Redesigning the Repair Network of Toner It Down! Inc.

Toner It Down! Inc. (TIDInc) is a leading developer and manufacturer of high-tech document management systems with a broad product line that includes printers, copiers, scanners and fax machines. The company has three major divisions:

- production-sales division, focusing on developing, manufacturing, marketing and distributing document management systems;
- consulting division, providing suggestions to businesses about how they can increase their document preparation and management efficiency;
- repair division, supporting the equipment that has already been sold.

In this project, you will be dealing with the third division.

Problem Definition

The managers responsible for the repair operations are not happy with the performance of the repair network in the Syracuse area. Simply put, the competitors of TIDInc can serve their clients much faster. It is doubtful that TIDInc will be able to retain its customer base in the Syracuse area, unless it renovates the repair network that serves this region.

You have been asked to carry out a simulation study of the local repair network with the purpose of determining the number of resources required to satisfy the customer requests in a timely manner. This is a preliminary study and you will focus on only one model of copiers that are currently in use in 10 business centers in the Syracuse area.

You have talked to the managers and found out that TIDInc uses the following process to respond to a customer repair request:

1. The customer request is received at the dispatch center. A repair mechanic is dispatched to the customer location.
2. The repair mechanic reaches the customer location. He/she diagnoses the problem. If he/she can fix the problem on-site, he/she does so and the customer request leaves the system.
3. If the mechanic cannot fix the problem on-site, the copier needs to be replaced with a new one and the broken copier has to be taken to the Dispatch Center where it can be repaired. For this purpose, the mechanic calls the dispatch center to request a van. The van replaces the broken copier at the customer location with one of the working copiers stored at the dispatch center.

Conversations with TIDInc employees have yielded the following key modeling insights.

- TIDInc has an ample supply of spare copiers at the dispatch center.
- Every business center uses the same type of copier.
- A van can only carry one copier at a time.
- Van operators indicate that swapping a broken copier for a working one at the dispatch center can take as little as 10 minutes, or as much as 25 minutes, but usually takes about 15 minutes.

triangular estimate

- Swapping copiers at the customer location takes a bit longer since operators must install the working printer and verify that it is functioning. Van operators indicated this usually takes about 30 minutes, but can take anywhere from 20 minutes to an hour.

Performance Measures and Objective

TIDInc is interested in two performance measures:

- Initial response time: This is the time interval between when a customer places the call and when a mechanic reaches the customer location.
- Delivery time for replaced copiers: This performance measure is collected only for the requests that require replacing a broken copier. It is the time interval between when a customer places the call and when a functional copier is delivered and installed for the customer.

Note that you do not have to worry about the completion times for on-site repairs, because

completion time for on-site repairs = initial response time + on-site diagnosis time + on-site repair time.

and the managers believe that they are doing their best for on-site diagnosis and on-site repair times — these times cannot be further reduced. Thus, in order to reduce the completion times for on-site repairs to a reasonable level, all they can do is to reduce the initial response time.

From their inquiries with the leading competitor's clients, the managers estimate that the average initial response time for the competitor is less than one hour. Also, in cases where the copier needs to be replaced, the competitor seems to be able to provide the customer with a working copier within three hours, on average, of the customer call (although large fluctuations in these times are possible). The objective is to design a repair network that will perform at least as well as the competitor's network.

TIDInc has asked you to assess how many

- mechanics (with cars)
- vans

are needed to build the most economical repair network that will reliably attain the performance goals stated above. Of course, you are free to examine other performance measures that you deem appropriate.

Data

TIDInc has collected a substantial amount of data through the GPS system installed on the mechanics' vehicles. The accompanying spreadsheet contains the following data related to the customer requests over 60 days:

1. Request number: This field is a simple counter.
2. Day: This field is the day in which the customer request is obtained.
3. Time of day: This field is the time at which the customer request is obtained (in hours).
4. Request location: This field is the location where the customer request is located.
5. Initial diagnosis time: This field is the amount of time between when a mechanic arrives at the customer location and when he completes the initial diagnosis (in minutes).
6. This field denotes whether the copier could be fixed on-site or if it had to be replaced. "Yes" indicates that the copier had to be replaced with a functioning copier from the dispatch center.
7. On-site repair time: This field is only defined for the requests that could be handled on-site. It indicates the amount of time between when a mechanic starts an on-site repair and when he completes it (in minutes).

You could estimate the travel times between the customer locations by using GPS data, but that will require too much work for this preliminary study. At this stage, you decide to estimate travel times by using the average speed of the vehicles, which is 60 kilometers/hour. The map on the last page shows the locations of the 10 business centers where the customer requests occur, along with the location of the repair shop.

