



# Wood anatomy and construction technique of Late Bronze Age rural cartwheels



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## ABSTRACT

A recent archaeological discovery of a Late Bronze Age cartwheel in north eastern France (Erstein, Alsace) has shed important new light on the technical development of wheels in Europe. The well-preserved wooden fragments were discovered at the base of a water well and were in secondary use as wedges to adjust a well lined with a hollowed tree trunk. Dendrochronological and radiocarbon results gave a chronological classification to the Late Bronze Age in 13th century BCE. Although the discovered wheel was not complete, these fragments provide a clear picture of the overall wheel design and allow a detailed reconstruction. The wheel disc comprises three parts that are held together by stump tenon joints and two mutually curved insertion strips with dovetail profiles that are located on opposite sides. The two outer boards have crescent-shaped cut-outs. The planks for the disc wheel were crafted from sycamore maple (*Acer pseudoplatanus*), and the strips and tenons were crafted from hazel (*Corylus avellana*) and ash (*Fraxinus excelsior*), respectively. The results of wood identification indicate that the selection and processing of wood were predominantly based on specific knowledge and supra-regional traditions. The recent find from Erstein is also compared with what is currently known from other Bronze Age sources from Europe. Together, these results clearly demonstrate that there were almost no regional variations in construction techniques from south of the Alps to northern Europe.

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## 1. Introduction

Approximately 2000 years after the beginning of the Central European Neolithisation, the first cartwheels appeared about 3500 BCE (Bakker et al., 1999; Burmeister, 2004; Piggott, 1983). The infra-structural precondition of an extensive network of paths had existed long before, as had the use of domesticated cattle as a reliable source of food and pack animal (Beneke, 2004). Thus, routes and a driving force were available. However, the progressive step to humanity's essential transport invention, the carriage with wheels, took place relatively late. The world's earliest archaeological evidence and depictions of carriages and wheels originate from Europe and the Middle East (Höneisen, 1989a; Piggott, 1983; Velušček et al., 2009) and occurred simultaneously around the middle of the 4th millennium BCE. A precise temporal and spatial arrangement of these first disc wheels is not yet possible. Another 2000 years later, at the end of the early Bronze Age (16th century BCE), the archaeological sources show an evolution of the disc wheel to the spoke wheel (Pare, 1987). Again, the evidence

suggests an almost simultaneous occurrence in Europe, the Trans-Ural steppes and the Ancient Near East. The origins of this new feature remain unclear. Most likely, the domestication of the horse and its use as a draft animal made a lighter construction necessary. Finds and depictions show the first light, horse-drawn, uniaxial carriages with spoke wheels, which have mostly been interpreted as war-chariots (Pare, 2004).

Chariots gained great importance in a cultic, ritual context and as a prestige vehicle during the Bronze Age (Gomez, 1985). At the same time, disc wheels continued to be used in common everyday life and were further developed by continuous technical improvements. By the end of the Bronze Age, this major technological innovation in human history was well established and widely used.

However, archaeological evidence of rural vehicles is rare. The few finds, however, provide an important insight into the everyday use of utility vehicles in prehistoric societies, which has not been previously examined in detail.

Here, we present the wood anatomical assessment and technical construction details of a Late Bronze Age rural cartwheel from Erstein (FR-Alsace). The discovery of this wheel gave rise to questions regarding its exact age, the choice and use of wood, the construction and, ultimately, the functional context of this exceptionally well-preserved cultural remnant of prehistoric transport.

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### 1.1. Archaeological context and chronological frame

In 2007, 2013 and 2014, a team of archaeologists from “Pôle d'Archéologie Interdépartemental Rhénan (PAIR)” excavated a surface of 12 ha on the loess terraces at Erstein, 20 km south of Strasbourg, which contained settlement structures from the Bronze Age (Fig. 1A; Croutsch et al., 2010, 2011). At the ground level, no traces of buildings, neither wooden remains nor ground plans of houses (e.g., post-holes), were preserved in the soil. However, eight wooden well constructions were preserved below the groundwater level for thousands of years. Two types of well linings, reaching the groundwater level at a depth of up to 3 m below the surface, were assembled in construction pits: a chest-like well lining (using timber logs) and a tube-like well lining (using hollowed trunk sections). All eight water wells were successfully dated by dendrochronological methods. The 72 archaeologically excavated and dendrochronologically dated timbers offer a chronological framework that was far more precise than that obtained using radiocarbon dates and pottery typology, thus allowing a better understanding of the settlement history at Erstein during the Bronze Age (Croutsch et al., 2011). The individual felling dates of the timber used for the wells show construction activities dating from the transition from the Neolithic to the Early Bronze Age, with felling dates from 2231 BCE to the Late Bronze Age in 1002 BCE.

