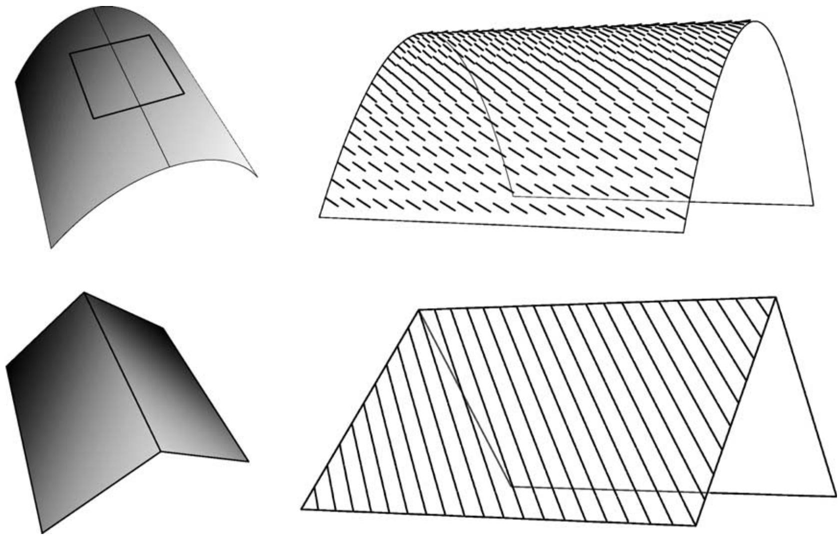

Fig. 20. Illustration of shading flow in the neighbourhood of an edge. When a shaded surface (left) is viewed such that an edge appears, the shading flow field (right) takes on different appearances depending on the nature of the edge. A fold occurs (top) when the surface bends smoothly away from the viewer (the typical occlusion case), and the shading flow field appears tangent to the edge. At a cut, the surface is discontinuous (or occluded), and shading flow is generally non-tangent to the edge.

Fig. 20. As smooth surfaces fold away from the viewer, the shading flow field becomes tangent to the edge. At the same time, the fold side of the edge "cuts" the background scene, which implies that the background cannot exhibit this regularity in general. Cuts, therefore, are those kinds of boundaries in which the shading distribution is transverse to the edge. This is fortunate as it naturally suggests a type of "figure" boundary, because it shows which is the occluding side and which is the occluded side of an edge [21]. This complements earlier work which classified shadow edges on the basis of the shading flow field [6].

Since shading information shares the same geometrical characteristics of texture flow, it opens up the possibility that shading flows may be signaled by cells that are orientation selective and tuned to low spatial frequencies (those tuned to higher spatial frequencies would localize edges, as before). The geometrical analysis described in this section thus suggests two additional kind of computations and orientation-based interactions in the columnar machine. Firstly, the computation of coherent shading flow can be done through texture-flow-like interactions (see Section 5) between orientation-selective cells of low frequency, and the result can be used for the interpretation of shape from shading. Secondly, the interaction between shading and boundaries for edge classification may be achieved though interaction between low spatial frequency cells and high spatial frequency cells. Thus, following the ideas above, signaling a fold-type edge could follow from an iso-orientation interaction between low spatial frequency (shading) and high spatial frequency (edge) cells, while cut-type edges requires interactions between cells of different orientations. This is illustrated in Fig. 21.

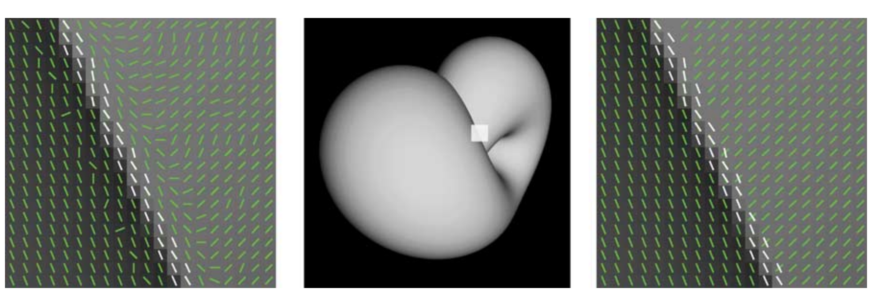

Fig. 21. Example of shading flow relaxation and the possible interaction between the flow and the edges to signal either fold- or cut-type edges. Note how the initial shading flow (left) of the marked region of interest (center) becomes fully coherent after few iterations of relaxation labeling based on the texture flow compatibilities (right), and how the relationship of the relaxed shading to the active high frequency cells (in white) indicates a fold on the left and a cut to the right. Indeed, the surface to the left of the edge occludes the one to its right, as is clearly seen in the image itself.