The costs of owning/operating different types of resources for one year are:

- mechanic (including the car): $140,000
- van (including the driver): $100,000.

Deliverables

Your project report should be made up of the main report for TIDInc, and appendices to allow other simulation specialists to repeat your analysis. The main part of the report is for non-specialists. They are intelligent and know the business, but are not familiar with all of the jargon that goes along with simulation. You can put the technical details in the appendices.

Your project report should not exceed **15 1.5-spaced pages**. Appendices are not included in the page count. Below are possible sections you may want to consider in your project report. You **should not** organize your report in such a way that each section feels like a mechanical answer to one of the issues mentioned. Make sure that your report flows well. Furthermore, if you feel uncomfortable with any portion of the outline suggested below except the Executive Summary, then you are encouraged to modify the suggested outline and use something with which you are comfortable.

- Executive summary: This is the part of your report that high-level managers will read. Give a synopsis of what you were asked to do, what you did and what you discovered. Do not just outline what is in the report. Focus on the results. Think **what you would want to know if you were a high-level manager** and this was all that you read. This section should be at most two pages.

- Problem description: Describe the current situation and the goal of the study.
- Modeling approach and assumptions: Describe the simulation model in general terms. This section is for intelligent non-specialists. (A non specialist is a person who has never seen simulation before.) They want to ensure that your model is reasonable and captures all of the important aspects. This is a hard section to write.
- Data analysis: Describe what input distributions are needed to drive your model and how you obtained them. You may want to defer a large part of this section to the appendices if it is predominately technical in nature. But you should at least describe what you found in the data in a manner suitable for intelligent non-specialists.
- Model verification: Explain in broad strokes how you checked that your model was correct as implemented. The goal is to convince decision makers that your model can be trusted to correctly answer the questions it was designed to answer.
- Model analysis: Describe how you used your model to answer the questions in which TIDInc is interested. Analyze the results and make recommendations. Think about **sensitivity analysis** for quantities that are uncertain or approximate, and how robust your recommendation is to such changes. This is the real meat of your report. Your readers are not simulation specialists and cannot possibly know all that simulation has to offer. Therefore **be creative** and try to go above and beyond what has been asked for.
- Conclusions: Briefly recap your findings and recommendations.
- Appendices: These are intended for a simulation specialist who has training at the level of having taken ORIE 4580/5580 in the past. Readers of this section understand simulation concepts and have some familiarity with Simio. Think separately about the model and the implementation of the model in Simio. The model exists separately from Simio and could have been implemented in another package. Give the details of your model. Briefly describe how your model is implemented in Simio, and explain any tricky aspects of implementing your model. Include enough detail on your model so that someone could replicate your model without actually looking at your Simio code. The quality (clarity, correctness, appropriate use of Simio constructs) of your code counts.

Your project is due **on Canvas on Tuesday December 3rd at 11.59pm**. Late reports will be penalized by 10% per day or part thereof, for up to 5 days, so the latest you can hand in a project is Sunday December 8th at 11.59pm. Be sure to give the name and Net IDs of all team members on the title page or equivalent. Be aware that software always goes down the day before a project is due. This will not be accepted as a reason for turning in the report late. Remember that this is almost the last week of classes, so you will be busy with other work — don't postpone this project (and especially writing the report) until the last moment.

Hints

- Average performance measures are important, but we are also interested in the distributions (risk!).
- A common mistake is to assume that the project is only an exercise in model building. The project is an exercise in **model building, model analyzing and report writing**. Make sure that you spend at least 30% of your time on each one of these activities.

