

## Beware of Pole-Zero Cancellations!

The OCF realization of the transfer function

$$G(s) = \frac{s - z}{s^2 + 5s + 6}$$

is not controllable when  $z = -2$  or  $-3$ , even though the CCF is always controllable.

Let's examine  $G(s)$  when  $z = -2$ :

$$G(s) = \frac{s - z}{s^2 + 5s + 6} \Big|_{z=-2} = \frac{\cancel{s+2}}{(\cancel{s+2})(s+3)} = \frac{1}{s+3}$$

— pole-zero cancellation!

For  $z = -2$ ,  $G(s)$  is a first-order transfer function, which can always be realized by this 1st-order controllable model:

$$\dot{x}_1 = -3x_1 + u, \quad y = x_1 \quad \longrightarrow \quad G(s) = \frac{1}{s+3}$$