

Assignment #4  
Carpal kinematic sequence  
Part 4A Research and Proposal  
Due October 27

For Thursday, please review the papers that have been uploaded (now) to the course calendar, and try to identify a topic that you think will provide interesting and manageable subject matter for a visualization in the Yurt. Do some visual sketching and verbal theorizing about what you are trying to show. You can focus on particulars of one bone-on bone interaction, the role of ligaments or a particular pattern of movement. If you'd like to have a clinical, analytical outcome as an organizing principle for your theme (such as a medical problem) that's fine, but it's not necessary. Another option would be to set up a comparison between two patterns of carpal motion, or simply concentrating on legible description of the motion of a given carpal bone in relation to its neighbors.

We will talk more on Thursday about the particulars of the project, but for now you should simply try to find an issue within the writings on-line that seems like it might be interesting to pursue as visualization. I have organized below the papers that are most relevant to our assignment into three broad categories that may simplify your exploration. Let me know if you have any questions.

### **Dart Thrower's Motion**

**In Vivo Triquetrum-Hamate Kinematics Through  
a Simulated Hammering Task Wrist Motion p. 18**

**The Advantage of Throwing the First Stone: How Understanding  
the Evolutionary Demands of Homo sapiens Is Helping Us  
Understand Carpal Motion p. 40**

**The Mechanical Axes of the Wrist Are Oriented  
Obliquely to the Anatomical Axes p. 31**

### **Thumb CMC**

**The Thumb Carpometacarpal Joint: Anatomy, Hormones, and Biomechanics p.113**

**In Vivo Kinematics of the Thumb Carpometacarpal Joint During  
Three Isometric Functional Tasks p. 9**

### **General Carpal and Metacarpal Kinematics**

**In Vivo Kinematics of the Scaphoid, Lunate, Capitate, and Third  
Metacarpal in Extreme Wrist Flexion and Extension p. 82**

**Elongation of the Dorsal Carpal Ligaments: A Computational  
Study of In Vivo Carpal Kinematics p. 56**

**A Method for Defining Carpometacarpal Joint Kinematics from  
Three-Dimensional Rotations of the Metacarpal Bones Captured  
In Vivo Using Computed Tomography p. 101**

Assignment #4  
Carpal kinematic sequence  
Part 4B Wizard of Oz sequential model  
Due November 3 & 5

Based on Trey's research papers and the visuals he has provided us, create a sequential kinematic visualization of the movement of a part of the wrist in support of a simple hypothesis; you should focus on a detail that you feel is significant, based on your analysis of the readings. The significance could be a medical one, or an evolutionary one concerning the efficiency of the dart-thrower's path, or you may simply be concerned with clearly visualizing a complex interaction between two or more surfaces during a given wrist motion.

Your kinematic sequence should involve four frames, which can be cycled through as a pseudo-animation using the "Wizard of Oz" technique, with an assistant pushing the keyboard button to cycle the frames as you narrate from inside the Yurt.

Naturalistically and accurately modeling complex 3D surface with CavePainting is, of course, very challenging and time consuming. Some of this surface building will almost certainly be necessary, but strategize to keep it to a minimum by saving special effort for the surfaces that matter most in the interaction you are trying to show. You might consider meshes, grid patterns or graphic profiles to clarify the configurations of surfaces by simplifying or abstracting them.

One of the difficulties of showing carpal motion is the visual subtlety of the carpal bones and their arrangement. Try to construct your model so that the users will easily understand what part of the hand they are looking at, from what angle, and what action or gesture is taking place. This might involve background imagery that shows the sequential gesture for the whole hand, even though the actual detailed form in your 3D model is limited to one or two bones. You might represent surrounding bones with abstract outlines or masked billboards, for example. Consider now you can represent movement of the forms in space with maximum clarity: a system of coordinates indicating the six degrees of freedom (x, y and z axes and pitch, yaw and roll) could help the user understand the nature of the 3-D kinematics. Indicating particular axes of rotation, or pathways of translation (movement) for individual bones might also be useful.

If there is a particular phenomenon you are concentrating on, like friction between two bony surfaces or strain on a ligament, think how you can color code this force or emphasis so that the narrative you are describing is established through visual means.

Because the science we are dealing with in this assignment is extremely subtle and somewhat speculative, it is not necessary that the hypothesis you advance be 100% correct, or even that the volumes or movements that you show be exactly accurate, but do the best you can within the limits of time, the Yurt space and CavePainting to stay close to the information and visuals provided by Trey. Alternatively, you could do a bit of your own research to flesh out your hypothesis, and if this takes you a bit afield from the specific research covered in Trey's papers, so be it.

Our goal is to review these projects on Tuesday and Thursday of next week.