I see no reason why the payments recorded in the Eleusis inscription should not be considered on exactly the same level as the payment for Assembly-attendance instituted in the fifth century by Pericles—as payment for services rendered to the state.

Heavy transport did not go on continuously; yet when it was necessary, no one at the time can have regarded it as a minor issue. No detail can have been left unconsidered, because there were always so many people about with a lively and personal interest in it—the officials, hoping for a fairly economical organization, and the eventual completion of the building in question; transport-organizers, anxious for their reputations; and yoke-drivers, concerned for the treatment of their beasts, interested in an unusual occupation, and enjoying the financial benefit.

There were accidents—blocks did fall off carts on the way—yet the system worked, the means were adequate. Nobody would have understood the distinction between efficiency and inefficiency made by modern critics of ancient devices. Why did harness remain unaltered from the time the first ox-yoke was used in Sumeria c. 3500 B.C. until the introduction of breast-strap harness (invented in China c. 330 B.C.) into Europe about the sixth century A.D.? The answer is, not that ancient society was slothful, uninventive, and slave-ridden, but that the harness then in vogue was perfectly adequate and went on being so.[2] People knew certain ways of doing necessary jobs. They could, therefore, see no reason for other methods to come into existence.

Newnham College, Cambridge

[1] See p. 17, n. 3.

[2] As I have shown, the availability of manpower has no bearing on heavy transport, because power was supplied by oxen. So that the question whether or not manpower was slave or free has no relevance here; and I would suggest that social status has nothing to do with technological invention, or the lack of it.