### Precision Auto Clone: An Integrated Decision Analytics Case

**Before submitting the final draft of your consultant’s report please carefully read all instructions. Your grade on the report will be reduced significantly if these instructions are not followed precisely. Do not include any Excel output other than the Tool Crib Cost Analysis Graph, the Inventory Simulation Graph, the Gender Pie Chart, and the Age Histogram.**

Warren Jackson is living the American dream. He was able to transform his hobby of automobile restoration into a profitable business venture. Warren was born in 1950, a member of the Baby Boom generation (people born during the [Post–World War II baby boom](http://en.wikipedia.org/wiki/Post%E2%80%93World_War_II_baby_boom) between the years 1946 and 1964). After college, he worked as a sales representative for an agriculture seed company selling to distributors in the Great Lakes states. On weekends, however, he worked on upgrading his 1955 Chevy Bel Air car that he purchased in 1968 when he was a senior in high school. The ’55 Chevy was the first car with a V8 engine that was successfully marketed in the United States (https://en.wikipedia.org/wiki/1955\_Chevrolet). He also helped repair and enhance cars for several of his friends and colleagues over the years. In 1981, he quit the seed business and founded Precision Auto Clone in his home town of Toledo, Ohio. Precision initially produced only the “egg crate” car grill used on 1955-57 Chevrolets. The business grew and Precision Auto Clone added the Ford Mustang grills featuring the rearing horse caricature to its product line a few years later. The Mustang car was a smash hit for Ford, selling over 22,000 units the first day it was offered in 1964 and nearly a half a million cars in that first year.

As the seventy-six million Baby Boomers born between 1946 and 1964 mature, their discretionary incomes have increased. It is estimated that they control over 80% of personal financial assets and more than half of all consumer spending. They buy 77% of all [prescription drugs](http://en.wikipedia.org/wiki/Prescription_drug), 61% of [over-the-counter drugs](http://en.wikipedia.org/wiki/Over-the-counter_drug), and 80% of all leisure travel. They also want to purchase shiny restored classic Chevy and Mustang cars that they could not afford in their youth. Demand primarily from the demographic has allowed Precision Auto Clone’s business to grow steadily to its current annual revenue of $24 million. Most of the company’s sales are direct sales to customers generated through on-line media, ads in car magazines and participation in classic car shows.

Precision Auto Clone occupies an 80,000 square foot facility in the industrial area of Toledo that was built in the 1950’s. The company has a large staff of semi-skilled workers with moderate employee turnover. The factory’s shop floor is organized into two work centers: Fabrication and Assembly. The Fabrication work center produces grill components from sheet metal and other materials while the Assembly work center takes these components and welds them together to produce the grills. If any chrome or other plating is required, it is sent out to a nearby subcontractor and quickly returned. Additional employees include those in the Tool Crib and Inventory Cage plus a small staff in the Purchasing, Sales, Accounting and Human Resources Departments.

Precision Auto Clone’s small computer network, maintained and supported by outside contractors, is used primarily for communication purposes with only the Purchasing and Accounting Departments running actual application software. Shop floor workers record their time on time cards by work order number and process code. The Accounting Department uses the time cards to pay the employees and to estimate the labor and material cost by work order.

Warren’s son Larry received his Bachelor’s Degree in Business with a major in Business Analytics at Ohio State University and has worked with his father for the past year. Since joining the company, Larry has been pressuring his father to utilize decision analytics wherever possible in the company. Warren has identified the six areas where decision analytics techniques can be employed to improve operations. He needs your expertise and assistance in completing these six tasks.

1. **Production Scheduling**

The first issue is determining the optimal production schedule (optimal product mix) for the next month. Assume for simplicity that the Fabrication and Assembly work centers will produce two end items - part numbers P-10 (the basic Mustang grill) and P-20 (the basic Chevy grill). These two end items are made by fabricating components sheet metal and other raw materials and purchased parts and then assembling fabricated components and purchased parts into the final product or end item that is sold to the customer. Product P-10 sells for $785 + L per unit and product P-20 sells for $780 + L per unit (where L is the next to the last digit of your student ID). Warren believes that there is sufficient demand to sell all the P-10’s and P-20’s that the plant can produce next month.

