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Game Guide: How to Teach the Slick Oil Distribution Game

This is a step by step guide for instructors or business leaders to facilitate the Slick Oil Distribution Game. The game was developed as a way to teach players the true value of mathematical optimization while also having some fun. You can read more about the background for this game in the blog post A Simple Game for Teaching the Value of Optimization.

Storyline

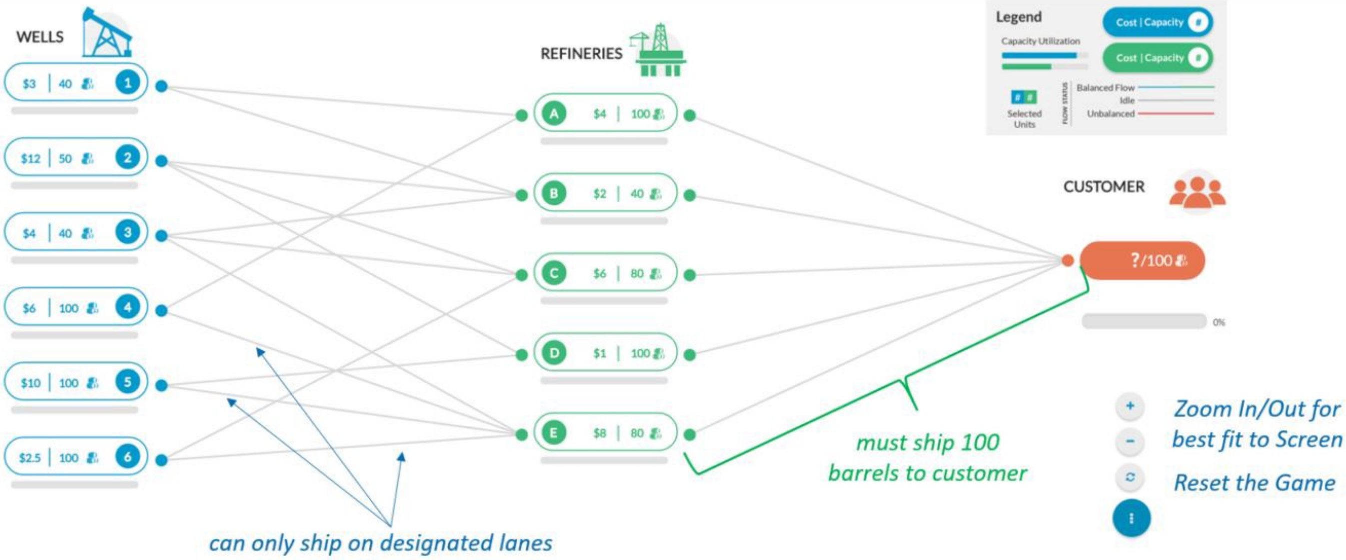
Slick Oil Company is a small oil manufacturer that recently signed a big deal with a new customer committed to purchasing 100,000 barrels of oil over the next year. After celebrating their success, they realize that they must quickly figure out how to use their current network to satisfy this new demand. Raw oil must be sourced from a well and then shipped to a refinery for processing before delivery to the customer. Slick's network of wells and refineries are already built and have extra capacity to be used for this new demand so no additional fixed costs need be considered. Each Slick well and refinery has an associated cost per barrel and capacity (in barrels). Not all wells are compatible with all refineries, however, and therefore only applicable combinations can be utilized. All refineries can service the new customer.
The player's reputation precedes them and Slick wants to hire THEM to help determine the ***optimal*** way to service their new customer. Now you will take a closer look at the data provided and all the potential flows from which to select.

Game

A PDF document including slides to help guide the game along can be downloaded for additional assistance in moving the game along. Click to view.

First, introduce the current network by having everyone proceed to the game's site (best in Chrome but works okay in Firefox as well): LAUNCH GAME
Make sure to instruct players to **continue to follow along with you** and not start trying to configure the network on their own just yet!

Utilize the below graphic (or the similar graphic within the PDF guide mentioned above) to walk through directions for using the game's interface:



Storyline: Now that the game site provides a view of the entire problem the players realize the network is actually pretty small. It should be a piece of cake to eyeball and determine the optimal solution for serving this new customer right? You will first walk through a couple approaches together to try to prove (or disprove) this.

