



## **AN INVENTORY MANAGEMENT SYSTEM FOR NATURAL BY DESIGN**

### **I. Background**

*Natural by Design, Inc.* (NBD) is a partnership that designs and develops interior and exterior landscapes for hotels, restaurants, condominiums, and private estates. In their designs, they use a mixture of commonly available plants, flowers, and shrubs; imported rare and exotic plants; pottery; and other materials. NBD employs thirty people and has gross sales of \$4.1 million with a before-tax profit of \$750,000. Keri Yamaguchi and Stan Fenton own the partnership equally. Keri, a designer, manages the artistic side of the business -- including supervising the design activity and job production and selecting vendors. Stan is the general manager who purchases inventory and supervises the sales and financial activities.

### **A. Acquiring Projects**

To acquire projects, the NBD salespeople call upon potential customers and identify project opportunities. Once the salespeople identify a real prospect, they introduce one or more of NBD's five designers to the client. The designers meet with the client, determine the client's needs, and then develop a design, including formal sketches and blueprints. The designers also prepare a written Design Bid (see Figure IMS-1) that contains a general description of the project, a list of plants and materials, and a detailed listing of both material and labor costs. The design bid and sketches are reviewed with the customer, adjusted as needed, and then approved (or rejected). If approved, the project is turned over to the Production staff for implementation. Accounts Receivable then follows up for payment. Usually, customers are slow to approve a design, but, once they do approve it, they want near immediate implementation. Because NBD's procurement process is very slow, the designers have learned to work only with plants and materials that are in inventory or that will very soon be in inventory. Except for very large and specialized jobs, the designers do not have the luxury of selecting plants that are not already on order or in inventory.

**Natural by Design**  
**14398 Union Road San Jose, CA 95190**  
**(408) 775-3600**  
**Design Bid**

**Client**

Client Name:	London Sq. Mall	Contact:	Amy Benson, Mgr.
Client Address:	12638 Mall Drive Scotts Valley, CA 95066	Phone:	(408) 834-5603

**NBD Staff**

Sales Assoc:	Bill Reinhardt	Phone:	(408) 775-3652
Designer:	Tamara Bakken	Phone:	(408) 775-3645

**Project**

Bid Date:	May 6, 1996	Project Site:	Main entrance
Est. Begin Date:	June 15, 1996		Mall Dr./Cinema Lane
Est. Compl. Date:	June 30, 1996	Bid Amount:	\$7,651.50

**Material Requirements**

<b>Plants:</b>					
Qty	Desc	Size	Unit Price	Extended Price	
3	laccospadix australasica palm	15 gal	\$749.00	2,247.00	
5	caryota mitis	7 gal	\$233.00	1,165.00	
7	marginata	2 gal	\$75.00	525.00	

  

<b>Pottery:</b>					
1	granite fountain (GFN48)	48 in	\$750.00	750.00	
3	granite pots (GP50)	50 gal	\$195.00	585.00	

  

<b>Materials:</b>					
10	decorative cedar bark (CBRK5)	5 cu ft	\$15.95	159.50	
1	top soil (TSOIL)	yard	\$20.00	20.00	

**Labor Requirements**

Hours	Desc	Unit Price	Extended Price
30	Production workers	\$30.00	900.00
10	Design consultant	\$65.00	650.00
10	Heavy equipment operator	\$65.00	650.00

**Figure IMS-1: Design Bid**

**B. Managing Inventory**

Effective inventory management is critical to NBD's success. They must have appropriate plants and other materials available when needed; however, because their inventory is expensive

to maintain, they do not want more inventory than necessary. But with order lead time averaging 5 to 6 weeks on some of their more exotic plants, they need to maintain sufficient stock to carry them until the ordered items are delivered.

The Design Group keeps inventory records to facilitate the effective use of inventory. Specifically, for each plant type, they maintain data about the plant type, size, average net cost, list price, quantity in stock, quantity in stock and on bid, quantity on order, and quantity on order and on bid. The on-bid quantities are tracked so that designers know the quantity of uncommitted inventory available at a point in time. Similar information is maintained about pottery and decorative items, but only in stock and in stock/on bid quantities are maintained. For landscaping materials, only the description, unit, net and list prices, and quantity in stock are recorded. An excerpt of this inventory data is shown in Figure IMS-2.