One unit of P-10 requires 4 hours of fabrication time plus 3 hours of assembly time. One unit of P-20 requires 5 hours of fabrication time plus 2.5 hours of assembly time. The scheduled hours and wage rates for workers for next month in these two work centers are:

### Work Center Hours/Costs

|  |  |  |
| --- | --- | --- |
| **Work Center** | **Scheduled Hours** | **Labor Cost Per Hour** |
| Fabrication | 10,000 | $40 + M |
| Assembly | 7,000 | 42 + M |

where M is the last digit of your Student ID. The material and plating costs of P-10’s and P-20’s are $131.00 and $127.00, respectively.

**Technical Instructions**

Formulate as a linear programming problem and double check your formulation against that shown on the **Linear Programming** Sheet in **Precision Auto Clone Linear Programming App.** This file is available on Canvas. See **Exhibit A**.

1. Alter cells D7, E7, B9 and B10 as indicated in the Data Input Instructions on this sheet.

2. Verify that **Solver** has been installed:

Click on top **Data** tab. If you see **Solver** at the top right corner, go to step 3. To install **Solver**, Click on **File**. Click on **Options**. Click on **Add-Ins**. Click on **Solver Add-in**. Click on **Go**. Check **Solver.** Click **OK**.

3. Click on the top **Data** tab. Click on **Solver**. Click on **Solve**. Click on **Sensitivity**. Click on **OK**.

4. Review the **Linear Programming** Sheet to view the optimal production schedule and profit. Review the **Sensitivity Report 1** Sheet to determine the marginal values of Fabrication and Assembly work centers hours and the limits of change. Review the range of change for the coefficients of the objective function.

**Report Instructions:**

State the optimal production schedule and the profit generated. Describe Linear Programming to the reader so that the reader has a conceptual understanding of it. Are all the labor resources used up? Overtime cost in the Fabrication and Assembly work centers is 150% of regular labor cost. What is the net economic benefit of overtime in each work center and what are the limits? Is the optimal production schedule likely to change due to increases or decreases in the costs of labor or material?



**Exhibit A: Linear Programming App.**

## **Tool Crib Staffing**

The next area requiring your assistance is to find the optimal number of service employees at the Tool Crib (Queuing Analysis). Employees in the Fabrication and Assembly work centers go to the tool crib to check out tools and tooling as needed to perform various operations shown on the Routing Sheet to make the Chevy and Mustang grills. The workers return the tools to the tool crib after completion of the required procedures. Larry conducted a study and found that Fabrication and Assembly workers arrive randomly at the tool crib at an average rate of 25 workers per hour. The time it takes for a tool crib server to process a tool request or return is also random with an average of 4 minutes. Servers in the tool crib make $10 + L per hour (where L is the next to the last digit of your Student ID number).

### Work Center Hours/Costs

|  |  |  |
| --- | --- | --- |
| **Work Center** | **Scheduled Hours** | **Labor Cost Per Hour** |
| Fabrication | 10,000 | $40 + M |
| Assembly | 7,000 | 42 + M |

where M is the last digit of your Student ID number. Tool crib servers process one tool request at a time and do not share work. Since arrivals and service times are random and the tool crib servers all work at approximately the same pace, the standard multiple channel/single phase queuing application can be used to determine the optimal number of tool crib servers that would minimize the average total cost per hour. The combined average wage rate of Fabrication and Assembly workers is calculated by {[10,000\*(40 + M) + 7,000\*(42 + M)] / (10,000 + 7,000) = 40.82 + M}. This average wage is being lost when the workers are at the tool crib instead of in their work centers making grills. This is the “customer” cost per hour used in queuing theory.



**Exhibit B: Queuing Analysis App**

**Technical instructions:**

Open the **Precision Auto Clone Queuing App.** available on Canvas. See **Exhibit B**.

1. Alter cells G6 and G7 as indicated in the Data Input Instructions on this sheet.

2. Look in the Total Cost Per Hour Column and find the minimum cost per hour. This row contains your optimal strategy and the costs and system attributes associated with it.

