John Sterman, *Business Dynamics, Systems Thinking for a Complex World*, includes an assignment Challenge (p. 212) that addresses the oil shock in the summer of 1979. He explains in the Instructors Manual, p. 82 what caused the lines:

"So, where did the gas go in 1979? The total inventory of gas in the system remained nearly constant. But the actions of nervous drivers moved the gas from below ground tanks at the corner gas stations to above ground rolling storage [in vehicle gas tanks]."

The fear of shortages was a self-fulfilling prophesy that created artificial, speculative demand that caused lines and price increases. OPEC and President Carter were blamed, but we did it to ourselves. The structure at right shows the dynamic.

Loop **B1, Fill 'Er Up**, shows that, as gas tanks become empty, drivers make purchases to fill their tanks.

Loop **B2, Consuming Gas**, shows that as gas in their tanks gets low, drivers tend to drive less (though perhaps not much less because most trips are not discretionary). This loop is weak until drivers begin to run out of gas.

Loop **B3, No Gas, No Sale**, shows that as stations deplete their supply of gas, the "fraction of desired purchases fulfilled" declines.

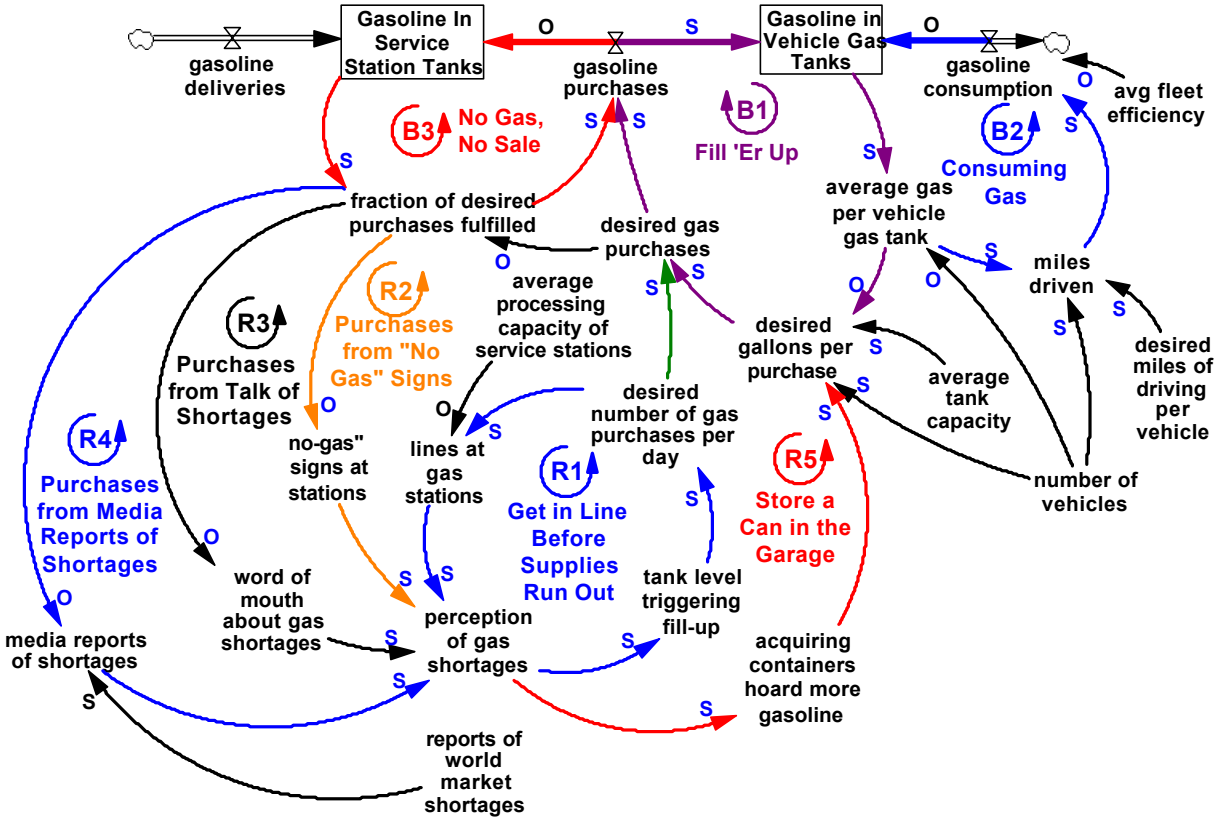
If drivers fear they won't find gas, they'll fill up more often, which creates lines that perhaps double or triple in length (see below). Therefore loop **R1, Get in Line Before Supplies Run Out**, shows that as drivers see lines, they increase their number of purchases. **R1** becomes a vicious cycle.

Also, because drivers are topping off their tanks earlier, the increased demand caused by putting extra gas into gas tanks causes stations to limit purchases or run out of gas. The loops **R2, Purchases from "No Gas" Signs**, **R3, Purchases from Talk of Shortages**, and **R4, Purchases from Media Reports of Shortages**, all contribute to the "perception of gas shortages." This reinforces more topping off, more purchases, and longer lines.

R5, Store a Can in the Garage, shows that hoarding also increases desired gas purchases. This drives **R1**, **R2**, **R3**, & **R4** to become even more vicious.

Sterman writes: "The crisis should ease once the average car is nearly full ... [and] once deliveries ... are accelerated, every customer should be able to buy what they need." "Rationing schemes such as odd/even license plate rules or maximum purchase rules (e.g., 5 gal max.) ... [only reinforce perceptions] that the shortage is real and cause drivers to top off more often ... strengthening the positive loops and intensifying the shortage. A much more effective policy is a minimum purchase of 10 gallons. You would have to pay for 10 gals whether your tank took it or not. ... Implementing such a counterintuitive policy would require great political courage on the part of government officials, but education about the dynamics of these self-fulfilling hoarding crises would help build public support. At the very least, policymakers should avoid imposing rationing schemes that only worsen the problem."

BD Challenge: Linking Stock & Flow Structure with Feedback (text p. 212, Instructor's Manual Exhibit 6-7)



Some calculations: Assume that gas stations deliver enough gas for every auto to drive 40 miles/day using 20 miles/gallon. This is 2 gallons/day/car, or 14 gallons/week.

If drivers normally wait until their 20 gallon gas tank is less than ¼ full, then they'd add ~15 gals/fillup, on which they could drive for 7.5 days. Therefore drivers using 14 gals/week and adding 15 gals/fillup would make 14/15 fillups/week (~1). If drivers become concerned they'll run out of gas, and begin to fill up when the tank is ¼ empty (and don't drive less), they'll still use 14 gals/week, but only add ~5 gals/fillup; they make 14/5 fillups/week (~3). Fillups per week goes from ~1 to ~3, meaning lines of vehicles in gas stations would be 3 times as long.

Vehicle gas tanks would go from an average of (1+ 1/5)/2 = 0.6 full (the average of full at !00% and a low level of ~20%) to an average of (1 + 7/10)/2 = 0.85 full (the average of 100% and just below ¾ full at 70%). The added gas per tank would be .25 * 20 gals = 5 gals/car. (Note this does not include the extra containers that drivers bring to the station to fill for an extra supply.)

Because stations deliver at a rate of 2 gals/day/car, this is 2.5 days supply. If this added demand comes within one week, that's 2.5/7 = .36, a 36% increase in demand for that week, enough to overwhelm the stations' ability to supply gas.

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