Precision Auto Clone Consulting Report

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Section 1: Production Scheduling

A powerful and versatile technique called *Linear Programming* was utilized to determine that the profit-maximizing production schedule for June is 2,000 units of P-10 and 400 units of P-20 which yields a profit of $824,600. This production schedule uses up all the available hours in both the Fabrication and the Assembly Work Centers. Linear programming is a mathematical technique that is used to find the optimal (maximum or minimum) alternative while remaining within a set of constraints. This application of Linear Programming at Precision Auto Clone is referred to as a "product mix problem". In a product mix problem, the objective is to find the amount of each product to produce in some period that will achieve the highest profit while staying within the firm's capacities for that period. The production alternatives in June are limited because there are only 10,000 hours of Fabrication time and 7,000 hours of Assembly time available. The product mix problem assumes that the revenues and costs of each product are known and constant in the period. The product mix problem also requires that the usage and cost of material and labor for each product are known and constant in the period. For a one-month period, these assumptions seem reasonable.

Linear programming also determined that the marginal values of Fabrication and Assembly time are $21.5 and $87 per hour respectively. This means that each additional hour of Assembly time procured at its current cost ($46 per hour for regular time) would generate an additional profit of $87. Since the company is paying a 50% premium for overtime, the company would be paying $23 (half of $46) to get a benefit of $87. So, each hour of overtime worked in the Assembly work center will generate $64 ($87 – $23) additional profit. This certainly makes economic sense.

Precision Auto Clone should try to schedule up to but not more than 500 hours of Assembly time in June. It is not economically advisable to schedule Fabrication overtime because the overtime premium of 50% on $49 ($24.50 per hour) is greater than the marginal value of $21.5 per hour.

Lastly, the linear programming results indicate that the optimal production schedule of 2,000 units of P-10 and 400 units of P-20 is unlikely to change due to increases or decreases in product revenues and/or costs in one month. As long as the profitability of P-10s does not increase by more than $43 nor decrease by more than $87, the optimal production schedule remains unchanged. Similarly, as long as the profitability of PP-20s does not increase by more than $108.75 nor decrease by more than $35.83, the optimal production amounts remain unchanged.

Objective Function:			P-10	P-20	
		Selling Price/Unit	$792.00	$787.00	
		Costs:			
Fabrication Cost/Hour	$44.00	Fabrication	$176.00	$220.00	
Assembly Cost/Hour	$46.00	Assembly	$138.00	$115.00	
		Material & Plating	$131.00	$127.00	
		Total Cost/Unit	$445.00	$462.00	
		Profit/Unit	$347.00	$325.00	
		Quantity Produced	2000	400	Total
		Profit By Product	$694,000.00	$130,000.00	$824,000.00
Constraints:					
Labor/Unit	P-10	P-20	Used	Available	
Fabrication	4	5	10000	10,000	
Assembly	3	2.5	7000	7,000	

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
D16	Quantity Produced P-10	2000	0	347	43	87
E16	Quantity Produced P-20	400	0	325	108.75	35.83333333

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
D20	Fabrication Used	10000	21.5	10000	4000	666.6666667
D21	Assembly Used	7000	87	7000	500	2000

Section 2: Tool Crib Staffing

The company uses Tool Crib for the employees in the Fabrication and Assembly workers to check out tools and tooling needed to perform various operations where the total hours scheduled for Fabrication is 10,000 and Assembly is 7,000. The Fabrication laborers are paid $44/hour while the Assembly workers get paid $46/hour. The initial expectation was that only 2 Tool Crib servers are needed because 2*15 (service rate) = 30 servers per hour exceeds the average arrival rate of 25. But since Queues are formed due to the workers arriving randomly at the tool crib at an average rate of 25 workers per hour, it needed an amazing and robust tool like *Queuing theory* to analyze and calculate the optimal number of servers at the Tool Crib. Queuing Theory is the most interesting and powerful mathematical tool to examine every component of waiting in line or queue, including the arrival process, service process, number of servers, number of system places, and the number of customers—which might be people, data packets, Labors in our case, or anything else which has many real-life applications and very efficient tool for running a business. A queueing model is constructed so that queue lengths and waiting times can be predicted and used to minimize the cost of literally anything that consists of queuing of any kind.