**Report Instructions:**

State the optimal tool crib staffing and the minimum expected cost per hour. Explain Queuing Theory to the reader so that the reader has a conceptual understanding of it. Warren’s initial expectation was that he only needs 2 servers because 2\*15 (service rate) = 30 served per hour exceeds the average arrival rate of 25. Why do lines form? Copy the **Tool Crib Cost Analysis Graph** and paste it into your report and discuss it. What is the expected wait time in seconds? What is the expected service time in minutes and seconds? Discuss the Idle %?

**3. Multi-Period Inventory Simulation**

Precision Auto Clone purchases special chrome plated bolts used in the grills from a supplier located in California. The covers come in boxes containing 200 bolts and Precision Auto Clone must order by the box. Assume weekly demand for the bolts is normally distributed with a mean of 400 bolts and a standard deviation of 50 bolts. The supplier is not totally reliable and the time between Precision Auto Clone’s order submission and delivery by the supplier (lead time) varies from 1 to 3 weeks. Precision Auto Clone only wants to consider Reorder Points in 200 unit increments. Using simulation, find the optimal inventory strategy for the bolts consisting of the optimal Order Quantity and the optimal Reorder Point that minimizes the sum of Order, Holding and Shortage costs.

**Technical Instructions:**

Open the **Precision Auto Clone Simulation App.** available on Canvas. (Note: Security on your computer may need to be temporarily altered to enable macros.)

1. Go to the Sheet named **Input**.

2. Alter cells D15 and D17 as indicated in the Data Input Instructions on this sheet.

3. Go to the Sheet named **Strategy** and click on the **Run button**.

4. When prompted, input a beginning Order Quantity (800) and the increment (200). Input the beginning Reorder Point (400) and Increment (200).

5. Review the **Expected Value Table** and find the two Order Quantity/Reorder Point combinations that had the lowest costs.

6. For these two combinations, rerun the simulation program entering that Order Quantity and Reorder Point combination using Increments of 0 for both. Write down the **Table Average** for each.

7. Compare the two and find the strategy with the smaller **Table Average**.

8. Rerun this optimal strategy with Increments of 0. Go to the **Simulation** Sheet. Copy the **Inventory Simulation Graph** and paste it into your report.

For each Order Quantity and Reorder Point combination, the Excel program runs a simulation of 2,000 weeks and returns the running average of the 2,000 weeks into the **Expected Value Table**. When you run a strategy with an increment of 0, the **Table Average** represents the running average of 72,000 (36 times 2,000) repetitions of that strategy.

**Report Instructions:**

State the optimal strategy and its estimated expected cost per week. Explain Simulation to the reader so that the reader has a conceptual understanding of it. Paste the **Inventory Simulation Graph** into your report. Discuss how the plot illustrates the Law of Large Numbers.

**Sections 4 – 6.**

The remaining three tasks require your statistical insight. The Personnel Department selected 36 factory employees at random for this statistical study and these sample results are included in an Excel file called **Precision Auto Clone Statistical Data** available on Canvas. Open this File. Click the **Name Sheet** and locate your name and the Number of your specific data set. Open this numbered data Sheet that contains your particular data set. Open a new Excel file and copy and paste your data set into Sheet 1 of this new Excel file.

Verify that **Data Analysis** has been installed: Click on **Data Tab**. If you see **Data Analysis**, then it is installed. To install **Data Analysis**: Click on **File**. Click on **Options**. Click on **Add-Ins**. Click on **Analysis ToolPak**. Click on **Go**. Checkoff **Analysis ToolPak**. Click on **Go**.

**4. Employee Gender and Age**

Warren would like you to use your knowledge of Descriptive Statistics and Statistical Estimation to enlighten him concerning the gender and age of the factory workers. Using your sample results, produce a **Gender Pie Chart** for the factory workers sampled. Construct a 95% interval for the percentage of males or females (pick one) in the entire factory workforce. Generate the **Descriptive Statistics** and **Histogram** for the age of the factory workers sampled. Construct a confidence 95% interval for the average age of the entire factory workforce.

