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Project

"Prestige Worldwide"

Prestige Worldwide is a global entertainment force! In their short existence they have dominated the world of music, videos, and securities. The next logical step for their expanding monopoly of all things cool is a foray into the wide world of sports.

Keeping true to their motto, "Only the Best," *Prestige Worldwide*, has scoured the United States to ensure the highest quality products for their valued customers:

Philadelphia Cheesesteaks
Atlanta Peanuts
Dallas Wings
Chicago Brats
Los Angeles Malts
Seattle Coffee

Prestige Worldwide wishes to maximize their profit before they take on their new project, so they hired two naval aviator OR (future) graduates to model their network and determine the best strategy to distribute the goods.

The Model

This network is an example of min-cost multi-commodity flow. Flow is not driven by "supply" and "demand," but rather through dummy "sink-to-source" type arcs. Each arc has an associated cost and upper-bound that factor into the formulation. Total cost in the network is determined by the following considerations:

$$C_{ij\_Production} + C_{ij\_Airport} + C_{ij\_Transport} + C_{ij\_Revenue}$$

Note that "revenue" costs are a negative (< 0) value, so a min-cost formulation should result in the greatest negative value, otherwise known as a profit!

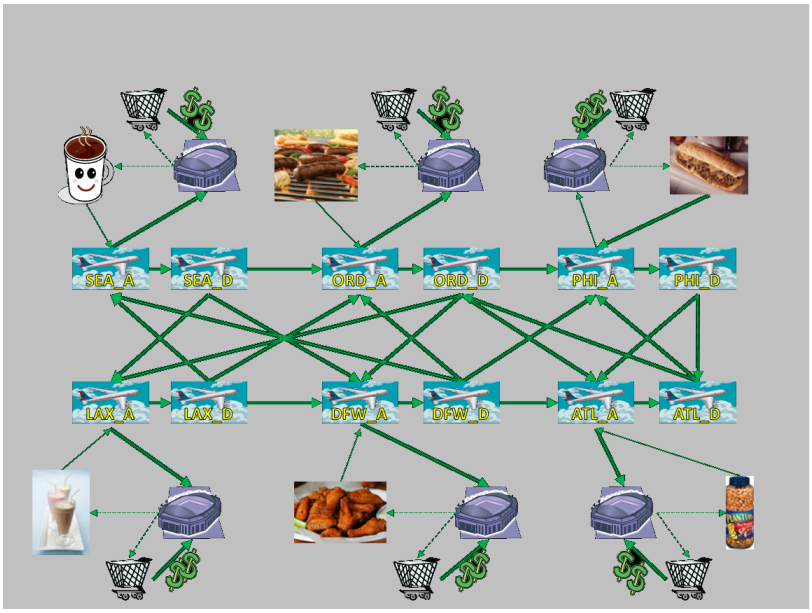
Fig 0: generic arcs and nodes

Nodes: $CITY_i$_START, $CITY_i$_END, $CITY_i$_VENDING, $CITY_i$_LOCAL, COMMODITY_SOURCE
Arcs: $CITY_i$_START -> $CITY_j$_END, $CITY_i$_START -> $CITY_i$_VENDING, COMMODITY_SOURCE -> $CITY_i$_START, $CITY_i$_LOCAL -> $CITY_i$_VENDING
"Dummy" Arcs: $CITY_i$_VENDING -> COMMODITY_SOURCE, $CITY_i$_VENDING -> $CITY_i$_LOCAL

Each source attaches to a city node and "produces" the city's product. Each city also has a "local" predecessor node that supplies a "backup" version of each commodity, should

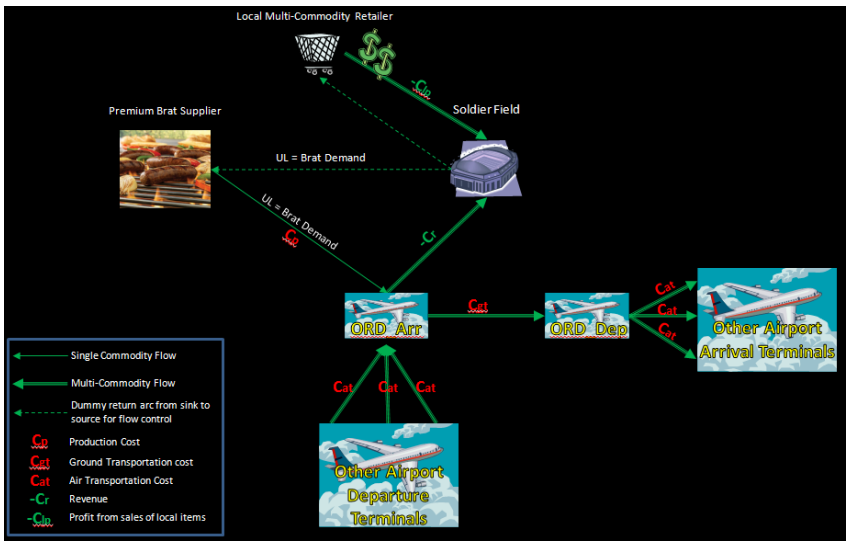
the “source” commodities be unavailable to that city. Those “local” nodes create revenue for the network, but not as much as products received from the “source.”

