Practice Problems – Module 8 – revised 2/2013

1**) LEGO MY LEGO** - This problem revisits making three types of LEGO furniture, Tables, Chairs and Stools.

Below is a summary in the product usage of Large LEGOs, Small LEGOs, the price each piece of furniture sells for, the after assembly capacity used (in Cu units) and a limit on production based on demand.

Tables – 2 large plus 2 small, sell for $16, use 9 cu units, no more than 150.

Chairs – 1 large plus 2 small, sell for $11, use 6 cu units, no more than 150

Stools – 1 large plus 1 small, sell for $7, use 3 cu units, no more than 50

Before assembly – there is a limit to how many Large and Small LEGOs combined can be purchased - no more than 1000 total LEGOs.

After assembly, the produced final products can take up no more than 1800 cu units.

In procuring LEGOs, assume Large LEGOs cost 2.4 per unit, and Small LEGOs cost 1.7 per unit.

Create a LP model that finds the maximum profit in making furniture. Decisions in this model include furniture as well as how many LEGO’s of each kind to order.

2) **Drvol Die and Tool** needs to order quantities of part XY76 which they need for machining purposes. They have two different suppliers they utilize to order the parts. Drvol Die and Tool has two plants that need XY76 for the next production period – the Omaha plant needs 850 units and the Lincoln plant 1100 units. Assume demand for these parts must be exactly met.

Supplier Alpha can supply up to 1500 units for 5.5 cents each. Supplier Beta can supply up to 1300 units for 4.7 cents each. There are no quantity discounts. To maintain strong relationships with both suppliers, at least 50% of the maximum of XY76 available from each supplier must be used/ordered. To ensure that there are no quality issues, each supplier must provide at least 30% of the individual plant’s need for XY76.

Finally, there is a little cost difference in getting the XY76 from the suppliers to the two Plants. Based on past data, assess a cost of 1.1 cents/unit for parts going from Supplier Alpha to Omaha, 1.6 cents/unit from Supplier Alpha to Lincoln, 1.3 cents/unit for parts going from Supplier Beta to Omaha, and 1 cent/unit from Supplier Beta to Lincoln. Find the least cost way for Drvol Die and Tool to procure part XY76.

Hint: You can simplify the ratio requirements by utilizing the information that part demand must be met exactly.

3) **I Really Do Read the Articles! -**  Below is a table that shows the number of people ‘reached’ (by men, women and total) by three ad types (Travel ad, perfume ad and a lingerie ad) for two different magazines (Sports Ill. and Around Town) that you have been asked to optimally ‘fit’ with ads. Also shown is a ‘Q’ factor which is an assessment of the overall attractiveness of the ad. Note that it does not vary by magazine.



We will use this data here in this problem, then again later in a different problem.

Our first task: Determine how many ads of each of the three types (travel, perfume, lingerie) should be placed in the next Sports Illustrated magazine that reach at least 35000 people and satisfy the other requirements stated below while minimizing the total number of ads.

The other requirements:

- The ads should reach at least as many men as women.

- For the ads selected, the average Q factor should be greater than or equal to 7.5.

- Each ad type can consist of no more than 50% of the total ad types used in the magazine. Thus, if there were 10 total ads, there can be no more than 5 travel ads, or 5 perfume ads or 5 lingerie ads. This is just an example!

Do not worry about integers. The solution is likely ‘ugly’ – we will address in Module 9.

4) **Who you going call … Again!** - Using the problem description for SodBusters from the chapter, augment the model to handle the following two additional requirements.

a) For just Farm 2 (let’s make Farm 2 the RBW location) - Another part of your operation is hosting sod tours. For every unit of Fescue I planted (in Farm 2 or the RBW Farm), 1000 people come to visit per summer (750 local, 250 outstate). For every unit of Tulsa Fescue at RBW), 1500 people come (750 local and outstate each). Plant grass such that at least 40% of the visitors are from out-state. Don’t forget you don’t have to plant all 35 units of sod.

b) For just Farm 1 (let’s make Farm 1 the Bixby location) - The Bixby location must adhere to local groundwater rules related to fertilization. Fescue I has a fertilizer index of 6.0/unit, and Tulsa Fescue has a F-Index of 4.8/unit. To not be in violation, the average F-index of sod planted must be less than or equal to 5.3 . Again, less than 35 total units can be planted at Bixby.