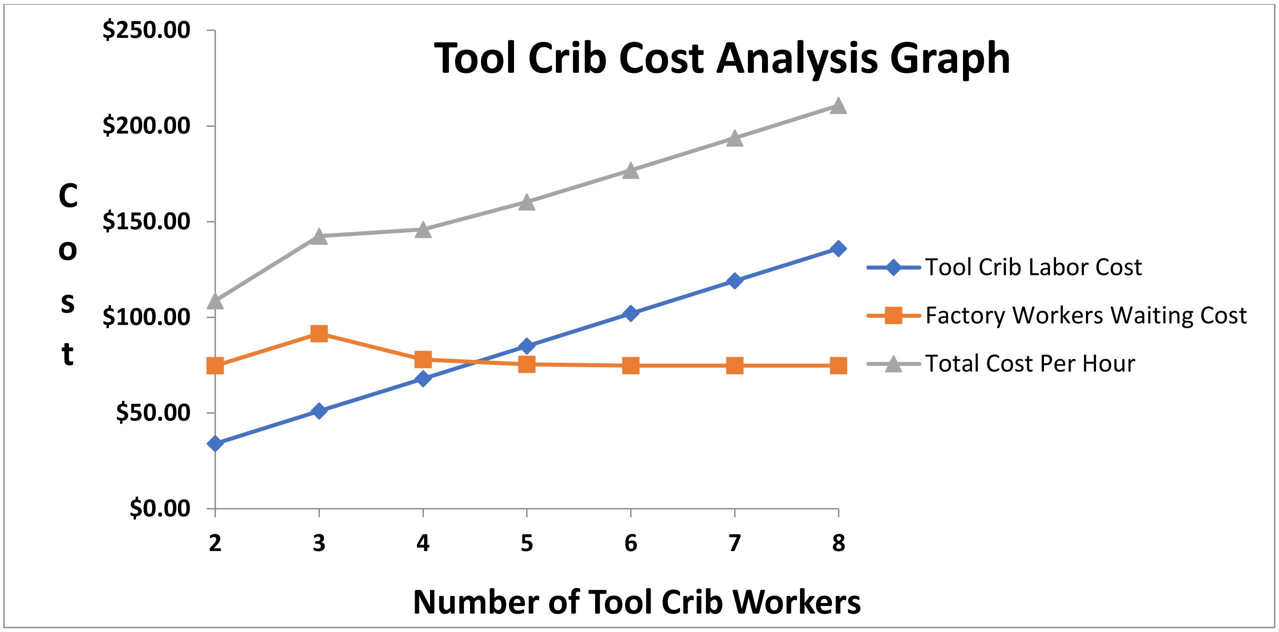
In our case, the tool crib server to process a tool request or return is also random with an average of 4 minutes which makes it even more difficult to minimize the waiting time. Since arrivals and service times are random and the tool crib servers all work at approximately the same pace, the standard multiple channels/single phase queuing application has been used to determine the optimal number of tool crib servers that would minimize the average total cost per hour.

The Tool crib labor cost/hour was $17 and the Factory Labor Cost/hour was determined by the combined average wage rate of Fabrication and Assembly workers turns out to be $44.82.

After applying this power tool, we found that the number of Tool Crib servers needed for the minimum total cost per hour was 2 which was responsible for a minimum cost per hour of $108.70 which takes into account the total Tool Crib workers' cost of $34.00 and the waiting cost of $74.70 of Factory workers in the queue. Avg number of workers waiting to be served is found to be 0 which is apparently the best case for this scenario.

On the other hand, the average wait time for the service to commence was also 0 seconds. It was also found that the tool crib was idle for 16.7% of the time which means 0.3 people on an average. So, approximately 30% of the total time of 1 worker is idle all the time. To save some more money, Precision Auto Clone can find them some work to do, to optimize their budget spent on labor costs.

