The very basic and simplest description of nuclear many-body systems is the (self-consistent) mean-field approximation to the many-body problem. In particular, shape is the property of mean field.
Thus, if some nuclei show the specific feature of axially-symmetric quadrupole deformation, it is most convenient to start with the mean field, which has the same symmetry.
In order to obtain shape and size of deformation, on which Jahn-Teller effect (JTE) says nothing, shell-structure of one-particle spectra in deformed potentials must be studied. The study has been developed uniquely and extensively in nuclear physics.

For simplicity, taking phenomenological one-body potentials which are well applied to observed deformed nuclei, I try to explain the shell-structure and how to use those one-particle spectra as a function of deformation (so-called Nilsson diagram), in the study of the shape (and other physics quantities) of particular nuclei with (N,Z) such as stable prolate nuclei, oblate nuclei, nuclei with weakly-bound neutrons etc.