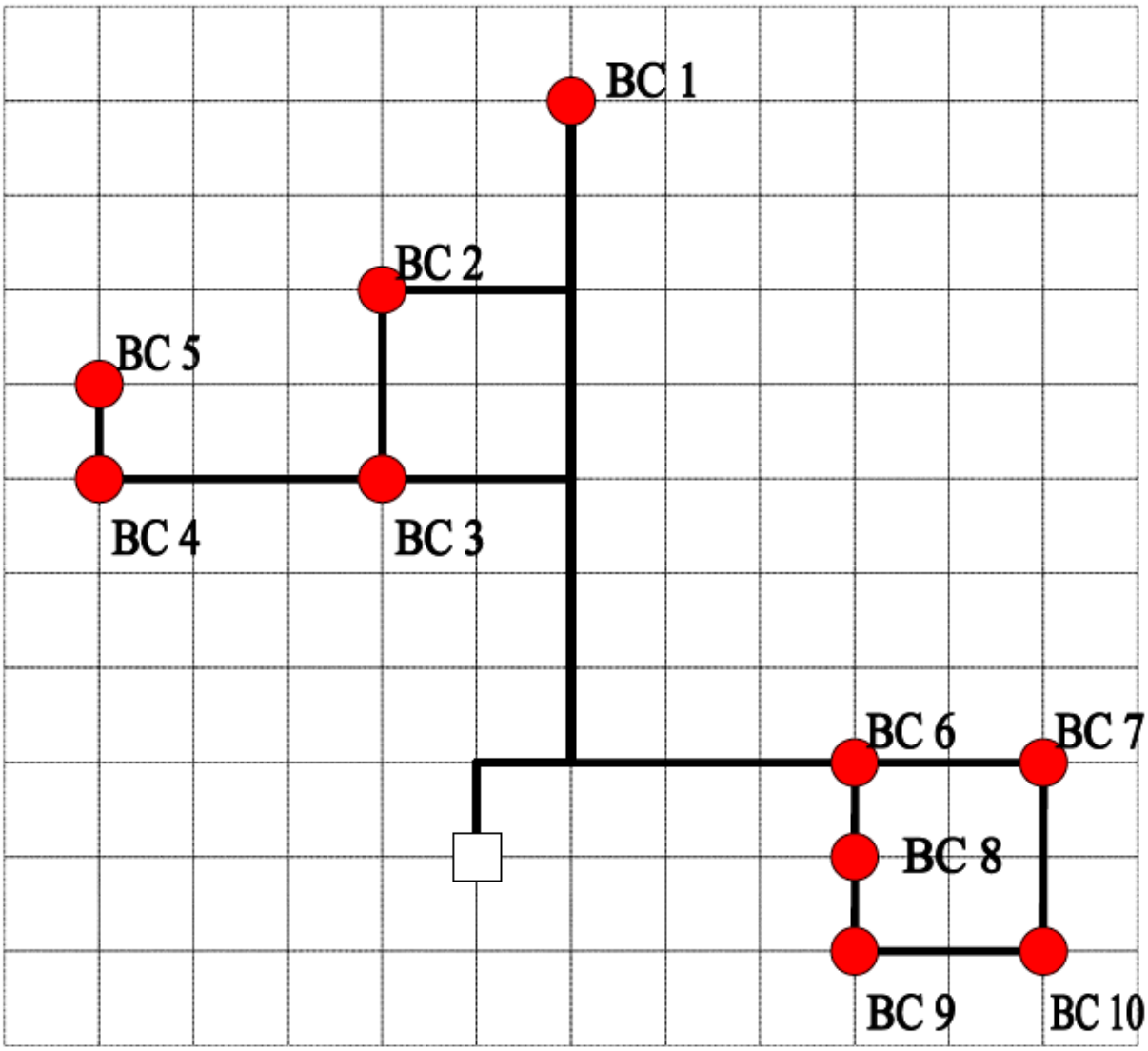
- Think about the **performance measures** that could be of interest.
- Think about the topics we covered (will cover) on output analysis and comparison of alternative systems, and use those you think are appropriate.
- The **quality of the report** (grammar, spelling, structure, quality of the writing, confining technical specifics to the appendix) counts, probably more than you think.
- Think about **sensitivity analysis** and where appropriate use **charts, tables and figures**.
- Your reports will be graded based on the following criteria: 1) Does the report answer all of the questions of interest? 2) Is the model built cleanly and correctly? 3) Is the input data correct? 4) Is the model appropriately verified? 5) Does the model produce the correct output? 6) Are proper output analysis techniques used? 6) Does the report explain the results and recommendations in a clear fashion? 7) How well written is the report? 8) Does the report have a logical progression that clearly describes the problem, modeling approach, analysis, results and recommendations?
- **Pay particular attention to the portions of the project description above that are formatted in bold.**

Project Team Evaluation

Due **Tuesday December 10th by 11.59pm on Canvas**.

Rate all of your team members on a scale from 0 to 10. A score of 10 means that the person contributed appropriately to the team effort. A score of 0 means that the person contributed nothing. Please also rate yourself. If you do not give a score of 10 to every member of your team, then briefly justify your assessment. When making your evaluation, consider the contribution of each team member to the project-related assignment you turned in earlier.

Your evaluations will remain confidential. If you do not hand in an evaluation form then we will likely assume that you rated your team-members at 10 and you rated yourself at 0.


BC 1
BC 2
BC 5
BC 4
BC 3
BC 6
BC 7
BC 8
BC 9
BC 10
Business center
Dispatch Center
Squares are 5x5 km^2