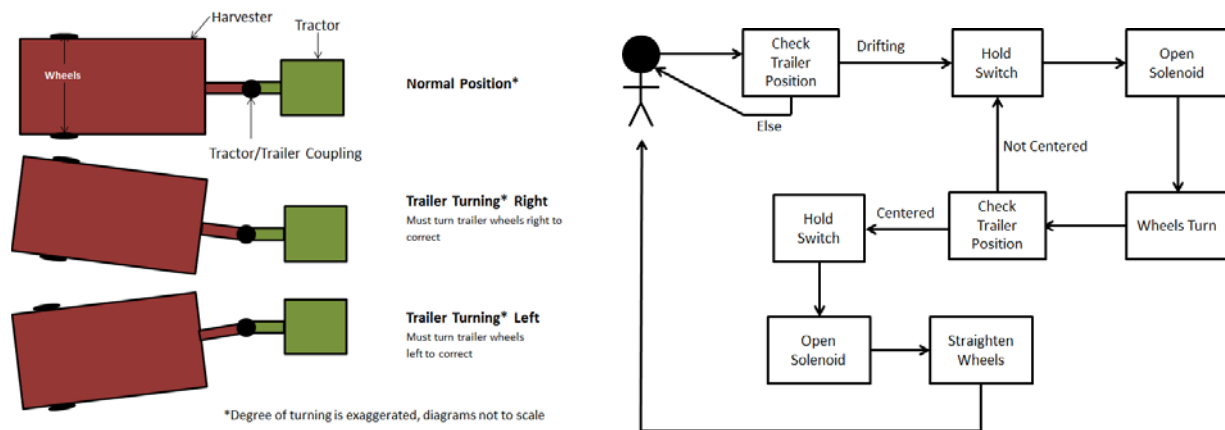


The Sweet Potato Harvester

Sweet potato is a high-value and high future growth crop with a continuous demand all year¹. One of the most critical aspects of maintaining supply is appropriate harvesting and post-harvesting storage. The Smith family farm in Portland, Michigan has been harvesting potatoes for a number of years by turning the ground using a side angle disk plow and partially exposing the sweet potatoes to make it easier for the workers to pick them. However, this considerably slows down the harvesting and as a result the plow can lead to about 25% loss due to skin abrasions during the harvest. In order to speed up and complete the harvest before a killing frost and reduce loss as a result of harvesting by the plow, the Smith family invested in a sweet potato harvester to harvest the crop. However, in order to maximize the crop yields, the sweet potato harvester requires a team of workers to ride on them as they are drawn through the fields. The harvester consists of a tractor and a trailer. As the trailer is pulled along the field by the tractor, it digs the potatoes out of the ground and workers on the trailer separate the potatoes and put them into large bins. This part of the process works well and is an efficient use of man-power.



One challenge associated with the current harvesting method is that the trailer is not fixed to the tractor and so can veer from the path and crush unharvested potatoes. To address this issue, the Smith family has to hire one additional worker whose job is to check the alignment of the harvester and correct its path as needed. This is a drain on the farm's operations as each manual worker required to monitor it results in the farm spending \$60,000 per year during the harvest season (~ 10 weeks as all the 12 harvesters operate for six days a week with the avg. salary of employees being \$10/hr).



Currently, to enable the trailer to follow a straight path, the worker uses a multi-directional switch that activates hydraulic pistons via electric solenoids. When the switch is thrown, it activates the solenoids which in turn cause the hydraulic fluid to flow from one piston to the other. The hydraulic flow helps push the pistons that are attached to the wheels making the wheels turn one way or the other. Therefore, a system is already in place that can be used to turn the trailer wheels. However, it must be manually activated by a worker who is visually monitoring the alignment of the trailer. Your primary task is to automate this system, including detecting misalignment and activating the solenoids accordingly.

As a part of your proposed solution you are required to consider few constraints and requirements. The solution must not interfere with the regular operation of any other part of the harvester. The proposed harvester design must operate continuously in a dirty, wet, hot, or dry environment, the trailer should be able to withstand an amount of roll and pitch of up to ± 13 degrees, and any system malfunction should not result in extensive downtime. The trailer must follow a straight path when plowing with its wheels having a maximum of 10 inch deviation from the center, it must turn on its length with a rotation greater than 90 degrees, it should require minimal maintenance, operate automatically, and should be non-hazardous to the employees working on or around it.

Your goal is to understand the current process of harvesting sweet potatoes and its challenges (*empathize*). Based on the information provided in this case (and some extrapolating), determine what issues/problem are faced by the Smith family (*define*). Within your group, you need to think about probable solutions to address the problem (*ideate*). As the engineer team involved in developing a solution to facilitate harvesting, what steps will you take? Propose a design for a prototype for the automated trailer steering system keeping in mind the above constraints and requirements. Keep in mind that the cost of your solution should be less than the cost of manually steering the trailers and also be economically rewarding. Finally, *test* your solution by presenting it to your peers which will help you look at the limitations in your solution.