**Technical Instructions:**

**Gender Pie Chart**

1. Count the number of male employees and female employees. Open a new sheet. Enter “Male” in cell A1 and the number of males in A2. Enter “Female” in B1 and the number of females in B2. Highlight these 4 cells A1:B2

2. Click on **Insert Tab**. Click on **Pie Chart**. Click on the first **2-D Pie Chart**. For layout choice, click on the **Pie Chart with Percentages** in the Tool Bar.

3. Put a title on the pie chart.

**Age Descriptive Statistics**

1. Go to Sheet 1.

2. Click on **Data**. Click on **Data Analysis**. Click on **Descriptive Statistics**. Click on **OK.**

3. Enter Input Range: C1:C37

4. Click on **Labels in First Row.** Click on **Summary Statistics.** Click on **OK**.

**Age Histogram**

1. Return to Sheet 1.

2. Click on **Data**. Click on **Data Analysis**. Click on **Histogram**. Click on **OK**.

3. Enter Input Range: C1:C37

4. Leave the Bin Range Blank

5. Click on **Labels**. Click on **Chart Output.** Click on **OK**.

6. Put a title on the histogram.

**Report Instructions**

Define and discuss Descriptive Statistics and Statistical Estimation so that the reader has a conceptual understanding of both. Estimate the percentage of the workforce that are male or female. Insert the **Gender Pie Chart**. Explain the gender 95% confidence interval in words. Discuss the sample mean, sample median, sample mode, sample standard deviation and range for age. Insert the **Age Histogram** and discuss it. Describe the 95% confidence interval for the average age of the entire workforce.

**5. Handheld Computers for Factory Workers**

Precision Auto Clone regularly evaluates the productivity of each factory worker and records their performance rating. A high rating indicates superior speed, consistent quality and accuracy. Larry has made the recommendation to equip each of its factory employees with a special handheld computer to automatically capture production data and thus increase productivity. Currently, factory workers manually record the work order number, start time, stop time, quantities, and other data associated with each completed manufacturing operation and then later this data is keyed into the Accounting Data Base. These handheld computers were tested on the 36 randomly selected employees. These employees were then given a 4 hour training course in the use of the computers. These individuals then utilized the computers on the production floor for one month and their performance ratings were re-evaluated and recorded in the **Precision Auto Clone Statistical Data.**

These devices will cost 30 cents per employee per hour to acquire and maintain. Their benefit is that production cost will be reduced by 10 cents per hour for each point increase in job performance rating. The computers will have to increase worker productivity by an average of more than three points per employee (30 cents cost / 10 cents per point benefit = 3 points) to be a profitable option. Precision Auto Clone wants to be at least 95% confident that they will make a profit before procuring the handheld computers.

**Technical Instructions**

1. Return to Sheet 1.

2. Create an additional column called “Performance Change” in Column H. The data in Column H equals Column G minus Column F.

3. Click on **Data**. Click on **Data Analysis**. Click on **Descriptive Statistics**. Click on **OK.**

4. Enter Input Range: H1:H37

5. Click on **Labels in First Row.**

6. Click on **Summary Statistics.** Click on **OK**.

7. Using these descriptive statistics, manually complete a hypothesis test with HO: µ < 3 and HA: µ > 3 where .30/.10 = 3 points of average increase in productivity is breakeven. Run the test at the .05 level of significance.

**Report Instructions**

Report the p-value and explain what it means to Precision Auto Clone. Define and discuss Hypothesis Testing so that the reader has a conceptual understanding of it and how it is used to determine whether or not the handheld computers will increase profits by cutting costs. Explain the Hypothesis Test results to the reader and what they mean.

**6. Personnel Screening Tests**

The Human Resources Department has questioned the accuracy of the screening process it currently uses in selecting which applicants should be hired as factory workers. Precision Auto Clone employs a large number of factory workers and there is regular turnover of these employees. The Human Resources Department currently requires that each factory job applicant take both a General Aptitude test and a Manual Dexterity test as part of the screening process. The General Aptitude test measures general intelligence and practical problem solving. The Manual Dexterity test measures coordination and other physical abilities that are essential in factory work. The applicant’s qualifications, references, and the results of the two tests are analyzed to determine who should be hired. Obviously, the company wants to hire applicants that will become productive workers. Precision Auto Clone subscribes to two testing services to provide updated General Aptitude and Manual Dexterity exams at a significant cost. These tests also take substantial time to administer, grade and analyze. Management is concerned with the accuracy of each test as a screening device and whether both tests are really necessary as part of the hiring process.

