Given the focus of biological anthropology and mechanical engineering, a consistent theme within these articles is biomechanical experimentation and models. Experiments allow for the collection of raw data, but models are useful for data analysis and hypothesis testing.

Berthaume and Kramer [xxx] put forth a working definition for anthroengineering…

Two potentially polyphyletic genera of hominins, *Paranthropus* and *Australopithecus*, are hypothesized to of differed in dietary ecology, where *Paranthropus* is hypothesized to of had a more biomechanically challenging diet. Berthaume and Kupczik [RSFS-2020-0085] examined differences in molar biting biomechanics between South African *Australopithecus africanus* and *Paranthropus robustus*. While they found large levels of overlap in biomechanical performance, *P. robustus* was found to require more force and energy to fracture the proxy food items than *A. africanus*. They interpreted their results in the context of other dietary reconstructions, and hypothesize three possible evolutionary scenarios concerning the dietary ecology of these hominins. They stress the importance of taking a holistic approach to reconstructing hominin dietary ecology, instead of analyzing characters (e.g., tooth/cranial shape, dental microwear, or carbon isotopes) in isolation.

Mammals long bones grow by depositing bone at the surface of the metaphysis (i.e., the shaft) that touches the growth plate. A previous study noted differences in metaphyseal morphology between hominoids were correlated with both ontogeny and locomotor patterns: while all hominoids started life with a relatively flat metaphysis, those that engaged in climbing developed a bumpier surface and those that engaged in bipedal locomotion maintained a flat surface. It was hypothesized the bumpy surface allowed the growth plate to better resist shear forces by “locking” the metaphysis and epiphysis together (<https://doi.org/10.1002/ajpa.24036>). Here, this hypothesis was tested with a parametric finite element model. Morphologically informed chimp-like and human-like models were constructed and loads were applied to simulate climbing and walking forces. As the hypothesis predicted, it was found growth plates for the bumpier, chimp-like models experienced lower von Mises stresses during climbing compared to growth plates for the flatter, human-like models. Across all models,

It was found that the chimp-like, bumpier morphology resisted shear forces more

Hammerberg and Kramer [RSFS-2020-0058] analysed centre of pressure (CoP) in the foot during the braking and propulsion phases of locomotion during a wide range of activities. For the first time, to our knowledge, they applied clustering analyses from spatial statistical methodologies to assess the consistency of the spatial component of CoP points across multiple, contiguous steps during human walking, thus allowing for robust statistical support to the qualitative results from their walking trials. Analyses revealed that while CoP is consistent to certain portions of the foot during propulsion and braking, the cluster is tighter during propulsion, indicating there is less variation in the forces passed to the foot bones during propulsion relative to braking. CoP during propulsion was also consistently located in the forefoot across all trials, while it was spread across the fore-, mid-, and hindfoot during braking, implying the forces during propulsion will consistently have an effect on the distal ends of the medial metatarsals during gait, but the tarsals and ankle bones (i.e., calcaneus and talus) are all likely to be affected by the forces of braking during bipedal locomotion. Their results further stress the importance of taking several steps into account during biomechanical locomotion analyses, and have both clinical and evolutionary implications.

Hatala et al., [RSFS-2020-0075] describe a new method for quantifying and analysing track ontogeny during locomotion. By combining physical experiments (i.e., motion capture, biplanar X-ray) with digital simulations (i.e., the Discrete Element Method) and 3-D animation/visualization, they were able to create validated simulations of footprint formation. These simulations allowed the researchers to investigate the patterns of substrate flow under the foot during footprint formation, allowing aspects of track morphology to be directly correlated with hidden aspects of track formation. This new tool will eventually allow researchers to test hypotheses about how aspects of foot morphology and anatomy and locomotion (e.g., kinematics and kinetics) relate to substrates and track formation, ultimately allowing for more accurate interpretations of fossilized tracks. The results of this study additionally have clear implications not only to scientific fields like paleoanthropology, but also to engineering disciplines like robotics.