NBD Inventory Report									June 13, 1996		
PLANT INVENTORY											
Code	Desc	Size	Last Ordered	AveNet\$	List\$	OIS	IS/OB	QOO	OO/OB		
lacco	lacco australasica	15 gal	06/11/96	450.00	749.00	3	3	3	1		
arenga	arenga pinnata	15 gal	05/15/96	310.00	516.00	4	2	3	0		
cham	chamaedorea	15 gal	06/09/96	300.00	499.00	0	0	2	0		
cera	ceratozamia molongo	14 in	05/30/96	240.00	400.00	4	2	6	0		
areca	arecastum coco	15 gal	05/15/96	275.00	458.00	11	5	0	0		
cary	caryota mitis	7 gal	05/30/96	140.00	233.00	14	9	4	0		
grnti5	green ti	5 gal	05/30/96	92.00	154.00	11	8	6	0		
grnti7	green ti	7 gal	06/09/96	140.00	234.00	8	5	6	0		
ficus14	ficus green gem	14 in	06/12/96	90.00	150.00	7	7	20	2		
ficus17	ficus green gen	17 in	06/12/96	240.00	400.00	6	4	12	0		
margi	marginata	2 gal	06/11/96	45.00	75.00	16	13	12	0		
POTTERY INVENTORY											
Code	Desc	Size	Features	AveNet\$	List\$	OIS	IS/OB				
TCP50	t/c pot	50 gal	hand painted	53.95	110.95	6	3				
GP50	granite pot	50 gal	oblade	110.00	195.00	5	3				
TCF03	t/c figurine-swan		glazed	25.50	45.00	3	1				
MBB30	marble bird bath	30 in	Doric base	128.50	250.00	2	1				
GFN48	granite fountain	48 in	fluted basin	457.50	750.00	1	1				
MATERIALS INVENTORY											
Code	Desc	Unit		AveNet\$	List\$	OIS					
CBRK5	decorative cedar bark	bag (5 cu ft)		7.50	15.95	53					
CRGRN	crushed granite	yard		7.50	14.00	12					
PGRV	pea gravel	yard		8.00	20.00	7					
GRV1	1" gravel	yard		5.90	12.00	18					
TSOIL	top soil	yard		12.50	20.00	10					
PBLKG	patio block-gray	each		.56	.84	94					
PBLKR	patio block-red	each		.56	.84	123					

Figure IMS-2: Excerpt from NBD Inventory Report

Inventory information is maintained as an Excel worksheet by the Design Group's administrative assistant, Connie Nguyen. Each day, Connie updates the numbers, prints the worksheet, and makes a copy for each designer. The designers work against the data on these copies in deciding which plants to include in their designs.

There are a number of problems with this arrangement. First, designers work simultaneously, and sometimes they unknowingly use the same last items from inventory in their bids. They try to coordinate their activities to prevent this, but sometimes it is not possible. Second, if a design bid is rejected or changed to eliminate plants or other materials, these items should be placed back in inventory; that is, Connie should subtract them from the appropriate on-bid quantity total and add them to the in-stock or on-order quantity total. Sometimes designers forget to tell Connie about these changes. As a result, the number of items available to be used in bids is often larger than the records show.

### C. Purchasing and Maintaining Stock Items

Stan Fenton is responsible for ordering stock, but because he lacks Keri's knowledge of plants, he relies on her expertise to select suppliers for all NBD's plant stock. Once a year Keri evaluates the price and quality of the plants and the quality of service provided by each plant supplier. She compiles this information into a report that lists the preferred and secondary supplier for each plant type; also listed are the total quantity of each plant type used by NBD in the previous 12 months and each supplier's order lead time, i.e., the average length of time between NBD's placing an order and receiving the corresponding shipment. (NBD does not need to maintain similar information for its other pottery and materials. These items are obtained from local suppliers who can usually deliver an order within 48 hours.) An excerpt from this report is shown in Figure IMS-3.

