**Exercise 3: Redesigning Power Take Off Controls for Safety Using the Proximity Compatibility Principle (PCP)**

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**Current Layout Assessment**

Examining the current control cluster panel (**Figure 1.1, J2**) of the John Deere tractor model under assessment reveals a *high proximity* of mixed tactile controls – there are a mix of levers that manipulate hydraulic capabilities, toggles and switches for integrated and custom electrical functions, and the power take off (PTO) toggle, which can be lifted to disengage the attached mechanism and depressed to disable the mechanism. The PTO toggle is distinguished from the rest of the instrument cluster by its heterogenous shape and John Deere Yellow color hue (Hex **#**FFDE00). This initial examination may conclude that the toggle placement, shape, and color are sufficient for safe operation of the tractor, but a brief analysis of the operator’s task behavior reveals areas for improvement.

**Operator Task Behavior Analysis**

One may think that operators of this tractor model are typically performing a divided attention task: using one hand to steer the tractor and the other to operate the hydraulic controls, often while rotating their heads/bodies to visually observe the task. However, most of the hydraulic control operation happens infrequently e.g. engaging a mower deck once and then driving continuously, lowering a baler and collecting hay and then waiting for the internal baling system to spit out a bale, etc. After the action is complete, the operator resumes a focused attention task – driving the tractor, thus their focus is now away from the control cluster and the PTO toggle.

Additionally, the high proximity of the PTO toggle to other controls, even if it’s shape and color are highly distinguishable, is an issue if the operator is focused on the ground ahead of them. The toggle is out of the periphery of the driver and if they have to make an emergency decision to depress the PTO toggle, they may fumble to find it with one hand and would have to: a) simultaneously take their eyes off navigating and b) operate the brake and clutch mechanism to slow the tractor down, adding crucial seconds to shutting down the attached farm machinery. Using this analysis, we propose a new PTO schema, illustrated in **Figure 1.2, J1**.

**Proposed PTO Stalk Schema**

We proposed adopting an already existing convention from John Deere’s consumer line of riding lawn-mowers – the steering column mounted stalk. Not only would this be a cost savings due to parts manufacturing and pre-existing engineering plans, but it also has more safety advantages and closely relates the operator’s true tasks.

Moving to a steering column mounted stalk would alleviate several safety challenges:

1. The stalk’s location is proximal to the driver’s hand position while navigating the tractor, allowing for more immediate operation in case of emergency, as compared to the previous design where it was co-located with the associated hydraulic levers.
   1. Though the stalk would not be clustered with the other hydraulic instruments, it’s removal from the cluster makes its operation more intentional and sequential e.g. engaging the PTO and then manipulate the hydraulic controls and vice versa.
2. The stalk has a more analog and hydraulic feel than a toggle. To engage the operator must pull the stalk down with some slight force, providing tactile feedback that the attached mechanism is working.
3. The stalk’s disengagement mechanism has the exact opposite feel, a slight flick up on the stalk easily disables the PTO.
4. The end of the stalk would be shaped like a bulb, John Deere Yellow in color, and contain relevant iconography allowing for quick visual recognition in low-light conditions and the ability to pull the lever with gloves on.

**Summary**

The proposed changes to the current PTO design from a toggle to a steering column mounted stalk will improve operator safety,