Round 1

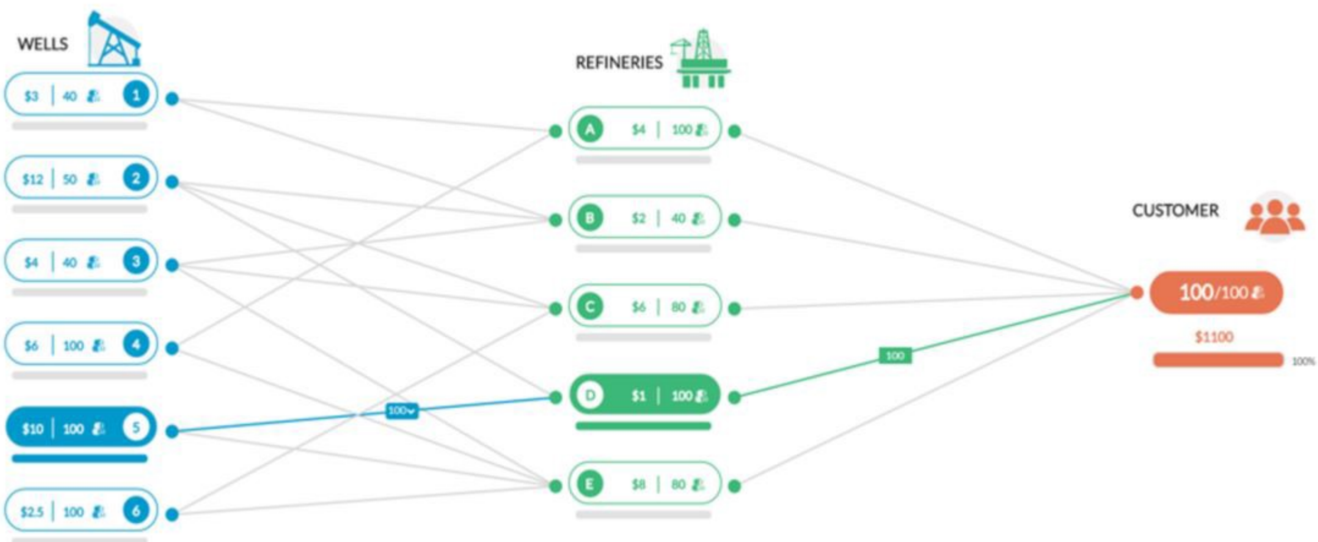
Note: Someone may suggest that you have to look at combinations and not just one node at a time at some point in the first couple rounds. Just tell them to 'hold that thought' and that we want to try a few different approaches.

Game: So we have to start somewhere right? Let's do that by focusing on the refineries first.

- What is the cheapest refinery we can utilize?
- Answer from participants should lead to D at $1 per barrel
- Does D have the capacity to satisfy all of the customer's demand?
- Answer should be *yes*

Great, so now let's continue to work through the network.

- Does well 5 have the capacity of 100 barrels required by refinery D?
- Answer should be *yes*
- If we use this network what is our cost to serve the new customer?



- Players should produce the below result — $1,100
- Do you think this is the optimal answer? Why or why not?

Round 2

(Advise players to use the refresh button in the bottom right of the page to reset)

Game: So now let's approach this from a slightly different angle. Let's start by focusing on the Wells this time.

- What is the cheapest well we can utilize?
- Answer from participants should lead to 6 at $2.50 per barrel (You might need to point out that the cost for well 6 is actually $2.50 and not $25)
- Does 6 have the capacity to serve all demand?

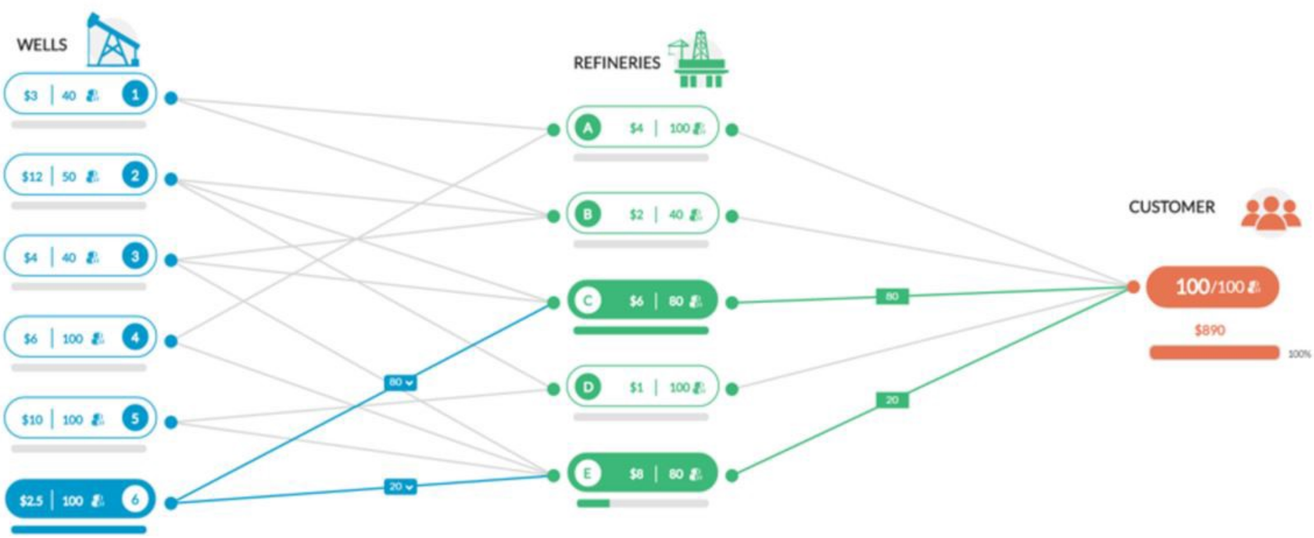
- Answer should be C at $6 per barrel
- Does refinery C have the capacity to handle all 100 barrels from well 6?
- Answer should be *no*

