EXERCISE QUESTIONS FOR EVALUATING CAPACITY (and Product mix)

Question 1

A law firm specializes in the issuance of insurance policies covering large commercial real estate projects. The projects fall into two categories: shopping centers, and medical complexes. The typical work involved in each transaction is quite predictable and repetitive. The time requirements (unit loads) for preparing a standard contract of each type are given in table below. Also listed are the number of professionals of each type and the number of available hours per professional per day (the rest of time is taken by other office activities):

	Unit Load - Shopping (hours per contract)	Unit Load - Medical (hours per contract)	No. of Professionals	Hours available (hours per professional per day)
Paralegal	4	6	4	6
Tax lawyer	1	3	3	8
Senior partner	1	1	2	4

For the month of Nov. 2010, the firm has generated 150 orders, 75 of each type. Assume one month equals 20 days.

a) What is the effective capacity of the process (contracts per day)?

b) Can the company process all 150 cases in November?

c) If the firm wishes to process all the 150 cases available in November, how many professionals of each type are needed?

Question 1 - SOLUTION

a)

The product mix is 50% shopping centres and 50% medical complexes. This is used to obtain a weighted average unit load:

	Average Unit Load (hours per contract)	Hourly Capacity (contracts per person per hour)	Daily Capacity (contracts per person per day)	Daily Firm Capacity (contracts per day)
Paralegal	$0.5(4) + 0.5(6) = 5$	$^1/_5 = 0.2$	$0.2 \times 6 = 1.2$	$1.2 \times 4 = 4.8$
Tax Lawyer	2	0.5	$0.5 \times 8 = 4$	$4 \times 3 = 12$
Senior Partner	1	1	$1 \times 4 = 4$	$4 \times 2 = 8$

Our solution suggests there is a bottleneck with the paralegals. Consequently, the firm's capacity is 4.8 contracts per day.

b)

The problem tells us there are 20 working days in the month. Therefore, the monthly capacity of the firm is:

$$20 \text{ days} \times 4.8 \text{ contracts/day} = 96 \text{ contracts}$$

Naturally, the firm is therefore unable to process 150 contracts in a month.

c)

	Daily Capacity (contracts per person per day)	Monthly Capacity (contracts per person per month)	# Employees Required
Paralegal	$0.2 \times 6 = 1.2$	$1.2 \times 20 = 24$	$\frac{150 \text{ contacts/month}}{24 \text{ contracts / month / person}} = 6.25 \rightarrow 7$
Tax Lawyer	$0.5 \times 8 = 4$	80	2
Senior Partner	$1 \times 4 = 4$	80	2

Question 2

Reconsider the law firm of Question1. Assume the prevailing revenues per shopping and medical projects are $4000 and $5000 per project, respectively, and that out of pocket expenses associated with each project are negligible. The (fixed) cost of operating the office is $500,000 per month.

a) What type of project is the most profitable?

b) At the current project mix (50%-50%), how much contribution margin is generated ($ per day)?

c) At the current product mix, what is the profit at capacity?

d) At the current product mix, what is the value of hiring an extra Paralegal?

Question 2 - SOLUTION

Shopping Centre

	Unit Load (hours per contract)	Hourly Capacity (contracts per person per hour)	Daily Capacity (contracts per person per day)	Daily Firm Capacity (contracts per day)
Paralegal	4	$^1/_4 = 0.25$	$0.25 \times 6 = 1.5$	$1.5 \times 4 = 6$
Tax Lawyer	1	1	$1 \times 8 = 8$	$8 \times 3 = 24$
Senior Partner	1	1	$1 \times 4 = 4$	$4 \times 2 = 8$

Completing only shopping centre contracts yields $6 \times \$4{,}000/\text{contract} = \$24{,}000$

