A NEW HUMAN SKULL MOUNT DESIGN

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Background

In 1874 Mütter Museum of The College of Physicians of Philadelphia, acquired a significant portion of anatomical preparations from Dr. Joseph Hyrtl, a well known instructor of anatomy and recognized worldwide for some of the finest anatomical teaching preparations and osteological collections of the 19th century. Among the objects acquired were 139 human skulls. Hyrtl's collection of skulls demonstrated the variety of cranial shapes within ethnic groups, as well as the plasticity of the skull in response to hormones, age, and occupation. Hyrtl's basic belief, rooted in his Roman Catholicism, was that while the physical body of man developed in response to the mechanistic influences of the natural world, man's mind, housed in his brain, developed according to a Divine plan. Therefore, the relationship of the external and internal measurements of the skull to the intellectual development of the individual was totally random. According to Hyrtl, everyone knew someone of mediocre intellect with a large head, and vice versa.

Dr. Samuel George Morton, an American physician and natural scientist during Hyrtl's time, held a different view that supported a theory of multiple racial creations each given specific, irrevocable characteristics. Morton claimed that he could define the intellectual ability of a race by the physical measure of the skull's capacity to house the brain. A large volume meant a large brain and high intellectual capacity, and a small skull indicated a small brain and decreased intellectual capacity.

Hyrtl did not believe in the study of phrenology as did Morton. The increased application of observation and physical measurement to understand and in some cases to support deep rooted beliefs in racial concepts were the main drivers for acquiring human skull specimens during 18th and 19th centuries. The importance of preserving and caring for the Hyrtl and other collections is in the context of this history and where we are today with the concept of race. A secondary and emerging importance in preserving these collections is that they are potential sources for chemical and genetic analysis relative to studies of human diseases and nutrition in early peoples from various regions.

Conservation need

The Hyrtl skulls have been on display with minimal conservation or cleaning since their acquisition in 1874. Contemporary methods and designs for mounting and display relied on a heavy cast iron base with custom brass wire frame to achieve three points of contact to cradle the base of the skull. Other mounts used the same style of cast iron base but utilized a shaved wooden post through the foramen magnum balancing the skull at a point under the cranial cap (fig. 1). In either case the skull is balanced on a platform that affords little stability in the context of vibration and movement while on display or in storage areas. Consequently loose dentition and bone fragments always collected near the base of the mount as vibration took its toll.

Action taken

Early in 2011 a museum development project was launched to fund conservation and remounting of the skulls in the collection. Funding was based on a sponsorship model open to the general public including museum staff. Development set an achievable sponsorship fee for cleaning and conservation of bone, replacing display mounts with new

Fig.1 Typical vintage mounts used in the collection
Mount with shaved wooden post. Some posts used a flathead nail at the top of the post to adjust the height of the skull

Mount with custom wire frame made of brass to cradle the skull

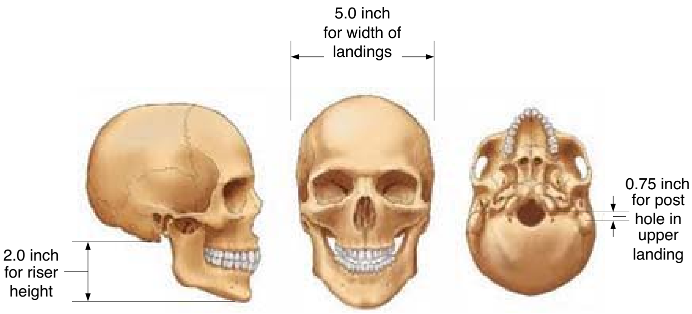


Fig. 2 Average skull dimensions for mount design

Fig 3. Foam Core model

mounts, and providing means of attaching a specimen label along with an attribution tag identifying the sponsor. Therefore the approaches taken were largely pragmatic, relying on typical practices and common materials used in the care of osteological specimens on exhibit and in collections that are as minimally invasive as possible.

Cleaning and conservation, although time consuming and labour-intensive, were not an activity that required any specialized technique. Soap solution followed by multiple deionised water rinses to remove detergent residue was sufficient for removing years of dirt and dust. Occasionally water and ammonia mixture was needed to remove stubborn wax and dust if any. Methanol and acetone were sufficient to remove residual glues and varnishes left over from earlier accession labels that were utilized in the past. Loose and dislodged teeth and bone, casualties of time, vibration and handling, were reattached or firmed up with prudent use of cyanoacrylate adhesive.