The max we can place there is 80 of the 100. So let's do that.

- What is the NEXT cheapest refinery that is compatible with well 6?
- Answer should be E at $8 per barrel
- Does refinery E have enough capacity to handle the 20 remaining barrels from well 6?
- Answer should be *yes*

Let's place the last 20 barrels of demand on that lane then.

- If we use this network what is our cost to serve the new customer?
- Players should produce the below result — $890



- Do you think this is the optimal answer? Why or why not?

Note: As mentioned earlier, typically, someone will have brought up that combinations are more important than just picking a single well or refinery at the start. Referencing that suggestion again here is a good segue.

Game: We previously mentioned that we have to consider both wells and refineries at the same time. So this time let's start by selecting the lowest cost pair.

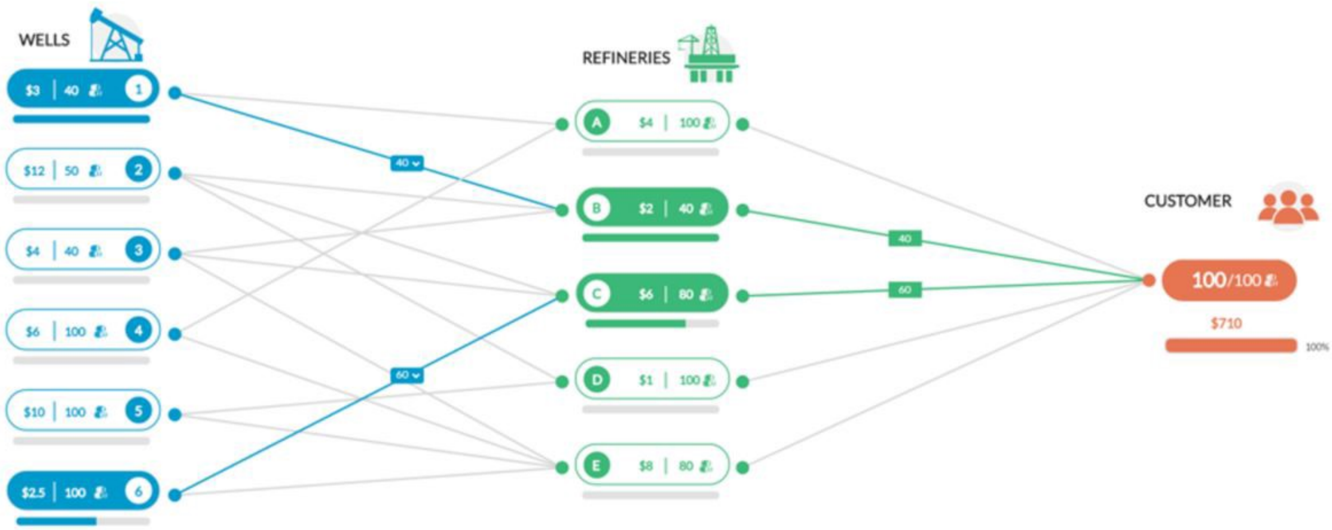
- Which pair creates the lowest total cost per barrel?
- Answer should be well 1 and refinery B at a total of $5 per barrel
- Does this pair have enough capacity to service all demand?
- Answer should be *no*

The max we can source through them is 40 barrels so let's do that.

- What pair has the second lowest cost per barrel?
- Answer should be well 6 and refinery C at a total of $8.50 per barrel
- Does this pair have enough capacity to service the leftover demand of 60 barrels?
- Answer should be *yes*

So let's source the final 60 barrels from here.