Assume that the handheld computer proposal will be implemented. Use your knowledge of Regression and Correlation Analysis to determine if the General Aptitude test and/or the Manual Dexterity test should be used to screen potential employees. An applicant named Stan Still took the two tests and got a 220 on the General Aptitude test and a 180 on the Manual Dexterity test. Using Regression, predict Stan’s performance rating if he were hired. Provide a 95% confidence interval around this estimate. Explain why Stan should or should not be hired.

**Technical Instructions**

**Current Workforce Productivity**

1. Return to Sheet 1.

2. Click on **Data**. Click one **Data Analysis**. Click on **Descriptive Statistics**. Click on **OK.**

3. Enter Input Range: G1:G37

4. Click on **Labels in First Row.** Click on **Summary Statistics.** Click on **OK**.

5. Find the average productivity of the current workforce.

**Regression**

1. Return to Sheet 1.

2. Click on **Data**. Click on **Data Analysis**. Click on **Regression**. Click on **OK**.

3. Enter **Input Y Range**: G1:G37*.*

4. Enter **Input X Range**: D1:E37.

5. Click on **Labels**. Click on **OK**.

6. Review the p-values for both General Aptitude Score and the Manual Dexterity Score. If both p-values are less than .05, then both tests should continue to be utilized and this Regression output should be used for the report. Do not worry about the p-value of the Intercept. If a p-value is very small, Excel will use scientific notation. For example a p-value of 2.34E-5 is actually .0000234 which is well below .05.

7. If only one test has a p-value less than .05, then rerun regression with only that variable in the X Range (see below).

**Only General Aptitude Score is significant**

1. Return to Sheet 1.

2. Click on **Data**. Click on **Data Analysis**. Click on **Regression**. Click on **OK**.

3. Enter **Input Y Range**: G1:G37.

4. Enter **Input X Range**: D1:D37.

5. Click on **Labels**. Click on **OK**.

**Only Manual Dexterity is significant:**

1. Return to Sheet 1.

2. Click on **Data**. Click on **Data Analysis**. Click on **Regression**. Click on **OK**.

3. Enter **Input Y Range**: G1:G37*.*

4. Enter **Input X Range**: E1:E37.

5. Click on **Labels**. Click on **OK**.

**Report Instructions**

Should Precision Auto Clone keep one or both screening tests. Provide the coefficient of determination and explain what it means. Define and discuss Regression and Correlation Analysis so the reader has a conceptual understanding of it and how it was utilized to determine the effectiveness of the Manual Dexterity Test and the General Aptitude Test in predicting Productivity. Present the Regression Equation that the Human Resources staff should employ to predict future employee performance. Describe how Human Resources should use it in screening future applicants. Illustrate its use by forecasting San Still’s performance rating if he were hired. Describe the 95% confidence interval around your forecast of Stan’s performance. Compare it to the average productivity of current employees to decide whether or not Stan should be hired.

**Final Report Instructions**

Precision Auto Clone has hired you as a decision analytics consultant to analyze the issues outlined in the case and to recommend optimal courses of action. You will submit a consultant’s report presenting your findings. **Do not include the computer printouts in your report other than those explicitly specified in the Report Instructions. Instead, explain in words the meaning of the information contained in the computer output.** Explain what the results mean to his Precision Auto Clone using minimal technical jargon. Your report should be clear, grammatically correct, typed (single-spaced) and be no more than 8 pages in length. **No title page** please. Clearly label each section. Begin each section with a sentence that will capture the reader’s attention and entice them to read the rest of the discussion in that section. The report should have a brief Introduction at the beginning and a brief Summary at the end.

**Grading Criteria for Written Case Study**

1. Describe and discuss the decision analytics tools used. (Weight 30%)

2. Technical analysis and accuracy of the results. (Weight 30%)

3. Clarity and user friendliness of the explanation of the technical results. (Weight 40%)