The graph below helps us to visualize the cost minimization by the use of 2 Tool Crib servers, where the orange line graph reflects the Factory workers' waiting cost (behind the counter cost) and the blue line graph indicates Tool crib labor cost and the orange is the sum of both the costs, which is the total cost due to queuing.


Tool Crib Cost Analysis Graph
$250.00
$200.00
$150.00
$100.00
$50.00
$0.00
C
o
s
t
2
3
4
5
6
7
8
Number of Tool Crib Workers
Tool Crib Labor Cost
Factory Workers Waiting Cost
Total Cost Per Hour

Section 3: Multi-Period Inventory Simulation

For a business to keep running and growing, it is important that it is well organized. The inventories need to be ordered on time so that the factory isn't idle at any point in time because an idle factory not just wastes the factory costs but also the labor costs. Meanwhile, it also faces a loss equal to the profits it could have made in that idle time. We have used one of the best analysis tools called *Simulation* to tackle this issue. Simulation essentially is a strategy that uses mathematical calculations to help us predict what might be the output. Those outputs in turn help us to make an optimal decision according to our situation. So basically, it means running a calculation for a large number of times to bring our required output which is minimizing the cost per week with the optimal number of inventories to order when we are left with a particular number of inventories.

The cost to hold a unit of inventory per week is $0.27. Whereas, the cost of each order is $300. In case of shortage, it costs a sum of $2.40 per unit. Clearly, the cost of shortage is greater than the cost of holding for obvious reasons, and thus ordering inventories on time is very significant.

For each Order Quantity and Reorder Point combination, a simulation for 2,000 weeks was run which returns the running average of the 2,000 weeks with a range of 800-1800 inventories to order when a range of 400-1400 inventories are left. By running the simulation with a running average of 72,000 repetitions, we minimized the cost to approximately $304.31 dollars per week according to the law of large numbers.

The below graph shows how the law of large numbers helps us simulate to get the optimal solution to this inventory handling issue of Precision Auto Clone. Initially, the graph shows a lot of deflection due to the small sample size but as we simulate it for large numbers which helps us get closer to the average value of the population as the sample size is increased, it becomes a straight line for a value of approximately $304.31. This number also gives us the optimal inventory strategy which is to order 1200 units of inventory every time it reaches 800.