Metal hardware such as latches, screws, nuts and bolts, springs, hinges, and wires are typically used in historical and contemporary skeletal articulations. The goal in restoring articulating hardware is to repair or replace any damaged hardware with equivalent hardware. Articulating jaw springs, for the most part required repair or replacement. Brass extension springs were used by the anatomical preparator, for the articulation of the jaw to the crania. A number of them were either missing or stretched. Consequently springs were replaced as needed on a case-by-case basis and the springs adjusted on either side of the jaw for balanced tension.

The vintage mounts, however, required different action to be taken. Refurbishing the old mounts would not provide any significant benefit to minimizing stress on the skull or in reducing the effect of vibration. Researching commercially available mounts for human skulls indicated that little or no progress has been made over time to improving the older concepts for the design of display mounts for exhibit or storage purposes. In short, procurement of modern display stands for the skulls would only perpetuate the problem of vibration and stress. Traditional bespoke (custom) fabricated mounts would not be cost or time effective for a viable development initiative to be successful. Consequently we came to the realization that a new design was needed, something that would

- provide for a uniform method of mounting
- consistently orient the skull to the Frankfort horizontal plane position
- provide for easy shelf storage and facilitate attachment of a label for identification in the context of exhibit display; and
- minimize vibration of the skull.

DESIGN OF A NEW MOUNT

An analysis of the Frankfort horizontal plane position indicated that a human skull could rest on a mount that is predicated on a simple stair-step design where the riser height is based on the typical vertical dimension from the base of the skull to the tip of the jaw. The landing dimensions then derived from the typical horizontal skull dimensions for jaw length and cranial length and the overall cranial width (fig. 2). Stability for the skull is then based on the geometric principle that three non-collinear points determine a plane: the tip of the jaw and two points at the base of the skull. A short post through the foramen magnum that is slightly less that the typical dimension for the opening of the foramen magnum would then facilitate orientation of the skull while assuring stability of the skull from shifting along the horizontal plane.

A 1:1 scale model of the new mount design was constructed from ¼ inch white foam core board to test the design using a plastic full size human skull (fig. 3). Adjustments were easily made to the foam core model without the concerns associated with the handling of a real human skull specimen in our collection. When alterations were completed to the model construction, dimensions were written on the model to facilitate fabrication of a working prototype from plastic materials.

BUILDING A PROTOTYPE

The working prototype was fabricated from cut pieces of black PVC foam board, 0.25 inches (6 mm) thick glued together with cyanoacrylate adhesive to form the step mount. A 1″ by 1.875″ polished acrylic post, drilled and taped for attachment to the upper landing, was used as the post for the foramen magnum (fig. 4).

The working prototype was then used to test the design on several real skull specimens in the collection. Archival foam