Medical Complex

	Unit Load (hours per contract)	Hourly Capacity (contracts per person per hour)	Daily Capacity (contracts per person per day)	Daily Firm Capacity (contracts per day)
Paralegal	6	$^1/_6 = 0.1\bar{6}$	$0.1\bar{6} \times 6 = 1$	$1 \times 4 = 4$
Tax Lawyer	3	$0.\bar{3}$	$0.\bar{3} \times 8 = 2.\bar{6}$	$2.\bar{6} \times 3 = 8$
Senior Partner	1	1	$1 \times 4 = 4$	$4 \times 2 = 8$

Completing only shopping centre contracts yields $4 \times \$5{,}000/\text{contract} = \$20{,}000$

The firm's profit is maximized by focusing on shopping centre contracts.

b) In the 50-50 mix, firm capacity was 4.8 contracts per day (or 2.4 contracts of each type). This yields the following revenue:

$$2.4(\$4000) + 2.4(\$5000) = \$21{,}600$$

c) Profit at capacity is:

$$\$21{,}600 - \frac{\$500{,}000}{20} = -\$3{,}400 \text{ per day}$$

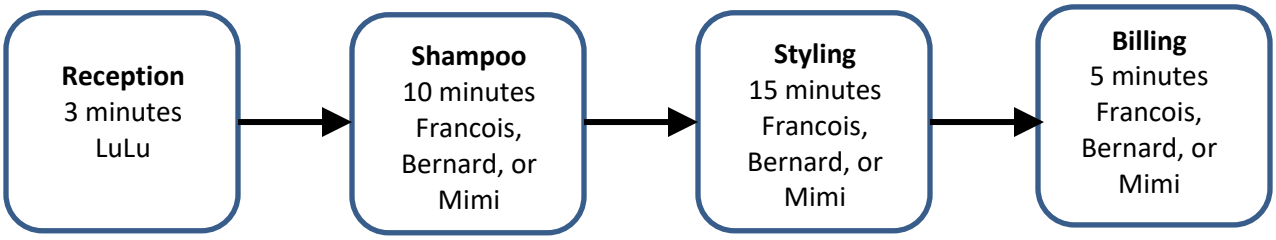
d) A fifth paralegal increases the firm capacity to $1.2 \times 5 = 6$ contracts per day, yielding:

$$3(\$4000) + 3(\$5000) = \$27{,}000$$

The difference is the *value* in adding a fifth paralegal: $27,000 - $21,600 = $5,400/day

Question 3

Three hairstylists, Francois, Bernard, and Mimi, run Fast Service Hair Salon for busy professionals in the Gold Coast area of downtown Chicago (See Figure below).



They stay open from 6:45 a.m. to 9:00 p.m. in order to accommodate as many people's work schedules as possible. They perform only shampooing and hairstyling activities. On average, it takes 10 minutes to shampoo, 15 minutes to style the hair, and 5 minutes to bill the customer. When a customer arrives, he or she first checks in with the receptionist (Bernard's younger sister LuLu). This takes only 3 minutes. One of the three stylists then takes charge of the customer and performs all three activities – shampooing, styling, and billing- consecutively.

a) What is the number of customers that can be serviced per hour in this hair salon?

b) A customer of Fast Service Hair Salon, an operations specialist, has suggested that the billing operation be transferred to LuLu. What would be the impact on the theoretical capacity?

Question 3 - SOLUTION

	Unit Load (min/customer)	Capacity (per hour per employee)	# Employees	Firm Capacity (per hour)
Reception	3	20	1	20
Shampoo/Styling/Billing	30	2	3	6

The salon can serve 6 customers per hour.

	Unit Load (min/customer)	Capacity (per hour per employee)	# Employees	Firm Capacity (per hour)
Reception	8	7.5	1	7.5
Shampoo/Styling/Billing	25	2.4	3	7.2

The impact is a much more *balanced* design where the capacity is similar among all operations. The new firm capacity is 7.2 customers per hour.