Fig. 1: Abstract of the network.



All products can reach all customers through the network. The “demand” for “source” commodities is represented by the UB on the “start” to “vending” arcs, while the “supply” of a product is represented by the UB on the arcs that leave the commodity nodes. The motivation for flow is driven by the negative costs (revenues) on the arcs that go into a vending node.

Fig. 2: The Chicago node cluster

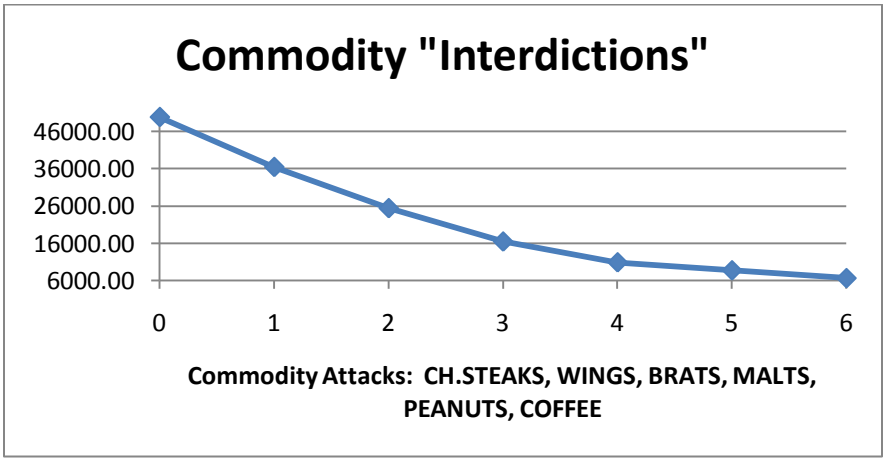


The movement of brats requires several costs before revenue can be gathered. The revenue and demand from the local source in Chicago offers reduced profit thanks to less demand (UB) and “cheaper” products.

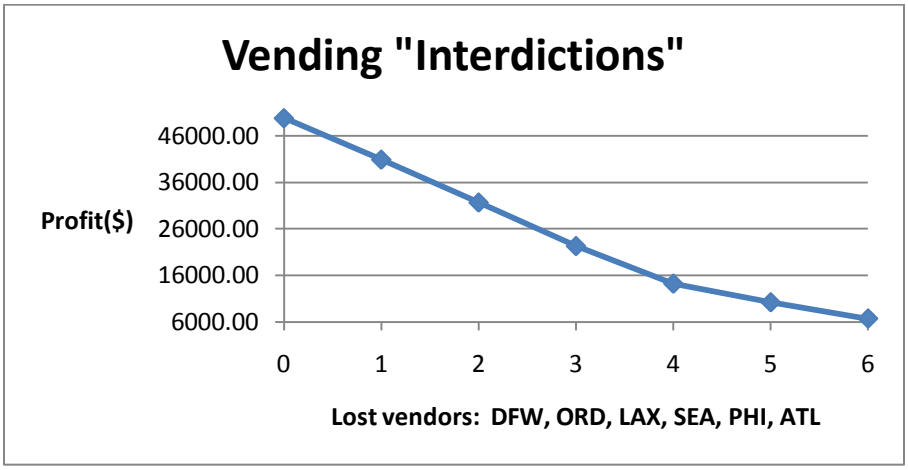
Interdictions

By allowing interdictions in the model, *Prestige Worldwide* can determine their most profitable commodities, their most valuable customers, the most crucial airports, and the necessary airways.

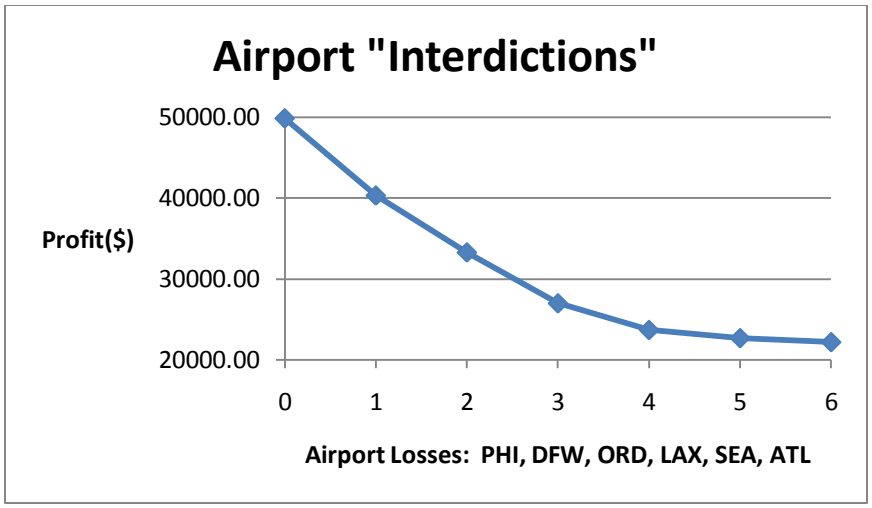
Fig 3-7: Interdiction results by category