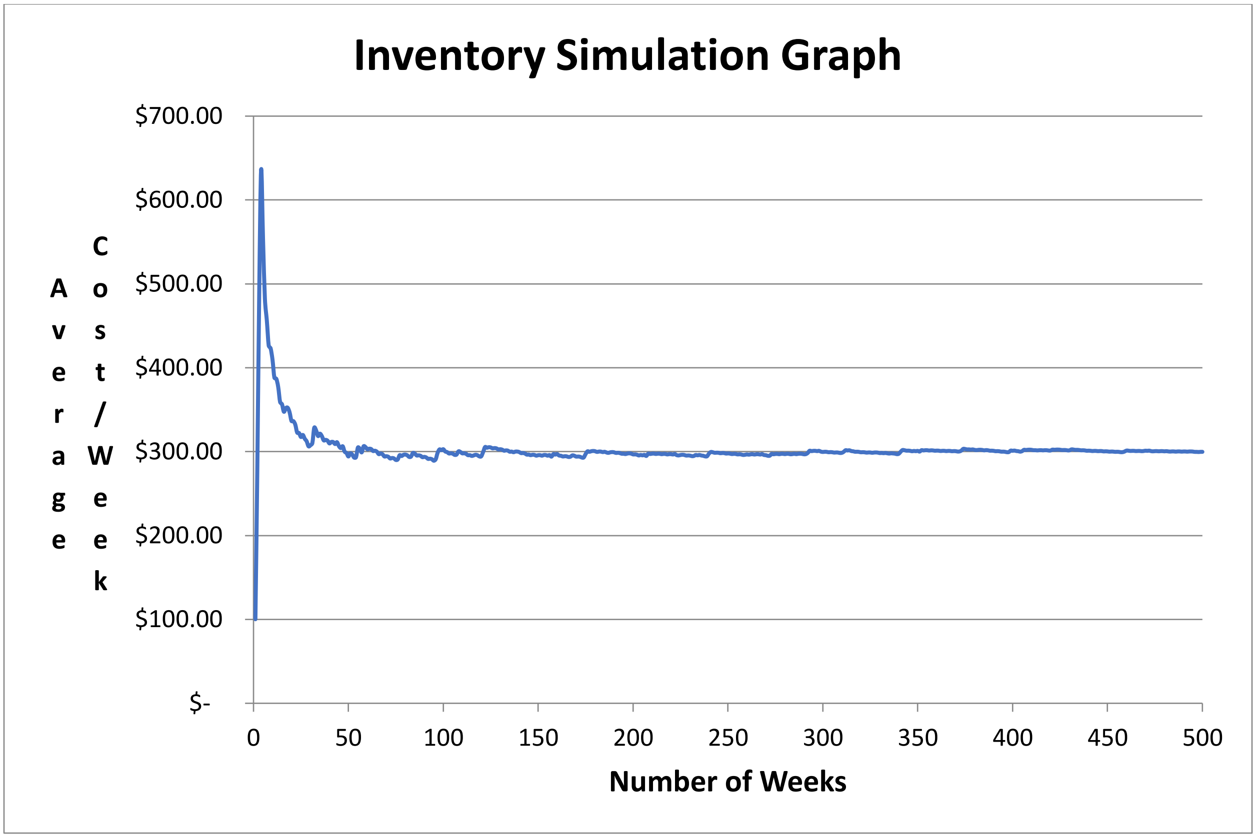


Figure 3.1

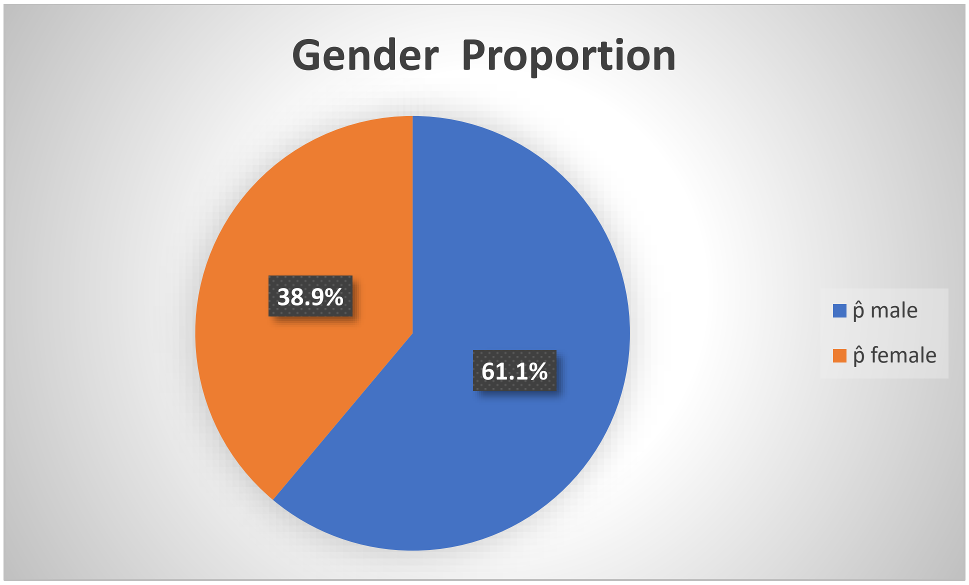
Section 4: Employee Gender and Age

To efficiently make decisions for a company, it is very important to know the workforce and its distribution. To achieve this, we used *Descriptive Statistics* which uses some coefficients like mean, median, mode, and standard deviation to summarize a given set of data, and *Statistical Estimation* to calculate the value of certain properties like the percentage of the population to visualize the results of the population to dive deeper into the analysis.

