ADDITIONAL CASES

CASE 18.2 TNT: TACKLING NEWSBOY'S TEACHINGS

Howie Rogers sits in an isolated booth at his favorite coffee shop completely immersed in the classified ads of the local newspaper. He is searching for his next get-rich-quick venture. As he meticulously reviews each ad, he absentmindedly sips his lemonade and wonders how he will be able to exploit each opportunity to his advantage.

He is becoming quite disillusioned with his chosen vocation of being an entrepreneur looking for high-flying ventures. These past few years have not dealt him a lucky hand. Every project he has embarked upon has ended in utter disaster, and he is slowly coming to the realization that he just might have to find a real job.

He reads the date at the top of the newspaper. June 18. Ohhhh. No need to look for a real job until the end of the summer.

Each advertisement Howie reviews registers as only a minor blip on his radar screen until the word Corvette jumps out at him. He narrows his eyes and reads:

> WIN A NEW CORVETTE AND EARN CASH AT THE SAME TIME! Fourth of July is fast approaching, and we need YOU to sell firecrackers. Call 1-800-555-3426 to establish a firecracker stand in your neighborhood. Earn fast money AND win the car of your dreams!

Well, certainly not a business that will make him a millionaire, but a worthwhile endeavor nonetheless! Howie tears the advertisement out of the newspaper and heads to the payphone in the back.

A brief—but informative—conversation reveals the details of the operation. Leisure Limited, a large wholesaler that distributes holiday products—Christmas decorations, Easter decorations, firecrackers, etc.—to small independents for resale, is recruiting entrepreneurs to run local firecracker stands for the Fourth of July. The wholesaler is offering to rent wooden shacks to entrepreneurs who will purchase firecrackers from Leisure Limited and will subsequently resell the firecrackers in these shacks on the side of the road to local customers for a higher price. The entrepreneurs will sell firecrackers until the Fourth of July, but after the holiday, customers will no longer want to purchase firecrackers until New Year's Eve. Therefore, the entrepreneurs will return any firecrackers not sold by the Fourth of July while keeping the revenues from all firecrackers sold. Leisure Limited will refund only part of the cost of the returned firecrackers, however, since returned firecrackers must be restocked and since they lose their explosiveness with age. And the Corvette? The individual who sells the greatest number of Leisure Limited firecrackers in the state will win a new Corvette.

Before Howie hangs up the phone, the Leisure Limited representative reveals one hitch—once an entrepreneur places an order for firecrackers, 7 days are required for the delivery of the firecrackers. Howie realizes that he better get started quickly so that he will be able to sell firecrackers during the week preceding the Fourth of July when most of the demand occurs.

People could call Howie many things, but "pokey" they could not. Howie springs to action by reserving a wooden shack and scheduling a delivery 7 days hence. He then places another quarter in the payphone to order firecracker sets, but as he starts dialing the phone, he realizes that he has no idea how many sets he should order.

How should he solve this problem? If he orders too few firecracker sets, he will not have time to place and receive another order before the holiday and will therefore lose valuable sales (not to mention the chance to win the Corvette). If he orders too many firecracker sets, he will simply throw away money since he will not obtain a full refund for the cost of the surplus sets.

Quite a dilemma! He hangs up the phone and bangs his head against the hard concrete wall. After several bangs, he stands up straight with a thought. Of course! His sister would help him. She had graduated from college several years ago with an industrial engineering degree, and he is sure that she will agree to help him.

Howie calls Talia, his sister, at her work and explains his problem. Once she hears the problem, she is confident that she will be able to tell Howie how many sets he should order. Her dedicated operations research teacher in college had taught her well. Talia asks Howie to give her the number for Leisure Limited, and she would then have the answer for him the next day.

Talia calls Leisure Limited and asks to speak to the manager on duty. Buddy Williams, the manager, takes her call, and Talia explains to him that she wants to run a firecracker stand. To decide the number of firecracker sets she should order, however, she needs some information from him. She persuades Buddy that he should not hesitate to give her the information since a more informed order is better for Leisure Limited—the wholesaler will not lose too many sales and will not have to deal with too many returns.

Talia receives the following information from Buddy. Entrepreneurs purchase firecracker sets from Leisure Limited at a cost of $3.00 per set. Entrepreneurs are able to sell the firecracker sets for any price that they deem reasonable. In addition to the wholesale price of the firecracker sets, entrepreneurs also have to pay administrative and delivery fees for each order they place. These fees average approximately $20.00 per order. After the Fourth of July, Leisure Limited returns only half of the wholesale cost for each firecracker set returned. To return the unsold firecracker sets, entrepreneurs also have to pay shipping costs that average $0.50 per firecracker set.