Question 4

A company makes two products A and B, using a single resource pool. The resource is available for 900 minutes per day. The contribution margins for A and B are $20 and $35 per unit respectively. The unit loads are 10 and 20 minutes per unit.

a) Which product is more profitable?

b) The company wishes to produce a mix of 60% As and 40% Bs. What is the effective capacity (units per day)?

c) At the indicated product mix, what is the financial capacity (profit per day)?

Question 4 - SOLUTION

a)

Product	Unit Load	Hourly Capacity	Hourly Margin
A	10 min/unit	6 units/hour	$120/hour
B	20 min/unit	3 units/hour	$105/hour

Product A is more profitable.

b)

Unit Load: $0.6(10) + 0.4(20) = 14 \text{ min/unit}$

Daily Capacity: $\frac{900 \text{ minutes}}{14 \text{ minutes/unit}} = 64.28 \text{ units} \rightarrow 64 \text{ units}$

c)

	Volume	Margin
A	$0.6(64) = 38.5$	$\$20(38.5) = \$770$
B	$0.4(64) = 25.6$	$\$35(25.6) = \$896$
		$1,666

At the current mix, daily contribution is approximately $1,666.

Question 5

Consider a process consisting of three resources:

Resource	Processing Time (min/unit)	Number of Workers
1	10	2
2	6	1
3	16	3

a) Where is the bottleneck?

b) What is the process capacity?

c) What is the flow rate if demand is 8 units per hour?

d) What is the utilization of each resource if demand is eight units per hour?

Question 5 - SOLUTION

Resource	Unit Load (min/unit)	Hourly Capacity (per employee)	# Employees	Hourly Capacity
1	10	6	2	12
2	6	10	1	10
3	16	3.75	3	11.25

a) A bottleneck exists in the second resource.

b) The firm's capacity is 10 units per hour.

c) Since this is below capacity, the realized flow rate is 8 units per hour

d)

Resource	Hourly Capacity	Flow Rate	Utilization
1	12	8	$\frac{8}{12} = 66\%$
2	10	8	80%
3	11.25	8	71%

Question 6

Consider a process consisting of five resources that are operated 8 hours per day. The process works on three different products, **A**, **B** and **C**.

Resource	Number of Workers	Processing Time for **A** (min/unit)	Processing Time for **B** (min/unit)	Processing Time for **C** (min/unit)
1	2	5	5	5
2	2	3	4	5
3	1	15	0	0
4	1	0	3	3
5	2	6	6	6

Demand for the three different products is as follows: product A, 40 units per day; product B, 50 units per day; and product C, 60 units per day.

a) Where is the bottleneck?

b) What is the flow rate for each flow unit assuming that demand must be served in the mix described above (i.e., for every four units of A, there are units of B and six units of C)?

Question 6 - SOLUTION

Product mix is

$$\frac{40}{150} = 26.\bar{6}\% \quad \text{Product A}$$

$$\frac{50}{150} = 33.\bar{3}\% \quad \text{Product B}$$

$$\frac{60}{150} = 40\% \quad \text{Product C}$$

Expected Unit Load is:

Resource	Processing Time for **A** (min/unit)	Processing Time for **B** (min/unit)	Processing Time for **C** (min/unit)	Unit Load (min/unit)
1	5	5	5	$0.26(5) + 0.33(5) + 0.4(5) = 5$
2	3	4	5	4.13
3	15	0	0	4
4	0	3	3	2.2
5	6	6	6	6

Resource	Unit Load (min/unit)	Capacity (per hour per employee)	# Employees	Firm Capacity (units/hour)
1	$0.26(5) + 0.33(5) + 0.4(5) = 5$	12	2	24
2	4.13	14.53	2	29
3	4	15	1	15
4	2.2	27.27	1	27
5	6	10	2	20

The bottleneck is at Resource 3. This yields a daily capacity of 120 units per day.

b) Assuming a capacity of 120 units, the daily flow, by product type is:

	Volume (units per day)
A	$0.2\bar{6}(120) = 32$
B	$.3\bar{3}(120) = 40$
C	$.4(120) = 48$