Basic servo linkage geometry (part 2)

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Last time we discussed the force and motion changes that occur if we change the control horn to servo arm length ratio. What we didn't discuss is speed and resolution. In the same way that a longer servo arm gives less applied force and more motion, it also affects resolution and speed. Since our radio decodes our stick motions into a set number of steps there are actually only a certain number of positions our control surfaces will move to. The resolution of the radio system is constant. When we increased the servo arm length we divided that same number of steps over a longer throw which means less precision in positioning the control surface. Conversely the speed of the surface movement has increased. Yes, the elapsed time of the overall motion is similar but it is covering more distance so if we've increased our motion from 2" to 4" we are covering that 2" motion that used to take .15 seconds to 2" in only .075 seconds.

The two tradeoffs could be important depending on your goal. If you are into IMAC style precision aerobatics you may only need a small amount of elevator throw. Many of these big aerobats need as little as +/- 20 degrees of elevator motion to execute the proscribed maneuvers. At the same time, you want a massive amount of torque and precision to move the large surfaces that are common on these aircraft and maintain a high level of precision. Revisiting our tradeoffs, torque is gained at the expense of motion with a shorter arm or longer horn whilst the same change trades speed for better precision. If the motion of the surface only needs to be +/- 20 degrees while your servo arm can move +/- 60 degrees, why not take advantage of all the precision and strength that a 3" servo arm and a 1" control horn would provide? Usually a compromise is made between this ideal and the limitations of available hardware, control rod routing options, etc. resulting in something like a 1.5 or 2 to 1 ratio and then limiting the throw electronically, along with the use of the exponential function. This gives away some of the precision gained but generally our radio systems have more precision than the pilot has!

Here is one last note about servo arm geometry. We all have learned the proper way to connect our linkage is with the servo arm at a 90 degree angle to the servo case at mid stick. This is the most linear motion available from a rotating servo arm which is what we want… but maybe not always. An exception to this is the throttle servo for gas engines. It's just a fact of life with gas engines that linear throttle motion leaves the upper half of stick motion having very little effect. If set up traditionally, we often build a throttle curve on the radio to lessen the initial motion of the servo in response to stick motion. This makes each "click" of throttle have a more linear effect. Assuming the throttle servo is pushing forward to increase throttle, try starting with the servo arm pointed nearly straight to the rear of the plane. The first 45 degrees of travel will result in a very small motion forward as much of the movement is to the side of the airplane in those first "clicks" of travel. Once past 45 degrees or so the motion quickly becomes more to the front of the airplane and throttle increases more quickly. Combined with some endpoint adjustments this can give you a similar effect to the throttle curve radio function. There is other "magic" available by changing the starting position of that arm. Ever hear of aileron differential? You don't have to have a computer radio for that either. Give it a try.