Draft *

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# *Diplodocus carnegiei*

## Production and Design

## of Replica Skeletons

*This is, indeed, a draft, but tables and figures will be available as soon as practical.

## Introduction/Background

The 1990 skeletal reproductions of Diplodocus carnegiei by DINOLAB take advantage of the cumulative technology acquired in the molding, casting, mounting, and exhibit of dozens of replica dinosaurs over a 30 year span of time. Among other things, this project is typified by a mounting strategy that utilizes key pieces of armature that are included in the sacrum and the major elements of the appendicular skeleton. We have also used a variety of plastics in different combinations for casting individual bones instead of the more common, all purpose, traditional plaster-of-paris of the past.

For example the elements of the axial skeleton, manus, pes, and skull are cast in W.E.P. (water extended polyester); while the ribs, ilia, femora, humeri, and scapulae/coracoids are all hollow cast in a gelcoat with fiberglass and resin. Other newly developed hollow-casting techniques may be used as well. A tinted gelcoat (resin) is used as a base in producing the fiberglass elements to simulate the natural color of the original, fossil bone. The W.E.P. parts may also be tinted to approximate the color of the original bone.

The bulk of the supporting armature will be the responsibility of the exhibitor, however, the appendicular elements and the sacrum will have the armature segments cast inside. Most elements are cast individually, which allows the exhibitor an infinite number of poses.

To simplify and expedite mounting by minimizing the drilling requirement for elements of the vertebral skeleton, some axial elements are cast around cardboard tubes that create cavities which serve as pre-drilling. Specifications for the various sections of armature are detailed in Table 1, which is keyed to Figure one.

The original skeleton of D. carnegiei may be seen at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania; where it has been on exhibit since 1907. This very popular dinosaur exhibit is a composite work consisting of parts of several incomplete diplodocid skeletons: CM 84, discovered by Coggeshall in 1899; CM 94, collected by Peterson and Gilmore in 1900; and CM 662, collected by Utterback in 1902 and 1913. A most impressive mount based just on CM 662 is presently exhibited in the Houston Museum of Natural Science in Houston, Texas.

Andrew Carnegie had the original, composite skeleton plaster molded and reproduced around the turn of the century by an Italian artisan, who painstakingly prepared approximately six hundred, individual, very intricate, plaster molds; which permitted exact plaster reproductions of virtually every bone in the skeleton. Ten cast sets of this gracile sauropod were presented to as many museums in major cities around the world, including: Mexico City, Mexico; Paris,France; Berlin, East Germany (GDR); Vienna, Austria; Madrid, Spain; London, England; La Plata, Argentina; Bologna, Italy; Munich, West Germany (FRG); and Moscow, Russia. The first set was placed on exhibit in 1905, when it was formally presented to the British Museum by Andrew Carnegie (Holland, 1906).

Years later, in 1953, those same plaster molds were requested and a loan arranged for their use by the Utah Field House of Natural History in Vernal, Utah (Unterman 1953). Over a period of several years, a complete skeleton was cast a piece at a time by the museum staff, who mounted it for exhibit outside near the west corner of the Museum. There it occupied a place of prominence as a Vernal City and Uinta Basin landmark until late May of 1989. At that time, an agreement had been reached between the Museum and DINOLAB for repair, stabilization, and construction of new molds for the production of a limited number of additional skeletons. All this after stabilizing and sealing the weathered elements that have endured the seasonal extremes of the Uinta Basin for the past 36 years.

It is evident now that the decision at that time to dismantle and repair the skeleton was a wise one, since close examination during preparation and stabilization has revealed incipient fracturing and surface deterioration due to weathering of numerous elements (Figure 2). Such damage would have been progressively more difficult, if not impossible, to repair after a few more years of precipitation and the temperature extremes typical of the harsh winters and hot summers of the Uinta Basin.

In addition to considerable repairs, alterations were also made to improve the scientific accuracy and integrity of the specimen. For example the manus and pes were earmarked for replacement with elements (or casts) provided by (?), when it was confirmed that those in the

original mount were camarasaurid rather than diplodocid (McIntosh, 1981). Extra care was taken to remove most of the more obvious molding marks and flaws remaining from the earlier casting project of 1953 (Figure 3) as well as trimming away remaining parts of the copious, supporting armature utilized in the Vernal, Utah mount (Figure 4). Old paint and other sealers were removed with a combination of water blasting and wire brushing (Figures ).

