Geometrical Anatomy?

There have been many efforts to model biological phenomena with mathematical methods. These have met with varying success. In general, mathematical models of physiological processes have been better-accepted than models of anatomy. This may partially have been due to the individuals that tend to study and work in these fields, but it may also be due to the limitations of the mathematics. Most mathematics that leads to deep and quantitative results is fundamentally numerical in its logic and works best for studying process in time. It grew out of algebra, calculus, and differential equations. It may be generalized to random processes, probability, and statistics.

Anatomy is fundamentally different. It is about structure; the logic is spatial and the interactions are parallel. We can to some extent model it with a serial process, by using arrays, but since our computing machines are serial processors, they basically scurry over the array, constantly updating for each moment of time. On the other hand, when one bone moves upon another, the logic of the movement is intrinsic to the bones. The shape of the bones is the logic of the movement. How they move and where and when they impinge upon each other is a direct consequence of that logic.

When we apply a variety of forces and restraints upon those bones through ligaments, muscles and their tendons, fat pads, fluids, and external compression and distraction, the whole complex of interactions functions smoothly and efficiently in real time using the logic of their spatial relationships and distributions. The nervous system understands that logic and uses it to control movement; to generate movements that it has generated millions of times before and movements that it has never produced before. Our minds almost effortlessly apply that anatomical logic to control millions of muscle fibers in hundreds of muscles to precisely move hundreds of bones bound together in complexly contoured and constrained, nearly frictionless joints.

We do not understand this anatomical logic in any, but the most superficial sense. Our attempts to model the anatomical system are almost totally different from what we understand the body's logic to be. Our logic machines are built upon totally different principles. Where computers are serial and digital the body is analog and parallel. Where computers are numerical, the body is geometrical. The logic of a bone is its structure; the logic of a muscle is in its attachments and its contractility; the logic of a ligament is in its insertions and elasticity. Each of these is an object with complex properties and intricate interactions with many other elements of the same and different types.

We do not have the computational capacity to understand the body in terms of its anatomical logic. Our tools are inefficient and cumbersome for working with anatomical logic, but it is possible that we may begin to understand that logic using the tools that we do have. Perhaps when we have defined the problems we can begin to develop new tools and logical machines to actually reason anatomically. It may be possible to begin to understand these types of systems in a fundamental and quantitative level. We have the computational capacity to deal with only very simple systems, but it is possible that we do have the capacity to begin to develop quantitative models of anatomical systems.

The analysis in this series of essays is a tentative first step in the direction of trying to define the anatomical logic of simple joints and joint systems. While much of it is analytical, there are attempts to also be synthetic in the approach.