(Trucks) A company manufactures two types of trucks. Each truck must go through the painting shop and the assembly shop. If the painting shop were completely devoted to painting type 1 trucks, 650 per day could be painted, whereas if the painting shop were completely devoted to painting type 2 trucks, 550 per day could be painted. If the assembly shop were completely devoted to assembling truck 1 engines, 1400 per day could be assembled, whereas if the assembly shop were completely devoted to assembling truck 2 engines, 1000 per day could be assembled. It is possible, however, to paint both types of trucks in the painting shop. Similarly, it is possible to assemble both types in the assembly shop. Each type 1 truck contributes $2500 to profit; each type 2 truck contributes $3000. Use Solver to maximize the company's profit.

Discussion: -

From question we are clear that there are two types of trucks and there are two steps involved in manufacturing it. Unit profit for each type of truck is clear and our objective is the maximize the profit. So, we should decide on the numbers of trucks that could be produced by company to maximize the profit. We have two types of trucks but only one painting shop and one assembly shop. Once the truck gets painted, it will flow to assembling shop. Per day limits of painting shop and assembling shops were given, but the inputs given illustrates the capacity of shops if they could completely have devoted to one type of truck. We can understand from question that, company can paint/assemble both types of trucks in these shops, which means our real problem is to set a constraint which limits our decisions (number of trucks) so that we will not overload the per day work which can be done by painting and assembly team.

This problem tests our mathematical skills. Do you remember "Work—Time" problems? Let's look at small example which might help you in understanding the concept. Suppose one painter can paint the entire house in seven hours, and the second painter takes nine hours to paint a similarly-sized house. How long would it take the two painters together to paint the house? If the first painter can do the entire job in seven hours and the second painter can do it in nine hours, then the first guy can do $(1/7)$ of the job per hour, and the second guy can do $(1/9)$ per hour. The question then becomes, how much then can they do per hour if they work together? Just do the summation $(1/7) + (1/9)$. Let us assume that "t" is the total time taken by two painters to complete the task, then the above summation is nothing but equal to $(1/t)$.

$(1/t) = (1/7) + (1/9)$ ---- This equation will help us in finding the time taken by two people to complete the job by working together. The important thing to understand about the above example is that the key was in converting how long each person took to complete the task into a rate. You can use this concept while writing the per day limitations of painting and assembling.

Mathematical Model: -

Parameters (Inputs):

$i \in 1,2, (\text{ Index for type of trucks})$
$A_i : Number\ of\ type\ i\ trucks\ that\ could\ be\ painted\ per\ day$
$B_i : Number\ of\ type\ i\ trucks\ that\ could\ be\ assembled\ per\ day$
$P_i : Profit\ expected\ from\ each\ type\ i\ truck$

Decision Variables:

x_i : *Number of type i trucks manufactured*

Objective:

$$Minimize\ Total\ Profit = \sum_{i=1}^{2}(x_i * P_i)$$

Constraints:

$x_i \geq 0;$ (1) *Non Negative constraint*

$$\sum_{i=1}^{2}(x_i/A_i) \leq 1$$ (2) *Per day limitations for painting the trucks*

$$\sum_{i=1}^{2}(x_i/B_i) \leq 1$$ (3) *Per day limitations for assembling the trucks*

Excel Implementation:

7[RA].xlsx

Please find the attached spreadsheet for solution.

		Truck Type 1	Truck Type 2					
						Inputs		
						Decision variables		
		Truck Type 1	Truck Type 2			Calculated Variables		
Painting		650	550			Constraints		
Assembling		1400	1000			Objective		
Profit		$ 2,500	$ 3,000					
		Truck Type 1	Truck Type 2					
Trucks to be manufactured		0	550					
Maximize the Profit		$ 1,650,000						
Painting Constraint		1	<=		1			
Assembling Constraint		0.55	<=		1			

As per the optimization model, solver suggested to go with 550 type 2 trucks which would bring profit of $1.65 M. Although there is scope for assembling more trucks, as there is scope for painting only 550 trucks, company could not use the resources completely. You can see the same on left-hand side of the assembling constraint which is showing 0.55.