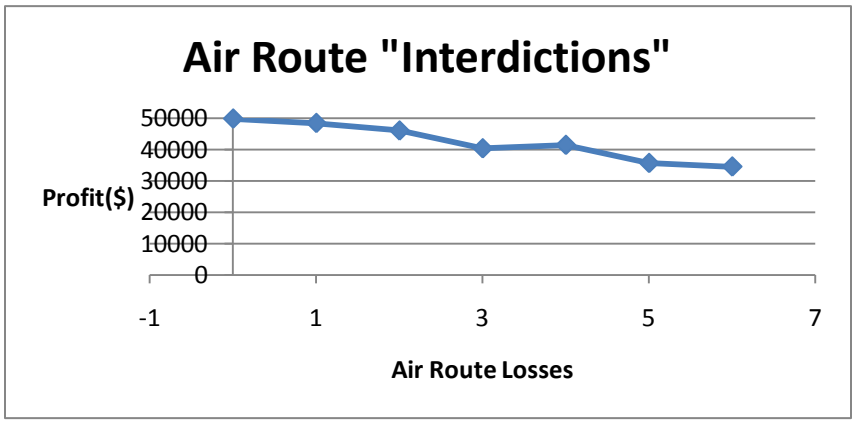
Not surprisingly, an attack on commodities is a nested strategy. In this scenario, Cheesesteaks are the most profitable product, followed by Wings, and so on until all "source" commodities have been cut off and vendors must rely on local sources only.



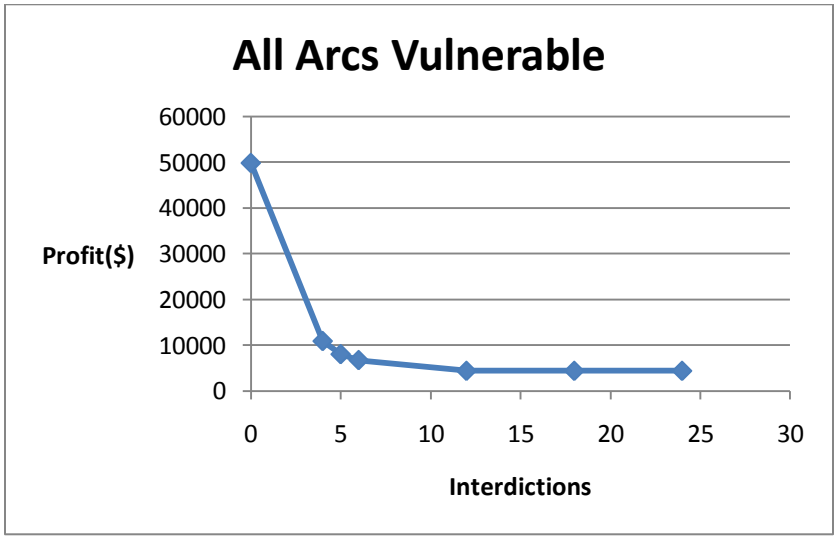
In this scenario, Dallas is our best customer. Once again, the interdiction strategy is nested.



The nested airport interdiction strategy follows pattern similar to the commodity interdictions. The "swap" of the last 2 interdictions may be a result of the local commodity suppliers being able to fill the void left by the shut-down airports.



Air route interdictions are the least severe. Notice the "bump" in the profits as interdictions increase from 3 to 4. This may very well be a result of the solver failing to reach optimality before reaching its iteration limit. However, this result may also be because the formulation forced a 4th attack as opposed to accepting only 3 attacks.



When all arcs are vulnerable, things get interesting. The strategy switches from a commodity only attack at 4 attacks to a "shut down Dallas" strategy on the 5th attack. By the 6th attack, there are attacks on Dallas, Cheesesteaks and LAX local. Eventually, the profit "bottoms out" at just shy of 5,000 when all demand is being filled by local suppliers.

Conclusions

While this model certainly does not represent all possibilities and locations, it reflects reality in its utilization of Excel's random features to model the ever-shifting natures of supply and demand. Some results stated the obvious. The most profitable commodity is that with the highest profit margin given comparable demands (cheesesteaks). Some results were less obvious. Dallas was the most valuable customer not because it had the highest demand or greatest "prices," but rather because it was most conveniently located to all suppliers. With more time, this model could have been utilized in a simulation where supply and demand were parameterized to reflect real world data. The results could then be presented based on fluctuating windows of time. This simulation, along with a user interface, would make the model a useful tool in ensuring a profit while guaranteeing, "Only the best!"

Prestige Worlwide!