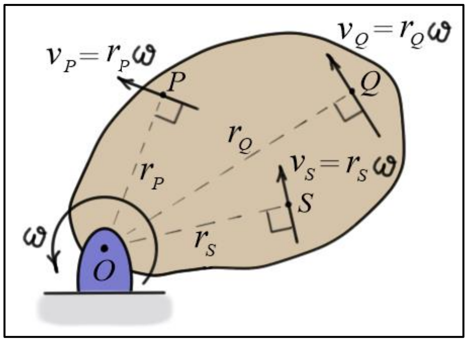
Elementary Dynamics
Instantaneous Centers of Zero Velocity

An ***instantaneous center*** is a point of a rigid body (or rigid body extended) that has ***zero velocity*** at a ***given instant of time***. The ***acceleration*** of that point is generally ***not zero***. The concept of instantaneous centers can be used instead of the relative velocity equation (discussed previously) to solve for the velocities and angular velocities of bodies within a system. As with other ***graphical methods***, it is useful to understand (or "see") the angular motion of a body. Although it applies to velocities and accelerations (linear and angular) of bodies in fixed axis rotation, it only applies to velocities (linear and angular) of bodies in general plane motion.

Fixed Axis Rotation

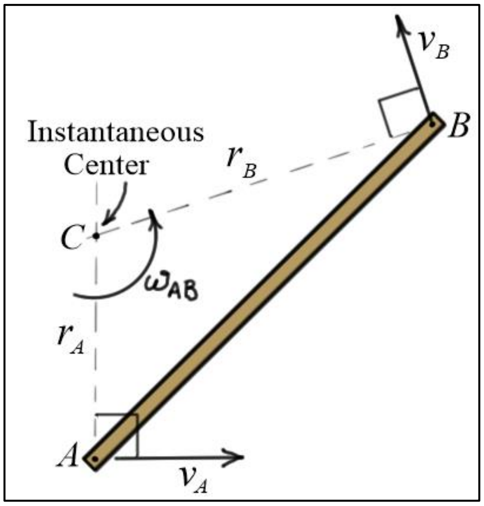
For a body undergoing ***fixed axis rotation***, the ***fixed-point*** *O* always has ***zero velocity***. It is always the center of rotation of the body, and it has ***zero acceleration***. The velocity of any point on the body is equal to the product of the angular velocity and the distance from *O* to that point.



For example, the magnitude of the velocity of point *P* can be written as $v_P = r_P\omega$. The direction of the velocity is perpendicular to the line connecting *O* and *P*.

General Plane Motion

In general plane motion, ***no point*** on the ***body*** has a ***zero velocity*** for all ***time***; however, a point *C* can be identified on the body (or body extended) that has a ***zero velocity*** at a ***given instant*** of ***time***. *C* can be found by identifying the ***point of intersection*** of ***lines perpendicular*** to the ***velocities*** of ***two*** (or more) ***points on the body***. For the bar *AB* shown in the diagram, *C* is identified as the intersection point of the two dashed lines *AC* and *BC*. Line *AC* is ***perpendicular*** to the ***velocity of A***, and line *BC* is ***perpendicular*** to the ***velocity of B***.



The velocities of the two points are $v_A = r_A\omega_{AB}$ and $v_B = r_B\omega_{AB}$. The ***instantaneous center C*** will be in ***different locations*** from ***one instant*** to the ***next***.

Rolling without Slipping

For a ***rolling*** disk, the ***velocity*** of the ***contact point C*** between the disk and the ground is ***zero***, so it is the ***instantaneous center*** of the disk at any time. The velocity of any point P is in the direction shown and has magnitude $v_P = r_P \omega$.