

# Gus The Grocer [FULL TITLE HERE]

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## Table of Contents

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Section
<a href="#">Introduction and Background</a>

# Introduction and Background

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## Author's note

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Defense contractors generally don't like when you go into too much detail about what you do or how their company works, even if it is for a paper for school. As such, I will be describing where I work and my job as a supermarket.

## My Origin Story

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I was originally hired as an intern with MiGrocery with the express purpose of collecting information on items that were delivered to be stocked in our canned goods department. Each canned good is supposed to have a log card with it. Each log card describes where the product was made and who handled it along with any climate conditions so we know if the product is safe for the sales floor. I was given a list of SKUs and a login for a piece of software we will call GrocerDocs which allows for realtime tracking of each SKU and a serial number for each unit of that SKU.

Unfortunately, the people who stock the warehouse and are not very organized and items of the same SKU do not always end up stocked together. In addition, just because GrocerDocs says an item is in a location does not mean it will actually be there when I look for it and each item may not have its required log card with it. Someone else could have taken the item without updating GrocerDocs or taken the log card and not uploaded it to GrocerDocs, or both.

GrocerDocs will tell me where each item is, but there's no way to check and see all of the locations I will need to visit without checking the location attribute for each SKU which could have several hundred serial numbers scattered about the warehouse where I work and on the sales floor that I do not have access to. I quickly realized that going SKU by SKU and searching all the different locations that for each specific serial number was inefficient. I found a way to export GrocerDocs' complete inventory and used R to extract a list of every serial number for every SKU I needed to find and order the list by location and export this information to a spreadsheet. I also added some columns to help me better keep track of product as it moved around the warehouse and so I knew which items I had already looked for and which ones I had uploaded. With my new program, I could now sync with GrocerDocs every morning to get the newest locations. Once I showed this to my supervisors, they thought I was a "tech wizard". Thus began the onslaught of spreadsheet generator requests.

## The Spinoff Series

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My supervisor, the canned food department head wanted a spreadsheet that had the item names and SKUs down the left and the item serial numbers listed horizontally with each serial number cell highlighted based on its status. She had recently spent several days creating this spreadsheet but since item status can change, it was no longer up to date and she needed a new one. Creating it by hand would take me several days each time, but automating it would only take several days once. Once completed, she showed the other department managers and the bakery manager decided he wanted one too. Then, the district manager decided he wanted me to make a spreadsheet that was

very similar but only listed items on the sales floor. The catch was that he wanted a single file for each department with a worksheet for every store. While there is no list of what each store should have on the sales floor, I could make a good effort at figuring it out by comparing across stores and making sure every store has the same number. Unfortunately for him, it was my day off and I was not going to accept my regular hourly rate. Ultimately, we agreed on a bonus of five hours of pay for coming in and creating the document.

At this point, my supervisor, the canned goods department manager, realized that I had not done any work for her in several weeks because I was working on generating spreadsheets of all sorts for other department heads. She wants me back on the log card project. By creating the location sorted spreadsheet of every item I need to find, I have already optimized the process as much as I can.

## The Dilemma

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Is it more economical to keep me on the log card project full time, keep me on the log card project and loan me out occasionally, or switch me to special projects full time?

## Analysis

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### Constrained Optimization

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At first glance, this presents itself as a constrained optimization problem where the total payoff is a function of my time spent on the log card project, my time spent on special projects, the time it would take someone else to complete the same work, and the urgency of each project. Traditionally, we would need to account for differences in pay, but the problem is much simpler if everyone is paid the same. It is also very easy to add that element back in later as a function of time spent on the project.

We can use the standard  $\pi$  as profit. We can also define my time on log cards and special projects as  $M_L$  and  $M_S$ , respectively. The time someone else would take is  $O_L$  and  $O_S$ . The urgency of each project should be a ratio that sums to one which we can call  $W_L$  and  $W_S$  as we are weighing our options. The constant value of each finished project is defined as  $V_L$  and  $V_S$ . However, each project is not yet finished so  $D_L$  and  $D_S$  denote the percent progress of the project on a zero to one scale. Thus, expected profit is written as

$$\pi = W_L V_L D_L + W_S V_S D_S - 13(M_L + O_L + M_S + O_S)$$

Because the weight adds to one, the equation can be quickly rewritten as

$$\pi = W_L V_L D_L + (1 - W_L) V_S D_S - 13(M_L + O_L + M_S + O_S)$$

The portion completed of each project,  $D$ , can be re-written as a function of the total time taken to complete the project for each person and the total time it will take to complete the project. We can call this total time for each project  $T_L$  and  $T_S$ . I have already optimized the log card project so  $D_L$  becomes  $\frac{M_L + O_L}{T_L}$ . For any special projects, we can say that it will take me one-tenth the time it will take someone else.  $D_S$  can become  $\frac{M_S}{.1T_S} + \frac{O_S}{T_S}$  which is simplified to  $\frac{O_S + 10M_S}{T_S}$ . The initial equation is

then rewritten as

$$\pi = W_L V_L \frac{M_L + O_L}{T_L} + (1 - W_L) V_S \frac{O_S + 10M_S}{T_S} - 13(M_L + O_L + M_S + O_S)$$

Finally, in order to make this giant mess usable,  $T_L$  and  $T_S$  must be able to be said in terms of each other. Each special project takes about twenty-five hours to complete. Based on current progress, we can estimate that the log card project would take about ten twenty-five hour weeks to complete. Thus,  $T_L = 10T_S$ . In order to make sure we are comparing the same amount of time, we must multiply any special project values by ten as well. This means that my and anyone else's time is limited to 250 hours as well.  $O_S$  and  $10M_S$  become  $250 - O_L$  and  $10(250 - M_L)$ , respectively. The profit equation becomes

$$\pi = W_L V_L \frac{M_L + O_L}{250} + 10(1 - W_L) V_S \frac{(250 - O_L) + 10(250 - M_L)}{250} - 13(M_L + O_L + 10(10(250 - M_L)) + 10(250 - O_L))$$

This cannot be simplified much more unless some of the variables are assigned numeric values.

While I do not know the true values of  $W_L$ ,  $V_L$ , or  $V_S$ , I can most certainly make something up. Let us say that the log cards are four times as important as any given special project and so  $W_L = .8$ . However, special projects are considerably more profitable and so  $V_S = 5V_L$  and  $V_S = \$10,000,000$ .

$$\pi = (.8 * 2,000,000) \frac{M_L + O_L}{250} + 10(1 - .8)10,000,000 \frac{(250 - O_L) + 10(250 - M_L)}{250} - 13(M_L + O_L + 10(10(250 - M_L)) + 10(250 - O_L))$$

Simplifying,

$$\pi = 1,600,000 \frac{M_L + O_L}{250} + 20,000,000 \frac{(250 - O_L) + 10(250 - M_L)}{250} - 13(M_L + O_L + 10M_S + 10O_S)$$

$$\pi = 6,400(M_L + O_L) + 80,000(O_S + 10M_S) - 13(M_L + O_L + 10M_S + 10O_S)$$

$$\pi = 6400M_L + 6400O_L + 80000O_S + 800,000M_S - 13M_L + 13O_L + 130M_S + 130O_S)$$

$$\pi = 6387M_L + 6387O_L + 79870O_S + 799870M_S$$

Now that we have an equation for profit

$D = \text{time on project} / \text{total time to complete}$

$V = \text{constant}$

$W = \text{constant}$