

ECS526 Final Project

Fall 2008

Assume that your Study Group is a Consulting organization. You are currently working with a customer to improve his operation. Group One customer has a small job shop (simulated via the Manuf1.gps program). Group Two customer has a larger unit, with a production line consisting of a conveyor, connecting several workstations (program Pallets1.gps). Group Three customer (Eroom.gps) is a hospital Emergency Room.

Customers are analyzing different configurations for improving their services and their procedures. Customers want to assess how these new layouts affect their service mean times, in order to calculate parameters such as number of operators, buffer sizes and to establish pricing policies. They also want to assess how such new mean times relate to server utilization, queue sizes, times in queue etc. In the last instance, your customers want to know how to best improve their organizations (in good English, how to make more money, with less resources, while keeping everybody happy).

You will analyze these systems, providing your customers with guidance and advice. To start, put some realistic values (\$\$) in your problem, reflecting salaries, cost of losing a customer, cost of extra space, personnel and equipment, of waiting times, etc. as you did with your previous homework. Experiment, and base your final selection and decision on these results, as it is actually done in real life. Make as much out of this project as you can (it may be a good job reference for you in an interview).

Analyses will be accomplished by implementing several experiments to help develop the equations (regressions and ANOVAs) that are used in assessing system configuration changes, improvements etc. By substituting in these equations the proposed parameters (number of spaces, workstations, clerks, machines, nurses etc.) one can estimate system mean time, queue sizes and all other measures of interest under the proposed settings.

Therefore, in addition to just mean time in the system, you also want to model several other performance measures and find the correlation among them. For example, obtain the correlation between responses times in the system, and (max and min) utilization of the servers, or (max/min) times in the queues, etc. (Pallets1.gps). Similarly, obtain the correlation between times in the system, and utilization of the clerk, of the operators, of the machines, etc. (Manuf1.gps). Or obtain the correlation between time in queue and number of nurses, etc. (Eroom.gps). These are just ideas. Use others, too.

Each Study Group will run (one time for each parameter combination) their program to developing multivariate regression and an ANOVA models.

The first group will work with program Pallets.gps and will optimize its operation, under the costs and schedules they come up to. This is an open-ended exercise.

The following three variables and values will be used in Pallets.gps experimentation:

Exper. One				Exper. Two			
Run	Spaces	Pallets	Stations	Run	Spaces	Pallets	Stations
1	4	13	6	1	3	10	4
2	5	13	6	2	4	10	4
3	4	15	6	3	3	13	4
4	5	15	6	4	4	13	4
5	4	13	9	5	3	10	6
6	4	15	9	6	4	10	6
7	5	13	9	7	3	13	6
8	5	15	9	8	4	13	6

1. Obtain the regression: $\text{Response} = A + B \cdot \text{Spaces} + C \cdot \text{Pallets} + D \cdot \text{Stations}$
2. Then, obtain ANOVA of Response on Factors A, B, C, and second ord Interactions.
3. Finally, compare the proposed results in a Table and Comment.

Use as Responses: times in the system, max and min utilization of the servers, and max and min times in the station queues (each Group member uses a different response and is responsible for these results). Find point and interval estimations for the best cases.

The **second** group will develop Regression and ANOVA models for the **Manuf1.gps** model. Run TWICE each parameter combination, in order to have TWO replications for each run, in order to be able to calculate the Operator \otimes Machine interaction.

Develop the models with the following two variables and values, as stated above:

Exper One			Exper Two		
Runs	Operator	Machine	Runs	Operator	Machine
1 & 2	7	3	1 & 2	8	3
3 & 4	7	4	3 & 4	8	2
5 & 6	5	3	5 & 6	6	4
7 & 8	5	4	7 & 8	6	3
9 & 10	5	5	9 & 10	6	2

1. Obtain ANOVA Model: $\text{Response} = A + B \cdot \text{Operator} + C \cdot \text{Machine} + D \cdot \text{Oper} \otimes \text{Mach}$
2. Obtain Regression Model: $\text{Response} = A + B \cdot \text{Operator} + C \cdot \text{Machine} + D \cdot \text{Oper}^{**2} + E \cdot \text{Mach}^{**2}$
3. Again, compare the two results in a Table and Comment.

Use as Responses, the times in the system, and the utilization of the clerk, of the operators, and of the machines. Also find a point and interval estimation for the best cases. These are only ideas and examples. You can develop more, on your own.

The Third group will analyze the operation of a Hospital Emergency Room. It currently has one doctor and two nurses. Analyze other configurations that increase the capacity of

the Emergency Room, the nurses, or both (interaction). For this, you will have to run more than one replication by setting (eg nurse-room capacity combination). Develop both, Regression and ANOVA models. Run TWICE each parameter combination, in order to have TWO replications for each run. This will allow you to calculate the Room Capacity⊗Nurse interaction

Consider not only costs but also the waiting times of patients (customers). Notice this system has “pre-emptive” feature. That is, if a gravely ill patient comes in, the current patient being treated by the doctor is then exchanged by the gravely ill patient.

Develop the models with the following two variables and values, as stated above:

Exper One			Exper Two		
Runs	Capacity	Nurses	Runs	Capacity	Nurses
1 & 2	10	2	1 & 2	15	2
3 & 4	10	3	3 & 4	15	3
5 & 6	10	4	5 & 6	15	4
7 & 8	13	2	7 & 8	13	5
9 & 10	13	3	9 & 10	13	4

4. Obtain ANOVA Model: $\text{Response} = A + B \cdot \text{Capacity} + C \cdot \text{Nurse} + D \cdot \text{Cap} \otimes \text{Nurse}$
5. Obtain Regression Model: $\text{Response} = A + B \cdot \text{Capacity} + C \cdot \text{Nurse} + D \cdot \text{Cap}^2 + E \cdot \text{Nurse}^2$
6. Again, compare the two results in a Table and Comment.

Use as Responses, the times in the system and in queue, and the utilization of doctors and nurses. Also find a point and interval estimation for the best cases. These are only ideas and examples. You can develop more, on your own.

Be sure to plot and tabulate all data first. Be sure also, to assess all assumptions for all models. Finally write a report (and PPT), addressed to your *customers*.

Each Group member will develop a different equation, obtained from a different result of the same run (e.g. one uses time in system, another max utilization) thus dividing total work among you. If you have questions, email me. Consultation between Groups is fine, as long as they are of general or methodological character (how to).

The Final Project FP Report, given both in Hard copy and CD, as well as all your Group Homework (in the same CD as the FP) are due a week after the last day of classes.

Good luck. I expect all projects to obtain at least a grade of A.

Jorge L. Romeu
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