Finally, Talia asks about the demand for firecracker sets. Buddy is not able to give her very specific information, but he is able to give her general information about last year's sales. Data compiled from last year's stand sales throughout the state indicate that stands sold between 120 and 420 firecracker sets. The stands operated any time between June 20 and July 4 and sold the firecracker sets for an average of $5.00 per set.

Talia thanks Buddy, hangs up the phone, and begins making assumptions to help her overcome the lack of specific data. Even though Howie will operate his stand only during the week preceding the Fourth of July, she decides to use the demands quoted by Buddy for simplicity. She assumes that the demand follows a uniform distribution. She decides to use the average of $5.00 for the unit sale price.

(a) How many firecracker sets should Howie purchase from Leisure Limited to maximize his expected profit?

(b) How would Howie's order quantity change if Leisure Limited refunds 75 percent of the wholesale price for returned firecracker sets? How would it change if Leisure Limited refunds 25 percent of the wholesale price for returned firecracker sets?

(c) Howie is not happy with selling the firecracker sets for $5.00 per set. He needs to make some serious dough! Suppose Howie wants to sell the firecracker sets for $6.00 per set instead. What factors would Talia have to take into account when recalculating the optimal order quantity?

(d) What do you think of Talia's strategy for estimating demand?

CASE 18.3 JETTISONING SURPLUS STOCK

Scarlett Windermere cautiously approaches the expansive gray factory building and experiences a mixture of fear and excitement. The first day of a new consulting assignment always leaves her fighting conflicting emotions. She takes a deep breath, clutches her briefcase, and marches into the small, stuffy reception area of American Aerospace.

"Scarlett Windermere here to see Bryan Zimmerman," she says to the bored security guard behind the reception desk.

The security guard eyes Scarlett suspiciously and says, "Ya don't belong here, do ya? Of course ya don't. Then ya gotta fill out this paperwork for a temporary security pass."

As Scarlett completes the necessary paperwork, Bryan exits through the heavy door leading to the factory floor and enters the reception area. His eyes roam the reception area and rest upon Scarlett. He approaches Scarlett booming, "So you must be the inventory expert—Scarlett Windermere. So glad to finally meet you face to face! They already got you pouring out your life story, huh? Well, there will be enough time for that. Right now, let's get you back to the factory floor to help me solve my inventory problem!"

And with that, Bryan stuffs a pair of safety glasses in Scarlett's right hand, stuffs the incomplete security forms in her left hand, and hustles her through the heavy security door.

As Scarlett walks through the security door, she feels as though she has entered another world. Machines twice the size of humans line the aisles as far as the eye can see. These monsters make high-pitched squeals or low, horrifying rumbles as they cut and grind metal. Surrounding these machines are shelves piled with metal pieces.

As Bryan leads Scarlett down the aisles of the factory, he yells to her over the machines, "As you well know from the proposal stage of this project, this factory produces the stationary parts for the military jet engines American Aerospace sells. Most people think the aerospace industry is real high-tech. Well, not this factory. This factory is as dirty as they come. Jet engines are made out of a lot of solid metal parts, and this factory cuts, grinds, and welds those parts."

"This factory produces over 200 different stationary parts for jet engines. Each jet engine model requires different parts. And each part requires different raw materials. Hence, the factory's current inventory problem."

"We hold all kinds of raw materials—from rivets to steel sheets—here on the factory floor, and we currently mismanage our raw materials inventory. We order enough raw materials to produce a year's worth of some stationary parts, but only enough raw materials to produce a week's worth

of others. We waste a ton of money stocking raw materials that are not needed and lose a ton of money dealing with late deliveries of orders. We need you to tell us how to control the inventory—how many raw materials we need to stock for each part, how often we need to order additional raw materials, and how many we should order."

As she walks down the aisle, Scarlett studies the shelves and shelves of inventory. She has quite a mission to accomplish in this factory!

Bryan continues, "Let me tell you how we receive orders for this factory. Whenever the American Aerospace sales department gets an order for a particular jet engine, the order is transferred to its assembly plant here on the site. The assembly plant then submits an order to this factory here for the stationary parts required to assemble the engine. Unfortunately, because this factory is frequently running out of raw materials, it takes us an average of a month between the time we receive an order and the time we deliver the finished order to the assembly plant. The finished order includes all the stationary parts needed to assemble that particular jet engine. BUT—and that's a big but—the delivery time really depends upon which stationary parts are included in the order."