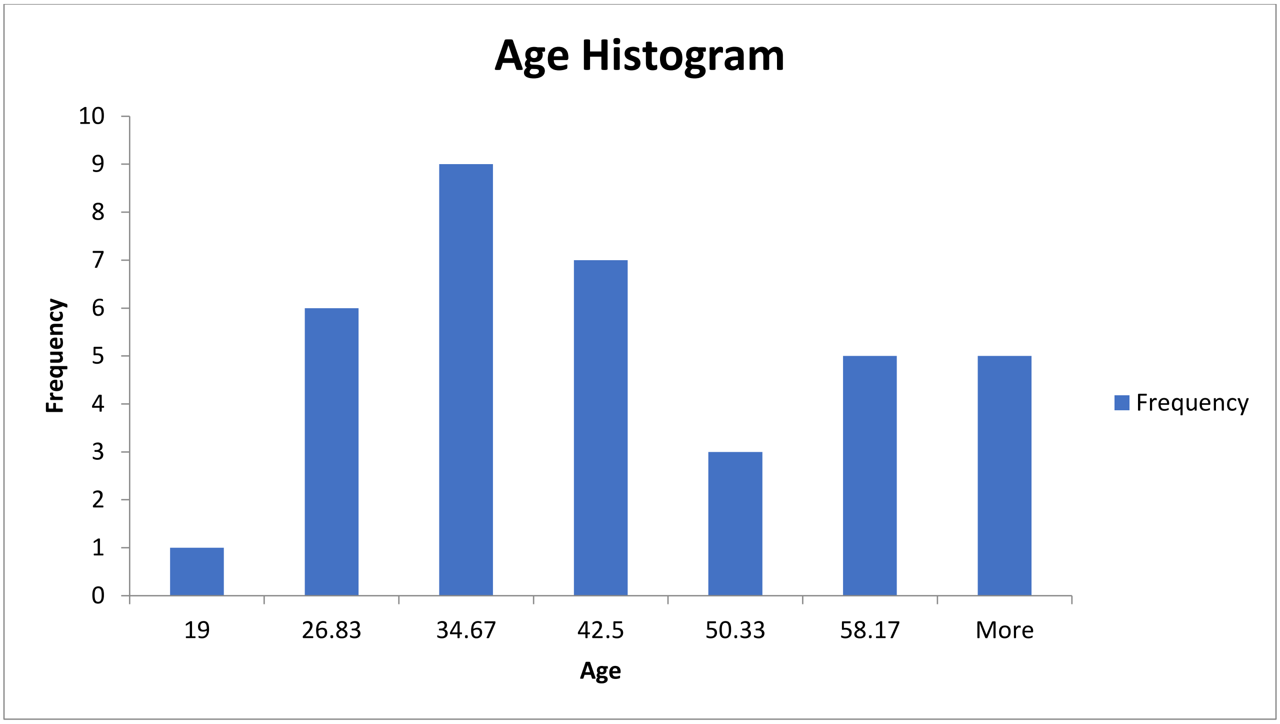
In this case, we used Descriptive Analysis to find the mean of the gender and age of the employees and Statistical Estimation to find the %age confidence of gender and age for a better idea of statistics and thus analyze the data better.

The Precision Auto Clone sample had 36 workers out of which 22 were male and 14 female employees which consist of 61.1% and 38.9% of the total population respectively as shown in the pie chart below.

For 95% gender confidence, which gives the true percentage of the whole population of the male and female workforce, we used Statistical Estimation and found that for 95% confidence of the proportion of the whole population, the percentage of males is between 77.3% and 44.9% whereas of females, it is between 55.1% and 22.7%.



Considering the Age of the workers, 40.1 is the *mean* age which means the best guess for the age of the workforce every day. The *median* or the 50th percentile of the sample is 37 which means half were more than 37 and a half were less than 37. The *mode* age was 31 which simply tells that the most often seen value for the age is 31. The data is quite variable as measured by a sample *standard deviation* of 14.0 which essentially reflects how dispersed the value of the age of the sample is with respect to the mean age. The youngest worker was 19 years old whereas the oldest was 66 which also owes to the variability in age. Since the minimum age observed was 19 and the maximum was 66, it gives us the *range* of the age of the employees which is the difference between the two. 95% *confidence* is in the range between 35.42 and 44.78 (40.1 $\pm$ 2(2.34)) which infers that we are 95% sure that the average number of employees falls under this range.



The above histogram shows the frequency of the age of the workers at Precision Auto Clone.