The fate of the initial set of molds is somewhat in question, but Wann Langston (personal communication, 1989) suggests that they seem to have been lost, strayed, or stolen during transport from ? to ?. Principals contacted in regards to the disposition of the molds could not provide specific information. It is truly a mystery that an estimated 3-6 tons of plaster molds could simply vanish!

The essential labeling information of D. carnegiei should include information as follows: This free standing mount of Diplodocus is a composite made of parts selected from three individuals: CM34, CM94, and CM662. CM84 and 94 are from the Morrison Formation of Quarry D, also referred to as Quarry 3, at Sheep Creek, Albany County, Wyoming discovered by A. Coggeshall on 4 July 1899. CM662 is from the Morrison Formation at Quarry A on the Red Fork of the Powder River, Johnson County, Wyoming. The bulk of the original elements are now on exhibit in the Houston Museum of Natural Science (McIntosh, 1981)

? Mary Dawson (personal communication, 1990)

Interesting features of this composite skeleton of D. carnegiei that require or deserve additional reference, explanation, and interpretation in labeling are:

1- Pathologies: the caudal series, e.g. anterior caudals (2 & 3?), caudals 19 and 20 and 23 and 24 have fused, pathologies that may be interpreted as the result of traumatic injury and perhaps subsequent arthritic degeneration of the cartilaginous tissues at the articular interfaces or, alternatively, ossification of ligaments on the lateral surfaces of some centra (ask Berman).
2- Sculpted elements include the left femur and tibia.
3- Stratigraphic and geographic data: The Brushy Basin Member of the late Jurassic Morrison Formation of Sheep Creek, Albany County, Wyoming.
4- Radiometric findings?
5- Associated faunal/floral elements
6- Exact number of caudals.
7- Sternals

To many observers, the design and construction of free-standing dinosaur skeletons is an art form and as such, there is no standard, step-by-step procedure used by the professionals who prepare the large, fossil quadrupeds for exhibition. However, we have had a measure of success with a recipe as follows:

1- Secure the sacral complex to a mobile, overhead support that will permit vertical movement over a range of 0 to 14 feet above the exhibit base, working surface, or floor (Figure 5).

2- Mount the vertebrae in 2 meter (6') segments beginning with the anterior caudals, then two meters of posterior dorsals, and so on in alternate order to balance the cumulative load. Of course, the individual elements of the axial skeleton should be totally prepared, drilled, and fitted on the armature in advance of permanent installation - atlas/axis through distal caudals (Figure 6).

3- Having determined the angle at the knees and positions of the pes, the hind legs can be fitted and secured. If the skeleton is to be transported a great distance, the legs can be assembled as separate units to be attached to the sacrum at the time of exhibit installation. If the exhibition is done in-house, that is, in the museum where it is constructed, the sacrum and pelvic girdle may be assembled as a single unit, including ischia and pubes.

4- As well, if the skeleton is exhibited in-house instead of transported any distance, the chevrons (haemal arches) may also be permanently installed with the caudal series.

5- Before fixing the anterior dorsal vertebrae in place, the cross piece for the pectoral girdle must be secured to the axial armature. Next, vertebrae are added alternately; anteriorly and posteriorly, as required.

6- The pectoral support is designed to be contained (concealed), as nearly as possible, within the scapula/coracoid, and the humeral attachment provided through the glenoid.

7- Some of the other diplodocid reconstructions, as well as other sauropods in general, have the angle of the scapula/coracoid with the horizontal plane greater then 45 , which I think is excessive.

This steep angle gives one the impression that the animal might throw its shoulder out of joint by the simple act of taking a large foreward step. Additionally, the anterior margins of the coracoids should project only a short distance farther forward than a vertical plane containing the contact of the last cervical vertebrae and the first dorsal (Figure 7).

8- The axial armature is based on the following set of measurements and a segmental design as illustrated below (Table 1). An important first step preliminary to the actual shaping of the armature is the accurate preparation of top and side views to scale of the planned exhibit. And before committing to a series of curves that contradict the natural position of the axial skeleton, a study should be made and the exact limit of movement or rotation observed and tested between each articulating set of vertebrae. A study of existing sauropod exhibits will be useful or an original study may be conducted using a large sandbox or sandbags to support the individual elements (Figure 8).

Note: for Fig. 8, see the Ueno Park Allo photos - legs on sand bags.

FIGURES

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