Scarlett interrupts Bryan and says, "Then I guess now would be as good a time as any to start collecting the details of the orders and solving your inventory problem!"

Bryan smiles and says, "That's the attitude I like to see—chomping at the bit to solve the problem! Well, I'll show you to your computer. We just had another consulting firm complete a data warehouse started by American Aerospace three years ago, so you can access any of the data you need right from your desktop!" And with a flurry, Bryan heads back down the aisle.

Scarlett realizes that the inventory system is quite complicated. She remembers a golden rule from her consulting firm: break down a complex system into simple parts. She therefore decides to analyze the control of inventory for each stationary part independently. But with 200 different stationary parts, where should she begin?

She remembers that when the assembly plant receives an order for a particular jet engine, it places an order with the factory for the stationary parts required to assemble the engine. The factory delivers an order to the assembly plant when all stationary parts for that order have been completed. The stationary part that takes the longest to complete in a given order therefore determines the delivery date of the order.

Scarlett decides to begin her analysis with the most time-intensive stationary part required to assemble the most popular jet engine. She types a command into the computer to determine the most popular jet engine. She learns that the MX332 has received the largest number of orders over the past year. She types another command to generate the following printout of the monthly orders for the MX332.

Month	Number of MX332 ordered
June	25
July	31
August	18
September	22
October	40
November	19
December	38
January	21
February	25
March	36
April	34
May	28
June	27

She enters the monthly order quantities for the MX332 into a computerized statistical program to estimate the underlying distribution. She learns that the orders roughly follow a normal distribution. It appears to Scarlett that the number of orders in a particular month does not depend on the number of orders in the previous or following months.

(a) What is the sample mean and sample variance of the set of monthly orders for the MX332?

Scarlett next researches the most time-intensive stationary part required to assemble the MX332. She types a command into the computer to generate a list of parts required to assemble the MX332. She then types a command to list the average delivery time for each part. She learns that part 10003487 typically requires the longest time to complete, and that this part is only used for the MX332. She investigates the pattern for the part further and learns that over the past year, part 10003487 has taken an average of one month to complete once an order is placed. She also learns that the factory can produce the part almost immediately if all the necessary raw materials for the production process are on hand. So the completion time actually depends on how long it takes to obtain these raw materials from the supplier. On those unusual occasions when all the raw materials already are available in inventory, the completion time for the part is essentially zero. But typically the completion time is $1\frac{1}{2}$ months.

Scarlett performs further analysis on the computer and learns that each MX332 jet engine requires two parts numbered 10003487. Each part 10003487 accepts one solid steel part molded into a cylindrical shape as its main raw material input. The data show that several times the delivery of all the stationary parts for the MX332 to the assembly plant got delayed for up to $1\frac{1}{2}$ months only because a part 10003487 was not completed. And why wasn't it completed? The factory

had run out of those steel parts and had to wait for another shipment from its supplier! It takes the supplier $1\frac{1}{2}$ months to produce and deliver the steel parts after receiving an order from the factory. Once an order of steel parts arrives, the factory quickly sets up and executes a production run to use all the steel parts for producing parts 10003487. Apparently the production problems in the factory are mainly due to the inventory management for those unassuming steel parts. And that inventory management appears to be completely out of whack. The only good news is that there is no significant administrative cost associated with placing an order for the steel parts with the supplier.

After Scarlett has finished her work on the computer, she heads to Bryan's office to obtain the financials needed to complete her analysis. A short meeting with Bryan yields the following financial information.

Setup cost for a production run to produce part 10003487	\$5,800
Holding cost for machine part 10003487	\$750 per part per year
Shortage cost for part 10003487 (includes outsourcing cost, cost of production delay, and cost of the loss of future orders)	\$3,250 per part per year
Desired probability that a shortage for machine part 10003487 will not occur between the time an order for the steel parts is placed and the time the order is delivered	0.85

Now Scarlett has all of the information necessary to perform her inventory analysis for part 10003487!

(b) What is the inventory policy that American Aerospace should implement for part 10003487?

(c) What are the average annual holding costs and setup costs associated with this inventory policy?

(d) How do the average annual holding costs and setup costs change if the desired probability that a shortage will not occur between the time an order is placed and the time the order is delivered is increased to 0.95?

(e) Do you think Scarlett's independent analysis of each stationary part could generate inaccurate inventory policies? Why or why not?

(f) Scarlett knows that the aerospace industry is very cyclical—the industry experiences several years of high sales, several years of mediocre sales, and several years of low sales. How would you recommend incorporating this fact into the analysis?