Description	Size	Sales/Yr	Supplier1	Supplier2
laccospadix australasica palm	15 gal	100	Palms(4)	Lunds(5)
arenga pinnata palm	15 gal	160	GPC(2)	Greens(3)
chamaedorea falcifera palm	15 gal	200	Palms(4)	Lunds(5)
ceratozamia molongo palm	14"	175	Palms(4)	Lunds(5)
arecastum coco plumosa	15 gal	265	Greens(3)	GPC(2)
caryota mitis	7 gal	350	Olsen(3)	Greens(3)
green ti	7 gal	400	TisRUs(5)	Olsen(6)
green ti	5 gal	600	TisRUs(5)	Olsen(6)
ficus green gem	14"	500	Figs(4)	Lunds(5)
ficus green gem	17"	350	Figs(4)	Lunds(5)
marginata	2 gal	500	GPC(2)	Greens(3)

Figure IMS-3: Suppliers, Lead Times, and Sales for Each Plant Type

Stan refers to this report when he is preparing a purchase order to determine what to order. He uses the annual sales quantity figure to determine the average sales per week of each plant; then he compares this figure to the current stock level, taking into consideration the time it will take to restock each plant type. For example, on June 12 he noted that the current stock levels of the 14-inch and 17-inch ficus were only 7 and 6, respectively. Given the information that, on average, NBD sells 4 of the 14-inch and 2 of the 17-inch plants each week and that the order lead time is 4 weeks, Stan rushed out an order for 20 of the 14-inch ficus and 12 of the 17-inch.

#### D. Tracking Inventory Transactions

Each day, Connie receives a number of forms that she must compile to update the inventory report. At the end of each day, the designers give Connie a copy of any Design Bids they have prepared (see Figure IMS-1), which list the materials they plan to use. Connie adds these item quantities to the in stock/on bid (IS/OB) or on order/on bid (OO/OB) totals, as appropriate. Also, each day, Connie receives copies of purchase orders from Stan, which she uses to update quantity on order (QOO) data, adding the order quantity for each plant to the QOO. (See Figure IMS-4 for a sample purchase order.) As orders are delivered, Connie receives copies of the shipping lists (see Figure IMS-5) from the Greenhousing Department and adds the quantities received to the QIS count and subtracts them from the QOO count. She also updates the IS/OB and OO/OB quantities, shifting OO/OB quantities to IS/OB as appropriate. For example, when the order of 3 laccospadix australasica palms is received, Connie updates the counts to indicate that QIS equals 6, IS/OB equals 4, and QOO and OO/OB equal zero.

In addition to updating inventory each time an order is placed, a shipment arrives, or a designer includes an item in a bid, Connie also keeps track of the stock items removed from physical inventory. Overseeing the physical inventory is the responsibility of the Greenhousing Department, which also performs all shipping and receiving tasks as well as caring for the plants in inventory. As Production crews load plants and other materials from inventory onto their trucks each morning, Bill Johnson, the Greenhousing clerk, fills out the Materials Used portion of NBD's Daily Work Report form (see Figure IMS-6), listing the description and quantity of items removed. Bill signs the form and gives it to the Production crew. At the end of the day, each Production crew submits these forms to Connie. Connie subtracts the listed materials from her QIS and IS/OB totals.

*Natural by Design, Inc.*  
**14398 Union Road San Jose, CA 95190**  
**(408) 775-3600**

<b>Supplier:</b>	Greens Etc.	<b>Address:</b>	1945 E Palmetto Road
			San Raphael, California
<b>PO Number:</b>	NBD054-94	<b>PO Date:</b>	5/15/96

**Bill To:** **Ship To:**  
 Natural by Design, Inc. (same)  
 14398 Union Road  
 San Jose, CA 95190

<b>Qty</b>	<b>Description</b>	<b>Size</b>	<b>Price/Unit</b>	<b>Extended Price</b>
5	arecastum coco plumosa	15 gal	284.00	1,420.00 <i>b7</i>
3	arenga pinnata palm	15 gal	315.00	945.00 <i>b6/b7</i>
				<b>Sub-total</b> 2,365.00
				<b>Tax</b> 189.20
				<b>Total</b> 2,554.20

**Figure IMS-4: NBD Purchase Order**

**Greens Etc.**  
**1945 E Palmetto Road**  
**San Raphael, California**

<b>Invoice Number:</b>	GR0976-94	<b>Account:</b>	NBD
<b>Invoice Date:</b>	5/28/96	<b>PO Number:</b>	NBD054-94
<b>Ship Date:</b>	6/05/96	<b>PO Date:</b>	5/15/96

