# Teaching and Learning Structural Geology Using SketchUp

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The books and maps we read, the posters we pin on our walls, the TV sets and computer monitors we spend hours watching, the white (or black) boards we use to teach, all reduce our world into planar images. As a result, and through years of oblivious practice, our brain is conditioned to understand the world in two dimensions (2D) only. As structural geologists, we know that the most challenging aspect of teaching and learning structural geology is that we need to be able to mentally manipulate 2D and three-dimensional (3D) objects. Although anyone can learn through practice the art of spatial visualisation, the fact remains that the initial stages of learning structural geology are for many students very challenging, as we naively use 2D images to teach 3D concepts.

While interactive 3D holography is not far away, some inexpensive tools already exist allowing us to generate interactive computer images, the free rotation, scaling and manipulation of which can help students to quickly grasp the geometry and internal architecture of 3D objects. Recently, I have experimented with SketchUp (works on Mac and Windows). SketchUp was initially released in 2000 by @Last Software, as a 3D modelling tool for architects, designers and filmmakers. It was acquired by Google in 2006 to further the development of GoogleEarth. Google released SketchUp for free, and provided a portal named 3D Warehouse for users to share their models. Google sold SketchUp to Trimble Navigation in 2012, which added Extension Warehouse for users to distribute add-ons. SketchUp models can be exported in a number of formats including .dae (digital asset exchange) useful to embed interactive 3D models into iBooks and html5 documents, and .kmz (keyhole markup language zipped) to embed interactive 3D models and cross-sections into GoogleEarth. SketchUp models can be exported into 3D pdf through the add-on SimLab, and .stl for 3D printing through the add-on SketchUp STL. A free licence is available for students and educators (SketchUp Make), and a few hundred Euros will give you access to SketchUp Pro.

Having the capacity to use 3D interactive sketches instead of static 2D images, and generate serial cross-sections through 3D structures, is a major step forward, which not only enhances students experience but also nurtures deeper learning. Explaining why on 2D sections upright folds can appear strongly asymmetric, or why a dextral fault can result in an apparent sinistral offset can be a very challenging thing to do. Tools like SketchUp can help make the learning process far more immediate and easier.

My collection of 3D SketchUp models is available at:
https://3dwarehouse.sketchup.com/user.html?id=1151977671192710697351083
See also interaction 3D model embedded into an eBook:
https://itunes.apple.com/au/book/introduction-to-structural/id1085911016?mt=13