Objective remains maximize sales subject to the original constraints, the ‘diversity’ constraints (each farm must have 5 unit planted of each fescue type) and these new requirements.

5) **Starducks Coffee** is a local establishment in Portland, OR that has developed a reputation for selling a dark vanilla-tinged coffee (Called “It’s to Quack for!” - or ITQF) that people travel from miles around to buy. For the next two week period, they wish to find the least cost way to mix together their 4 main types of coffee (REG, DARK1, DARK2, VAN) to meet anticipated customer demand of 475 lbs. Their optimal mix can exceed 475 lbs if necessary.

The ITQF mix has some requirements. It must consist of at least 20% of the VAN coffee as a foundation of the unique flavor. ITQF must meet or exceed an average ‘robustness’ target of 5.7 and an average ‘color’ target of at least 3.75. From years of experience, there are explicit measures of robustness (RB) and color (CR) on a 1-7 scale for each of the four foundational coffees.

REG has a RB rating of 4.7, a CO rating of 3, and a per pound cost of $4.

DARK1 has a RB rating of 6, a CO rating of 5, and a per pound cost of $4.5.

DARK2 has a RB rating of 6.9, a CO rating of 4.6, and a per pound cost of $6.

VAN has a RB rating of 3.2, a CO rating of 2.1, and a per pound cost of $4.85.

Additionally, for the next two weeks, there is an unlimited supply of REG and VAN coffee to use, but only 150 pounds of DARK1 and 200 lbs of DARK2.

Find the optimal way (least cost) of blending together the ITQF coffee for the next two week period.

6) **I Really Do Read The Articles – Part Deux**

Revisit the problem description from Problem 3 above, and include the second magazine. Because people read these two magazines (versus just look at the pictures), your goal is to place ads such that the number of ads used overall is minimized.

Ads must be placed such that each magazine reaches at least 35,000 people. Additionally, the average Q factor for the ads placed in each magazine must be greater than or equal to 7.5. Sports Ill. must reach at least 50% men. Around Town must have ads such that at least 40% of the total people ‘reached’ are men. There must be at least 8 of each ad type that appear in both magazines combined.

Create and solve a LP that finds the minimum number of ads needed to meet the various requirements. Do not worry about integer numbers.

7) **The Edmond Public School** system has received a grant from the NEA which pays the district a certain amount of money per counselor ($1250) and teacher ($1500) that it sends to specialized training on technology in the classroom and the growing need for business and technology graduates in the workforce (i.e., MIS Majors). They look to create a LP model to help them decide how many teachers and counselors from each of their three high schools (North, Memorial and Santa Fe) they should send to the training to maximize the payment to the district. The model must make decisions for how many teachers and counselors to send from each individual high school. (Do not worry about integer solutions for now).

A total of 30 combined teachers and counselors can be sent. At least 10 TOTAL of each type must be sent to training. There is a cost associated with transporting the staff from the high school to the training. Each person (teachers and counselors cost the same) sent from North costs the district $10, from Memorial $11 and from Santa Fe, $12.50. The most that can be spent on transportation is $340 – this is refundable from the NEA. However, the cost limits means that we are not guaranteed that all 30 seats will be filled.

Other restrictions: There must be at least 2 teachers and 2 counselors sent from each school. Of the total number in attendance, an individual high school can supply no more than 40% of the total, but no less than 30%.

Finally, each school was asked to allocate 5 ‘points’ to specify a preference ranking between teachers and counselors attending the training (higher is more preferred) . The final allocation of training seats to schools (by staff category) must provide a weighted average of at least 2.75 for each school. North weighted teachers a ‘3’ and counselors a ‘2’, Memorial the reverse (teachers a ‘2’ and counselors a ‘3’), and Santa Fe ranked teachers a ‘1’ and counselors a ‘4’.

Find the optimal decisions for how many teachers and counselors should attend training from each of the three schools.