**Bill To:** **Ship To:**  
 Natural by Design (same)  
 14398 Union Road  
 San Jose, CA 95190

<b>Qty</b>	<b>Description</b>	<b>Size</b>	<b>Price/Unit</b>	<b>Extended Price</b>
5	arecastum coco plumosa	15 gal	284.00	1,420.00
Note: arenga on back order; will ship and invoice separately				
				<b>Sub-total</b> 1,400.00
				<b>Tax</b> 113.60
				<b>Total</b> 1,513.60

**Figure IMS-5: Shipping List from Greenhousing Clerk**

## Production Daily Work Report

**Date:** 6/17/96  
**Project:** LS Mall  
**Submitted by:** Monica Goce

**Materials Used:**

<u>Code</u>	<u>Qty</u>	<u>Unit Cost</u>	<u>Ext. Cost</u>	<u>Approved by</u>
cary	5	143.00	715.00	<u>B. Johnson</u>
margi	7	45.00	315.00	<u>B. Johnson</u>
cedar bark	10	7.50	75.00	<u>B. Johnson</u>
<b>Total Cost of Materials:</b>				1,105.00

**Labor:**

<u>Worker</u>	<u>Hours</u>	<u>Cost/Hr</u>	<u>Ext. Cost</u>	<u>Task</u>
Monica	8 hrs	18.00	144.00	installed plants and bark
Bert	8 hrs	18.00	144.00	installed plants and bark
<b>Total Cost of Labor:</b>				288.00

6/17/95

Date

Monica Goce

Lead Worker Signature

**Figure IMS-6: Production Daily Work Report**

### E. Increasing Competition

A major concern for NBD is competition. In recent years, a number of similar firms have begun operation, and business that at one time was easy to obtain has now become very competitive. Due to competitive pressure, NBD is increasingly required to reduce its prices. While, on the one hand, Keri and Stan strive to provide the best and not necessarily the cheapest product, on the other hand, they cannot entirely ignore price levels set by their competition. To retain profitability in this environment, NBD must be as efficient as possible in all aspects of its business. This means buying at a low price, minimizing inventory costs, and passing on these savings to their customers.

### F. Current Use of Information Technology

Currently, NBD has made only limited use of information technology to improve its efficiency and effectiveness. The designers have access to one microcomputer and a laser printer, which they use to prepare design bids. Connie, who is taking evening classes at the local university to complete an MIS degree, recently developed an Excel spreadsheet template to help the designers prepare design bids and to improve the format consistency and the mathematical

accuracy of this form. Connie also has a microcomputer; she uses an Excel worksheet to maintain inventory count data and Microsoft Word for Windows to generate miscellaneous reports. She shares the Design Group laser printer. A third microcomputer, a second laser printer, and another Excel worksheet are used by Stan. Stan prepares purchase orders manually.

## **II. Inventory Management System Project**

Stan and Keri want to develop a computerized Inventory Management System (IMS) to help them keep track of their inventory and to integrate the Design, Greenhousing, and Purchasing functions. They've heard about systems that use electronic forms to generate purchase orders and bids and data entry screens on which inventory and shipping/receiving personnel can record all materials received into or removed from inventory. In these systems, the inventory database is instantly and automatically updated as each transaction occurs. For example, when Stan generates a purchase order, the number of an item on order would be updated; similarly, when a designer creates a design bid, the number of an item on bid would be updated. Automatic updating of the database will not only reduce Connie's workload but also provide up-to-the-minute inventory information for designers.

Lacking their own IS staff, Stan and Keri have decided to hire a consulting team to develop the system. Your task as a member of the consulting team is to determine the requirements of an information system that will maintain up-to-the-minute inventory counts by tracking all purchase orders, shipping lists, design bids, and production work reports. You are to analyze these documents only as they affect inventory. That is, you need to sift through the myriad details in these documents to identify which data are needed to maintain inventory status and to determine when and how much stock to order. You do not need to model all the project or cost data, nor do you need to keep track of clients, project teams, accounts receivable, or accounts payable. You should assume that, if Stan and Keri want to automate these functions, they will fund future development projects.

In addition, to minimize costs, Stan and Keri have stipulated that NBD's existing hardware devices (three 486 DX2 microcomputers and two HP LaserJet printers) must be incorporated into the new system configuration and that commercially-available software must be used to construct the system. The new IMS must be operational within 6 months, and development costs must not exceed \$55,000, including consulting fees, any additional hardware or software, training, documentation, data conversion, and so on.