The youngest well lining consists of two stacked hollowed-out trunks. The upper oak (*Quercus sp.*) trunk has a dendrochronological felling date of 1002 BCE. For the lower alder (*Alnus sp.*) trunk, only a  $^{14}\text{C}$  date was possible and gave 1442–1273 BCE ( $2\sigma$ ). This shows that the well was in use for at least 271 years. Several recycled planks were found at the base of the lower well lining, which were used to adjust the hollow trunk to a straight position before filling the construction pit (Fig. 1B). Among these wooden wedges, two parts of a wheel were discovered (Fig. 1B and C). Although dendrochronological dating of the wheel itself was not successful due to the species of wood used, it can still be put in a close chronological frame: because the wheel belongs to the lower part of the well, we can propose a chronological classification to the Late Bronze Age in 13th century BCE.

### 2. Methods

When wood is in contact with ground its components are rapidly degraded by microorganisms such as bacteria and actinomycetes (Blanchette, 2000). It is only below groundwater level, in a waterlogged environment, that microbial and fungal activity is reduced and archaeological timbers can be conserved for thousands of years (Tegel et al., 2012).

However, when they are exposed to atmospheric conditions, wood structures begin to degrade rapidly, mainly due to shrinking, checking and collapse, which in turn hampers to study wood anatomy and toolmarks. Even stabilisation efforts using chemical methods cannot preserve the wood in the same state it was discovered. For that reason, the wheel was examined directly after its excavation and before any conservation or stabilisation measures were taken.

A safe determination of wood genus or species can only be achieved by microscopic observation of the anatomical features. Thin sections from all parts of the wheel (planks, tenons and strips) were cut using razor blades. The sections were then mounted on glass slides and embedded in glycerine. All anatomical features were observed under a reflected-light microscope at 40–400 $\times$  magnification along cross-sectional, radial and tangential surfaces. The wood anatomical atlas and identification key of Schweingruber (2011) herein served as a basis for wood identification.

### 3. Results and discussion

#### 3.1. Construction of the wheel

The wheel from Erstein is a wooden disc wheel with crescent-shaped recesses (Fig. 2). This design can be considered a further development of the Neolithic disc wheel (Höneisen, 1989b; Schlichtherle, 2002, 2004), which was constructed without a hub and consisted of only one or two boards and a rectangular centre bore that was firmly connected to the axle. In the case of wheels that consisted of two parts, two or three grooves with a dovetail profile were prepared

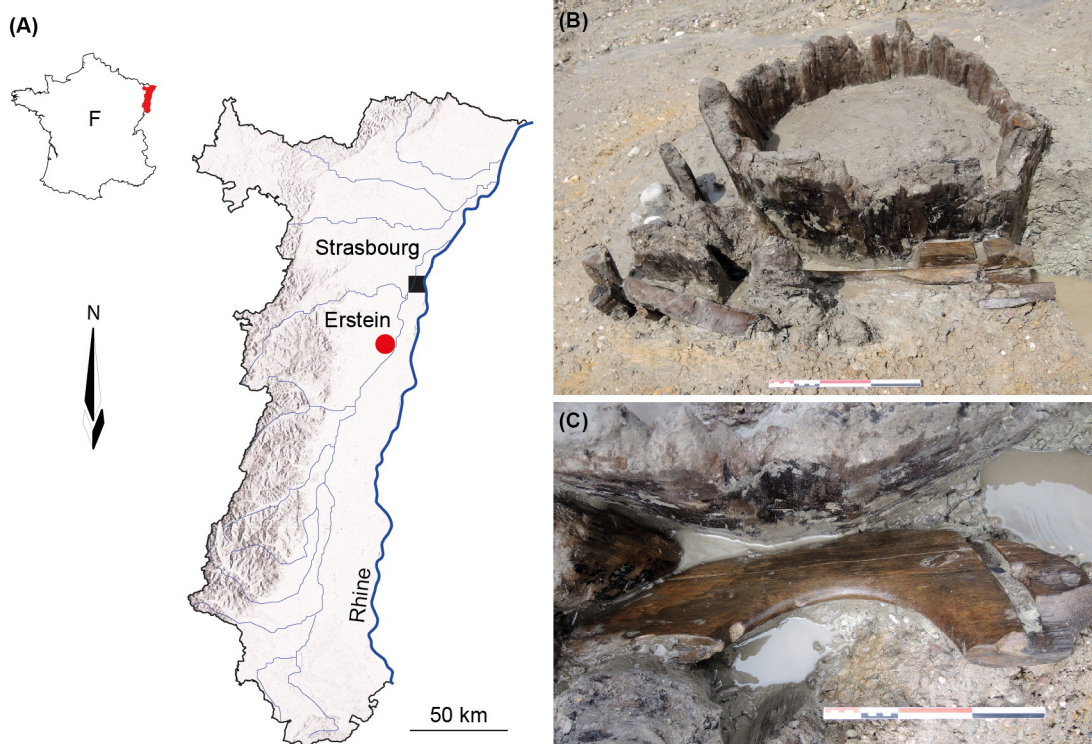


Fig. 1. (A) Location of the Bronze Age settlement of Erstein. (B) Hollowed alder tree lined water well. (C) Cartwheel fragment at the base of the well lining.

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