Cell’s dorsal surface is $\Omega$ ; the boundary of this surface is $\partial\Omega$ (see figure). This flat surface is in the x-y-plane; x-axis is the direction of the tactic directional cue, and the cell is polarized in that direction.

The ventral surface, $z=h(x,y)$ , is given by the equation: $\Delta h(x,y)=-T/P$ , where $T$ [pN/um] is the cortex tension and is a given parameter, and $P$ [pN/um^2] is variable in time (see below). The boundary condition for eq. $\Delta h(x,y)=-T/P$ is $h(x,y)=0 \text{ on } \partial\Omega$ . In addition, the volume of the cell is conserved: $\int_\Omega h dxdy = v$ where $v$ is the constant model parameter – cell volume.

The boundary of the dorsal surface (we’ll call it cell edge) is deforming in a locally normal direction (see fig) with local velocity, which is a function of 1) angle $\theta$ between the x-axis and polar angular coordinate of the point at the edge, and 2) of the contact angle $\varphi(\theta)=\arctan\left[\nabla h(x(\theta),y(\theta))\right]$ where $x(\theta),y(\theta)$ are Cartesian coordinates of the point at the cell edge with polar coordinate $\theta$ . To measure $\theta$ , we need to define the cell center (cross in the fig). One convenient way to define it is find the dashed line parallel to the x-axis which divides the dorsal surface in two equal halves (so that areas to the left and right from this line are the same: $A_1=A_2$ ), and then take the center of the dashed line (see fig).

Let us try the following velocity of the boundary, which can be derived from a force balance combined with Young-Dupre eq.:

$$V(\theta)=\kappa_1\underbrace{(A_0-|\Omega|)}_{\substack{\text{this term stabilizes}\\ \text{the dorsal surface}\\ \text{area } |\Omega| \text{ to around}\\ \text{target area } A_0}}+\kappa_2\underbrace{\cos(\theta)}_{\substack{\text{this is graded}\\ \text{protrusion-}\\ \text{retraction}}}-\kappa_3\underbrace{T\cos(\varphi(\theta))}_{\substack{\text{this is influence}\\ \text{of contact angle}\\ \text{and cortex tension}}}+\underbrace{\kappa_4 P}_{\substack{\text{this is}\\ \text{effect of}\\ \text{pressure}\\ \text{pushing on}\\ \text{endoderm}}}.$$

Here $\kappa_{1,2,3,4}$ are model parameters.

First, scale and non-dimensionalize the model. I would take volume^1/3 as length scale, T*(length scale) as force scale; (length scale)/kappa_2 as time scale.

Then, think about the numerics. The algorithm probably should be similar to that in Hunter’s paper:
At any time step,

1) On a given $\Omega$ , solve $\Delta h(x,y)=-T/P$ with $h(x,y)=0 \text{ on } \partial\Omega$ . Find P from the condition: $\int_\Omega h dxdy = v$ . (In Hunter’s paper it seems they have some neat trick for doing that)
2) Find the cell center, compute $V(\theta)$ , deform the cell edge.