## **III. Interviews with NBD Users**

Given Connie Nguyen's interest in MIS, Stan and Keri asked her to be part of the consulting team and to guide the team through interviews with NBD employees. The following interviews provide more detail on how the design bid, shipping list, and production daily work report are prepared.

## **Interview with Tamara Bakken, Designer**

The consulting team, accompanied by Connie Nguyen, met with Tamara to determine how the designers interact with the Inventory Management System. Connie began by asking Tamara how she prepares a Design Bid.

"I have to admit that, after six years as a NBD designer, I've fallen into an almost unconscious -- if that's the right word -- method of estimating materials and design and labor hours. I refer to my preliminary sketches to determine the materials needed. Estimating the total price of plants and materials is pretty clear cut. Connie distributes updated price lists for all inventory items on each day's inventory report. All we designers do is find the desired item on the list and enter it and its price on the spreadsheet template that Connie created (see desbid.xls). We enter the quantity of each item, and then the spreadsheet calculates the extended price and the total price for materials. The finished bid is approved by Cheryl and then shown to the client and, if approved, I retain one copy and give the original bid to Connie, who, I guess, forwards one copy to Sue Kaufman in Production and another to Accounts Receivable, and retains the original to file and to update inventory data on her spreadsheet. Is that right, Connie?"

"Pretty much," Connie said. "For now, we just want to understand what you do. If you can't think of any other details about how the designers prepare bids, do you have any complaints about the current system? Are there any improvements you'd like to suggest?" Connie asked.

"Hmmm, let me think. It would be nice if all I had to do to prepare the bid was enter the inventory code and quantity for materials and the system would retrieve the appropriate description, price, etc. Same with labor. If we had codes for labor type, all I'd have to do is enter the code, and the description and hourly price would be plugged in. Is that within the scope of your project?"

"I'm not sure," Connie responded for the group. "We'll have to talk with Stan and Keri about that. Do you have any other complaints or suggestions?"

"Well, currently, I feel quite constrained as a designer. I have to know when implementation will likely occur so that I can select plants that will be available. I guess what I'm trying to say is that, if a design will be implemented immediately upon approval, I pretty much have to go with plants that are currently available. I sometimes find myself steering a client away from certain plants because I know that we're unlikely to have them in time for implementation."

"What would the system have to be able to do to help you avoid this constraint?" one of the consultants asked.

"I have no idea .... I guess if it could shorten the lead-time, that would be a big help."

"Can you think of anything else we should know?"

"Not that I can think of now. But I'll let you know if I come up with any other ideas."

accuracy of the form. Connie also has a microcomputer that can do most of the work involved in maintaining and tracking inventories and shipping lists.

### Interview with Bill Johnson, Greenhousing Clerk

"Hi, Connie. Folks. Come on in. Sorry I don't have enough chairs for everyone, but I don't think this will take too long."

"Hi, Mr. Johnson," Connie said and then introduced the members of the consulting team. "If I understand correctly, your interactions with the inventory tracking process include the Production Daily Work Report (PDWR) and the shipping list. Let's start with the PDWR. Could you tell us about your role in completing that report?"

"Well, it's pretty simple. All I do is record the unit cost and extended cost for items removed from inventory and sign my name. The lead production worker has already written the date, project name, and item code and quantity on the form when I see it. So that's about it. Told you this would be a short meeting."

"How do you know what unit cost to enter for each item?" asked a consultant.

"Pretty simple. All I do is refer to the most recent inventory report that lists the net cost and list price for all inventory items. Then I calculate the extended cost. That's it."

"Do you ever have any problems, like entering the wrong unit or extended cost?"

"Oh, occasionally, I botch the job. Especially if I'm trying to do two things at once. Some mornings are more hectic than others. But Connie here usually takes me to task for any errors I make, don't you, Connie?"

"Well, sometimes," Connie responded, "but I live in dread that I'll let errors slip by me. Can you think of any way we could avoid the occasional calculation error?"

"Humph. That's your job, not mine. Don't know much about those computer things and can't say that I care to learn. I think it's a disgrace that kids nowadays can't compute in their heads. Have to have a calculator to add two plus two. Not me. I do all my calculating by hand, thank you."