Cook et al., [RSFS-2020-0083] constructed a cranial finite element (FE) model of the type specimen *Homo* *floresiensis* (LB1) to test hypotheses about its dietary ecology. The found *H. floresiensis* generally experienced higher strains than the australopithecines included in the sample, and similar strain magnitude distributions to their human sample. However, the strain patterns in the zygomatic bodies and arches more similarly matched that of chimpanzees. *H. floresiensis* was efficient at transmitting bite force (i.e., mechanical advantage), but had high strains during biting that risk TMJ subluxation or dislocation during powerful molar biting. Contrary to previous findings from a biomechanical analysis of the mandible, the cranium of *H. floresiensis* was found to be nearly as wek or weaker than modern humans. Results suggest *H. floresiensis* was poorly suited for feeding on objects that required high bite force or highly repetitive chewing

Biomechanical models rely on a number of input parameters, including muscle force. Estimates of muscle force production are therefore critical for accurate biomechanical models. Previous methods for estimating muscle force often assume homogeneity of muscle fibre type within a muscle: that is to say, all muscle fibres are assumed to have the same force production capabilities. Holmes et al., [RSFS-2021-009] extend previous research on muscle mechanics by combining physiological cross-sectional area (PCSA) estimates for muscles with muscle fibre type data. By taking into account heterogeneity in muscle fibre type, they show how muscle force production for the masseter and temporalis in a chimpanzee were significantly overestimated in previous studies (which assumed homogeneity) by 44% and 36%, respectively, and bite force was previously overestimated by as much as 63%. The decrease in muscle force estimates when taking into account heterogeneity may seem counter-intuitive, but it is due to the abundantly expressed MHC -cardiac muscle fibre type, which has an exceptionally low muscle fibre tension value.

Extant primates are often used as models for understanding extinct hominins. The loads and strains experienced by a *Macaca* mandible are often thought to be representative of anthropoids, and thus used to interpret the mechanics of mandibular morphology of extinct hominins. In Smith et al., [RSFS-2021-0031], a finite element model of a *Pan* mandible is compared to a *Macaca* to determine if they have similar deformation regimes, and the experimental results from *Macaca* are broadly applicable to primates. While the overall deformation regime (i.e., how the mandible deforms) is similar between these two genera, there were differences in loading and strain regimes, implying differences in morphology cause the forces to be transmitted differently in the mandible and the resulting strain patterns to be unique in each species. An important finding of their study is that, due to the omission of balancing (i.e., non-biting) side muscle forces, 2D finite element models cannot produce accurate estimates of mandibular biomechanics: this is particularly true when the strains around the mandibular symphysis are being considered.

In a complimentary set of publications, Pryor McIntosh et al., [RSFS-2021-0032] and [RSFS-2021-0033] investigated the morphology and biomechanical function of the trabecular bone in the brow ridges of 5 species of anthropoids. Their sample included 3 species of hominoids (*Pan*, *Gorilla*, and *Homo*) to provide a phylogenetic framework for understanding hominin evolution, and two outgroups representing species of African (*Papio*) and American (*Cebus*) monkeys. They found the subcortical bone in the supraorbital bone was moderately oriented and had a high bone volume fraction. Interestingly, the trabecular bone in this region tended to be transversely isotropic in morphology, forming sagittal plates which spanned the mediolateral length of the region, and connected by shorter struts in the mediolateral direction. Finite element models of 4 chimpanzee crania with boundary conditions to mimic mastication revealed the plates did not align with the primary and secondary strain orientations. This suggests that, although the orientation and morphology of the trabeculi in the supraorbital ridge may be adaptive to resist repetitive loads, as it is in other areas of the body, like the femur, it is unlikely these loads come from mastication.

Teeth and, in particular, dental enamel, is a highly resistant material with many unique features that make this possible. Borrero-Lopez et al., [RSFS-2020-0070] review the mechanisms through which mechanical failure can occur in enamel (i.e., fracture, wear) from a materials engineering perspective. They explain how aspects of enamel structure and properties, like elastic modulus gradients, can help protect enamel by, for example, redirecting microcracks and preventing catastrophic enamel failure. In leveraging indentation mechanics, a fundamental physical (‘anthroengineering’) basis for exploring many aspects of the evolutionary biomechanics of tooth function is developed.

The mechanical properties of the foods consumed determine what type of loads are transferred to the teeth and subsequently skeleton of a primate, and are thus important in understanding masticatory biomechanics. Traff and Daegling [RSFS-2020-0087] use a novel testing rig to investigate biomechanical differences in more compliant young and more mechanically challenging mature leaves during simulated chewing. They found mature leaves required more total force to breakdown and broke down into smaller pieces, presumably because their higher fiber content makes them more brittle. They discuss the “tough/brittle” dichotomy often used to describe mechanically challenging foods, and suggest this dichotomy may not be appropriate for describing young and mature leaves.