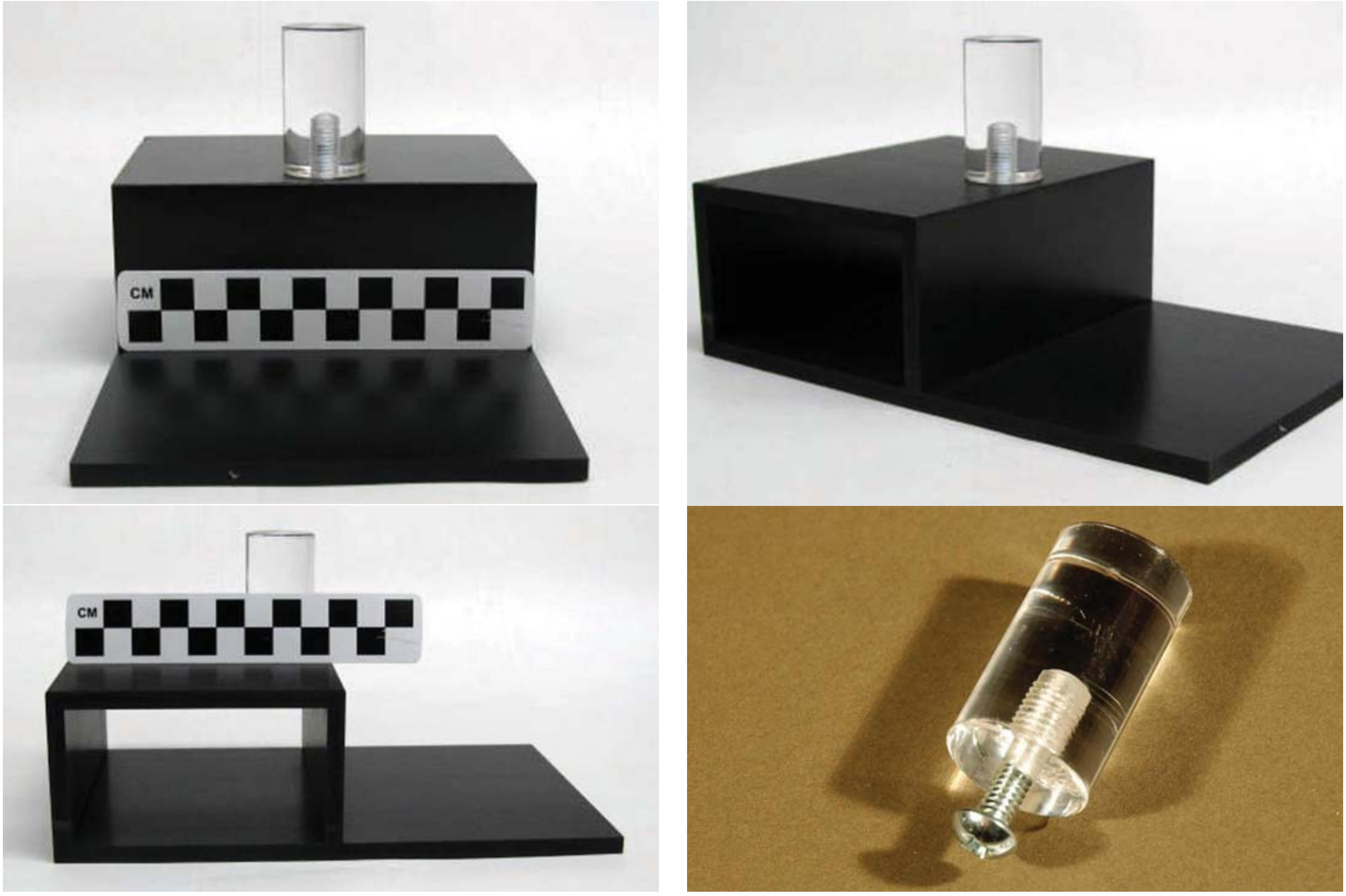


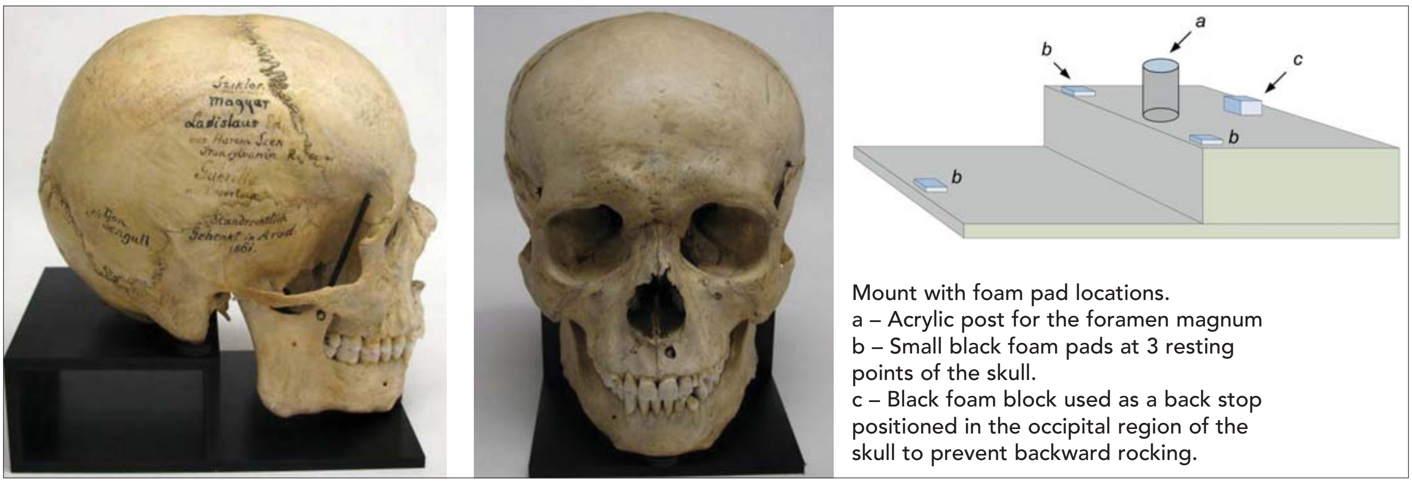
Fig. 4 Prototype mount views and acrylic post

resting pads were cut out and glued to where skull contact points are on the mount to dampen vibration and provide skull protection from resting on a hard plastic surface (fig. 5). The working prototype proved to be a good design, as no additional mount modifications were needed to go into production. The basic mount is low profile and can be used in a display of the skull in tight exhibit spaces or even in collections storage areas.

