Displacement/Deformation(spring) analysis of opening the umbrella. Again, we show one of the eight, rotationally symmetrically distributed, ribs in a displaced state.

We seek now how the angles \( \Psi \) and \( \Phi \), and the lengths \( x \) and \( l \), change with \( \theta \). This is a matter of geometry of displacement and rotations. Consider \( \theta, a, b, c, \) and \( d \) as given. From the geometry, construct two relationships from which you can compute \( \Psi \) and \( \Phi \) in terms of these given quantities.

Deduce, again from the geometry, an expression which will allow you to compute the length \( l \) given \( \Psi \) and \( \Phi \) and the given lengths.