"Well, for instance, would it help if all you had to do was enter the item code and quantity and the system would retrieve the unit cost and calculate the extended cost?" one of the consultants hesitantly suggested.

"Entering the codes and quantities is the lead production worker's job. Not that I don't know all the codes, mind you, but I tend to believe the best 'system' is one where everyone does his job and doesn't stick his nose in anyone else's business."

"Okay, then, what about the shipping list? How do you process that document?" one of the consultants asked.

"Again, that's pretty simple. All I do is retrieve the appropriate purchase order -- Stan sends me a copy each time he prepares one -- and compare the items on the shipping list to those on the purchase order. Usually things match. If they don't, I call Stan to let him know about a shipment error -- you know, the supplier sent 12 arecastum coco plumosa instead of 10, or substituted 17-inch ficus green gems for 14-inch. Usually, Stan tells me to accept the shipment and forward the shipping list to him, instead of to Connie here like I usually do. I guess Stan waves a magic wand over it and then sends it on to Connie."

"A magic wand?" a consultant interrupted.

"Yeah, a magic wand. In other words, he signs his John Henry to indicate that he approved the shipment."

"Oh, I see. Do you mark the shipping list in anyway?"

"Sure thing. On the purchase order, I initial each line that agrees with our purchase order to indicate that we received that quantity of that plant or whatever. I circle each quantity that's in error and note the shipment quantity; same with items -- circle any ordered items that don't agree with the shipped items and indicate the name and quantity of the item shipped in error. Course, sometimes, the supplier sends something totally different from what was ordered. You know, sends laccospadix australasica palms instead of marginata. That's usually the kind of shipment error that Stan has me return, unless, of course, we happen to be low on lacco palms!"

One of the consultants frowned, scratched his head, and asked, "Would it be correct to say that you usually accept whatever the supplier sends you? From the sounds of it, you're usually so desperate for plant inventory that you'll accept whatever you can get."

"That's pretty much the case. Guess that's where you come in. You high-paid consultants are going to throw some computers at us to make the problem go away."

"Okay, Mr. Johnson, you've been very helpful. Thanks for your time," Connie said as the consultants filed out of the cramped office.

"No problem, Connie. Just don't go thinking about putting one of those computer things down here in the greenhouse. Too damp. Can't tell what might happen."

#### **Interview with Monica Goce, Lead Production Worker**

"Hi, Monica," Connie said. "Thanks for agreeing to meet us after work. Let me introduce the consulting team." After introducing the team, Connie turned the interview over to a consultant.

"We've already talked to Bill Johnson about his role in completing the Production Daily Work Report. Now we need your take on the subject."

"That old goat! He fries my pajamas. Just this morning we had a big to-do because he had entered the wrong extended cost for an item. Do you think he could admit that he had multiplied wrong? No way!" Monica shook her head in disgust.

"Does that kind of thing happen very often?"

"More often than it should, or would if he'd just condescend to use the calculator sitting on his work table."

"What do you do when you know that a figure's wrong?"

Monica chuckled. "I just wait until he's out of sight, then I scratch out his error and enter the right number. There's no sense trying to reason with the man."

"I think we're getting ahead of ourselves," Connie said, trying to change the topic away from employee politics. "Monica, would you explain how you complete the PDWR?"

"Sure, sorry for the digression. There's a stack of PDWR forms just inside the Greenhousing office. The first thing I do each morning is to consult the Production Plan (see Figure IMS-7) folder to determine what project or projects my team is working on that day and what inventory items we need to take to each site. Then I enter the date, project code, item code, and quantity on a form for each project. Usually doesn't take me more than 30-40 minutes. Then I find our driver and have him bring the truck around to the loading dock. I hand the forms to old Bill and keep an eye on him to make sure that he gets all the right stuff loaded on the truck. At the end of the day, I write in the names of the employees who worked on each project, the number of hours, and a description of the work done. I drop the forms in Connie's in-box before I punch out."

"What about the cost per hour and extended cost figures?" one of the students asked.

"Oh, yeah. I enter the average cost per hour for a particular kind of employee -- for production workers, that's about \$18 an hour -- and multiply by the number of hours."

"Do you ever make mistakes?"

"Seldom. Unlike some people I could name, I'm not too proud to use a calculator. I usually perform the calculations manually and then verify them with a calculator."