Section 5. Handheld Computers for Factory Workers

Handheld Computers can be a better idea to increase the efficiency of the workers at the factory since manual data entry could be erroneous and tiring at the same time. After testing this new technology on a sample of 36 workers, after giving them a four-hour training, the performance rating of the workers (which reflects superior speed, consistent quality, and accuracy) was evaluated and compared with the older ratings and found that the devices did cost $.30 per employee per hour. However, they were responsible for reducing the production cost by $.10 for each point increase in job performance rating. This clearly means that there should be at least more than 3 points ($0.30/$.10) of increase to observe profit in installing the new technology. We wished to be at least 95% confident that the factory would make a profit out of this new technology before investing in these Handheld Computers.

We used an awesome analysis tool called *Hypothesis Testing* to determine the feasibility of installing handheld computers in Precision Auto Clone. This tool essentially uses the theory, methods, and practice of testing a hypothesis by comparing it with the null hypothesis which simply refers to the statement we wish to disprove. In the Hypothesis Test, we prove one statement is right and the other is wrong. We start with the statement that we wish to disprove which is commonly known as a null hypothesis. The null hypothesis is only rejected if its probability falls below a predetermined significance level, in which case the hypothesis being tested is said to have that level of significance. So, we basically start off by taking a false idea and rejecting it finally depending on our mathematical calculations using probability by using the mean, standard deviation, and sample size of a population.

By running a simulation to find descriptive statistics of the employee data available to us from the sample of 36 employees amongst the population of 800 we found the average increase in productivity of 4.69 which is measured by the performance rating scale used by the company to determine the efficiency of the employees and a sample size of 36 employees used in the calculations.

The null hypothesis, in this case, would be that the average increase in productivity would be less than 3 performance ratings because the company gains profit only after this breakeven point of 3 performance ratings. We compared the average increase in productivity of 4.69 with the breakeven point of 3 performance rating which is 2.67 standard deviation apart and we only consider 1.64, we could safely reject the null hypothesis and consequently, it was clear that the thought of installing Handheld computers will be successful with a confidence of 95%. To dive deeper and analyze better, we used the concept of p-value which is used to find the smallest percentage with which we can reject the consideration of not installing Handheld Computers. In this case, the p-value was found to be 0.0052 which signifies that it is 0.52% likely that our decision of installing Handheld Computers won't yield us any profits.

Clearly, it is safe to invest in Handheld Computers if there is a probability of 99.48% of getting a profit if workers use this to increase their performance rating.

Section 6. Personnel Screening Tests

Since the hiring of workers is a significant decision for a company as incompetent workers do no good to a company, the company's decision to conduct screening tests was a game-changer. But, conducting these tests namely the General Aptitude test and Manual Dexterity test are costly and time-consuming, so it is important to verify if these could be of any help.

To predict whether the screening tests would be beneficial, we are going to use a super amazing tool called *regression*. Regression analysis is a reliable method of identifying which variables have an impact on a topic of interest. The process of performing a regression allows you to confidently determine which factors matter most, which factors can be ignored, and how these factors influence each other. In this case, we have our eyes on the performance of the workers of the factory with the use of handheld computers. We run regression analysis on the factors that affect the performance of the workers which are the General Aptitude Score and Manual Dexterity Score to finally compare it with the mean performance of the workers equipped with handheld computers.

The regression analysis made us realize that the General Aptitude Score was significant however, the Manual Dexterity Score was less than a threshold significant, hence it was insignificant. Stan Still, one of the workers to be hired at Precision AutoClone scored 220 on the General Aptitude Test and 180 on the Manual Dexterity. Since his Manual Dexterity score is insignificant, we only considered his General Aptitude Score to analyze his performance. It was found that his General Aptitude Score was 50.992 + 0.214*180 = 89.512 which is way below the mean performance of other employees with computers at the company which is 101. For a confidence level of 95%, we calculated that his score should be in the range of 77.588 and 101.436. This means that his maximum score for the General Aptitude test could be 101.436 which is greater than the average score of the other employees by 0.436 but the range mostly lies below 101 hence, he should not be hired.