A MOUNT BASE

Our specific exhibit needs, however, required a provision to secure an object label for the skull specimen that was 6" by 2.875". The solution for that turned out to be an inverted picture frame fabricated from the frame molding used for shadow boxes. A deep rabbet molding was selected with a side dimension of 3" and a surface to glass depth that closely approximated the 0.25" (6 mm) thickness of the based PVC foam board (fig. 6). The shadow box design was then taken to a local picture frame shop for the bespoke (custom) fabrication of a prototype for the mount base where the inside window dimension matched the mount based dimension. A piece of foam core the size of a piece of glass for the shadow box was placed inside the box and secured with framer points, attached to the inside of the box. Picture frame bumper pads were then attached to each corner of the base to dampen vibration and minimize movement when placed on a flat, smooth exhibit surface. The base and mount work together to form a low cost display platform for the skull (fig.7).

Fig. 5 Skull fitted and resting on mount



Mount with foam pad locations.
a – Acrylic post for the foramen magnum
b – Small black foam pads at 3 resting points of the skull.
c – Black foam block used as a back stop positioned in the occipital region of the skull to prevent backward rocking.

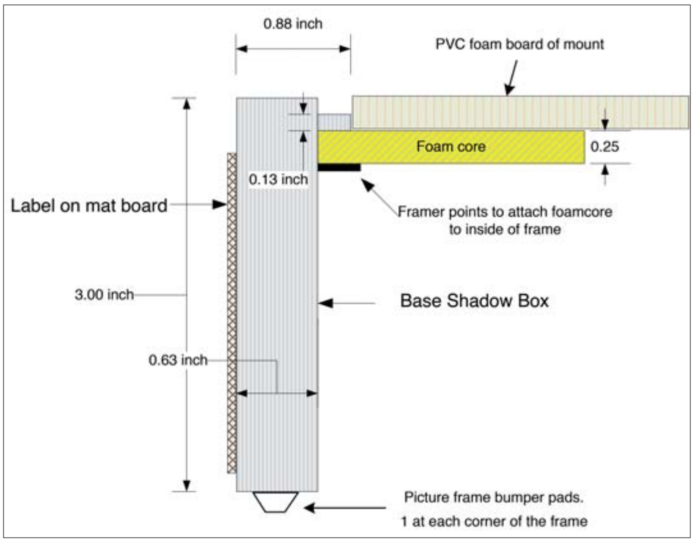


Fig. 6 Dimensions for base construction

MATERIALS

Sintra, closed-cell PVC foam board was selected for the mount fabrication material because of its light-weight, rigid and archival properties. It is easily formed, milled, cut and cemented. It is used primarily in the manufacture of signs, exhibit displays and framing.

Foam core was chosen for modeling the mount because it is a strong, lightweight, and easily cut material used for the mounting of photographic prints, as backing in picture framing, in 3D design and modeling. It is also widely available at art supply centers and cost effective in the modeling of the design.

Cyanoacrylate (a generic term typically referring to a family of strong fast-acting adhesives with industrial, medical and household uses) was used in fabrication because of its adhesion and penetration properties and a recommended adhesive used for Sintra. The material can be obtained from any number of suppliers and relatively inexpensively. The cyanoacrylate adhesive used in the context of osteological repairs is a PaleoBond product widely used in paleontology and used for natural and permineralized bone repairs. There haves been some earlier uncertainties regarding long term stability and the jury is still out on this. Reversibility and removability is good with newer formulations. Repairs, if any, are localized, documented and do not affect other areas of the specimen that may be used in the future for chemical analysis.

Water, surfactants (detergents), water-ammonia mixture, etc. are widely used for routine cleaning and care of osteological specimens, and therefore the preferred cleaning agents of choice. Historical osteological preparations required removal of soft tissues by methods that did not completely remove oils. These oils continue, over time, to leach out and polymerize into waxes that are ideal sticky pads for dust and dirt. Detergents and sometimes organic solvents are used in the cleaning process to dissolve surface wax with embedded dust and dirt.

SUMMARY

The working prototypes for the mount and wood base were used to source a manufacturer for custom commercial displays. The competitive pricing for fabricating the mounts and bases for all 139 specimens was one third the cost of anything commercially available, making for a practical and viable development initiative in terms of labor and materials, to clean, repair and remount the Hyrtl skull specimens, while significantly improving the stability of the objects on display.

Fig. 7 The skull on its mount on top of the wooden display base for label attachment