Rotate 90 Degrees

Concerning the orientation of directions in everyday life, we apply conventions on two levels; unconscious and conscious. We learn by experience that when we look in a mirror that things are reversed right to left. Try the mind boggling exercise of holding a pencil in your right hand and looking at your image in a mirror. Pretend that the image is a picture of you. Notice that in the picture, you are holding the pencil in your left hand. When we look in the mirror we can consciously analyze this orientation, based on years of experience, and figure out easily how to brush our teeth, comb our hair, or apply cosmetics. This is an example of conscious correction for proper orientation. On the unconscious level consider what happens on the retinas of our eyes. The eye, acting like a pinhole camera projects an image that is upside down and reversed right to left onto the retina. The information regarding the image is transmitted via nerve pathways to the brain and unconsciously is changed in orientation so that the world is seen in its proper direction. The point of all of this is that it is perfectly natural to make corrections in orientation when necessary. For our

purposes it is necessary to make some conscious adjustments to orientation when we examine the hodograph.

In this chapter we pause in order to visualize the effect of the 90 degree rotation that was described in Chapter 12.

Visualize the orientation of the orbit

Let's see what effect this 90 degree rotation convention for velocity will have on visualizing elliptical orbits generated by our hodograph. The 90 degree rotation is relative. In other words when rotate the tangential velocity by 90 degrees we are doing it relative to the orientation of the radius. We would achieve exactly the same relative orientation, that is a 90 degree relationship between radius and tangential velocity, if we rotate the radius on our mind by 90 degrees instead of rotating the tangential velocity. In that case our convention would be that the true radius and true position of the planet is always 90 degrees away from where it is represented on its hodograph. I find that rotating the radius by 90 degrees is easier to visualize at times than trying to visualize a 90 degree rotation of the velocity. So if the hodograph

is drawn so that the velocity is always pointing in the true correct direction , it generates an ellipse that represents the orbit of a planet which must be rotated by 90 degrees in order to represent the planet in correct orientation. On the other hand if we have a hodograph that represents the true directional orientation for the radius , we must rotate the velocity arrows 90 degrees to obtain the true direction for tangential velocity. But let's assume that the our choice is to designate that the velocity orientation is correct.

For example, the hodograph in *figure a* creates an ellipse whose major axis is oriented in the vertical direction. But in reality the orbit that corresponds to the hodograph velocity arrows if their orientation is taken to be correct, is redrawn *in figure b* as a horizontally oriented ellipse at exactly 90 degrees from where it occurs on the hodograph. The orbit is represented by a red dashed ellipse in the two figures below. The hodograph in *figure a* contains the Inverse Proportion Machine arrangement for the planet when it it as the end of the semiminor axis. The total velocity arrow is oriented correctly in this hodograph in *figure a*. This velocity arrow is thus correctly placed on the orbit to the right without changing

its orientation. It is the orbit itself, represented in red, that we have rotated by 90 degrees in *figure b*:

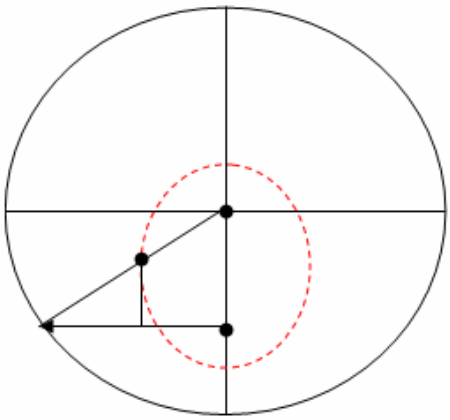

Figure a

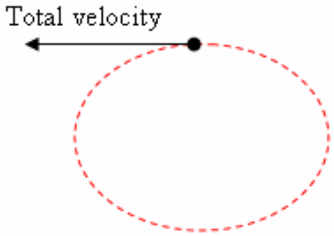

Figure b

It is best to restate our 90 degree rotation convention as follows. When interpreting the hodograph, the correct spatial orientation will result from rotating the major axis of the ellipse by 90 degrees if the velocity directions on the hodograph are to be taken literally. Equally valid is to take the orientation of the major axis of the ellipse to be correct and rotate the direction for all velocity vectors by 90 degrees.