- If we use this network what is our cost to serve the new customer?
- Players should produce the below result — $710



- Do you think this is the optimal answer? How would we PROVE it's the absolute lowest cost solution?

- Answer should lead them to understand that in order to prove you found an optimal solution you must determine the cost to serve a barrel of oil through each and every applicable combination of well and refinery. You must then calculate the sum of every potential combination of well/refinery totalling 100 barrels of oil in order to determine which generates the LEAST COST. A LOT of work to do by hand even for this small problem!

Optimization Discussion

Storyline: Approaches like those we have applied thus far are commonly called 'greedy' approaches. Greedy approaches make decisions for one part of the problem at a time without considering the 'whole'. Most people naturally utilize this approach when asked to 'eyeball' solutions or solve 'by hand'. They can be useful for very simple problems but quickly become unreliable.

Final Round:

(Advise players to use the refresh button in the bottom right of the page to reset)

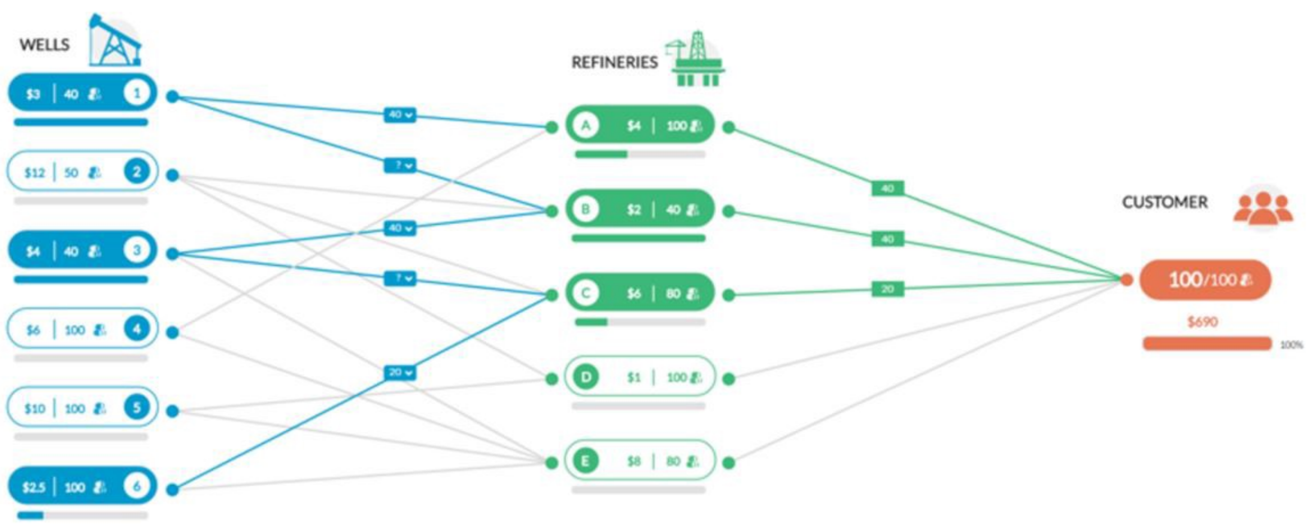
Game: I can say for sure that $710 is not the optimal answer. Take a few minutes to try to

NOTE: Typically, one or a few people find the right answer, but many don't. The real determination, for those who do find the optimal solution, is whether they stumbled upon it or whether they can explain how they reasoned it out. Note those who find the optimal solution and use them to help with the final storyline.

Lessons Learned:

Storyline: (Select one person who got the optimal answer to address)

- So what is the optimal answer?
- $690 (see applicable combinations below)



- What iterations and thought process did you do to get there? Why didn't you pick the combination of Well 1 and Refinery B?
- We are looking for everyone to realize that in order to find the 'optimal' solution they must counterintuitively give up the cheapest Well/Refinery pair to create two other 'cheap' ones that can satisfy more demand.

This 'aha' piece buried within the optimal solution is the basis for the true value generated by mathematical optimization. Even if the players were able to find the optimal solution proving the absolute best answer. The well known society for operations research and management science, INFORMS, defines optimization as 'Narrowing your choices to the very best when there are virtually innumerable feasible options and comparing them is difficult'. In short, because of the general nature of optimization, players need to be led to fully grasp how quickly the number of potential 'feasible' solutions will grow even with the smallest increase in the scope of the problem. It all lends to the generation of very difficult 'needle in the haystack' challenges which require the power of mathematical optimization to uncover. Ending the game with a discussion around these key realizations wraps up the lesson nicely.

Game over!

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