"Can you think of any changes that would make your job easier?"

## PRODUCTION PLAN

June 1, 1995

### **Project Bid Information**

Project:	LS Mall	Project Site:	Main entrance
Begin Date:	June 14, 1995		Mall Dr./Cinema Lane
Compl. Date:	June 18, 1995	Bid Amount:	\$7,457.50

### **Project Team**

Sales Assoc:	Bob Reinhardt	Production:	Sue Kaufman, Monica Goce, Bert Swenson
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### **Material Requirements**

#### **Plants:**

Qnty	Code/Desc	Size	Net/Unit	Ext. Cost	Deliver	Install
3	lacco	15 gal	450.00	1,350.00	6/16 @ 8 am	6/16
5	cary	7 gal	140.00	700.00	6/17 @ 8 am	6/17
7	margi	2 gal	45.00	315.00	6/17 @ 8 am	6/17

#### **Pottery:**

1	GPN48	48 in	457.50	457.50	6/15 @ 8 am	6/15
3	GP50	50 gal	110.00	330.00	6/15 @ 8 am	6/15

#### **Materials:**

10	CBRK5	5 cu ft bag	7.50	75.00	6/17 @ 8 am	6/17
1	TSOIL	yard	12.50	12.50	6/15 @ 1 pm	6/15

#### **Tools:**

2	contouring rakes				6/15
2	spades				6/16 - 6/17
2	landscaping rakes				6/16 - 6/17

### **Labor Requirements**

Desc	Hours	Cost/Hr	Ext. Cost	Time	Tasks
Design consultant Tamara	12	40.00	480.00		Bid Process
	5	40.00	200.00	by 6/10	Complete final blueprint
	3	40.00	120.00	6/15 10 am	Oversee installation of fountain & pots
	1	40.00	40.00	6/16 8 am	Inspect contouring
	1	40.00	40.00	6/18	Inspect finished site
Production workers Monica & Bert	6	18.00	108.00	6/15 2 pm	Contour surface
Monica & Bert	8	18.00	144.00	6/16 8 am	Install large plants
Monica & Bert	16	18.00	288.00	6/17 8 am	Install small plants & bark
Eqpmnt operator Jerry	6	45.00	270.00	6/14	Remove existing structure
	4	45.00	180.00	6/15	Situate fountain & pots

Total Est. Designer Hours/Costs:	22	880.00
Total Est. Labor Hours/Costs:	40	990.00
Total Est. Material Costs:		3,240.00
Total Est. Hours/Costs:	62	5,110.00 (67 percent of bid)

**Figure IMS-7: Production Plan**

Inventory Cost Rate is represented as a percentage of the base type cost. For example, if a plant type cost is \$500 and the inventory cost rate is 42 percent, the inventory cost is \$210.00.

"Sure, if talking the old goat into retiring is something you can include in your system design! Just kidding. He's really not as bad as I make out. My job wouldn't be half as challenging if I didn't have to fight Billy every step of the way. There I go again. Digress. Digress. The change I'd most like to see is for the system you're working on to automatically fill in as much as possible on the PDW Report. I mean, all I'm doing is copying information from the Production Plan."

"So, you're saying that the item code and quantity for each project for each day is already listed on the Production Plan. All you do is copy it?"

"That's it. Seems kind of silly. The worker names, tasks, and estimated hours are also on the Production Plan. So it seems that your system could generate a default PDW report and I could just edit it to note any changes to plan."

"Are there often changes to plan?"

"Runs in streaks. For days on end, everything goes according to plan. Then all of a sudden we'll have unexpected stockouts, or a job will take much more or much less time than expected, or a worker won't show up for a couple of days. Or sometimes a designer will inspect a job in progress and decide that we need to install eight marginata instead of the seven in the blueprint. Designers are given some discretion to make goodwill kinds of adjustments at no cost to the client. They don't go through the bother of revising the bid and plan; they just make the change, getting Stan's or Keri's approval if the cost is significant."

"Are the changes common enough that generating a default form wouldn't be practical?"

"No, I'd guess that at least 95 percent of the time I'm just copying the production plan word-for-word. So, yeah, if you could generate a default PDWR and let me edit it if necessary, that would be helpful."

"Using a default PDWR data entry screen would also help you complete the form more easily and accurately. You'd enter the project code and date and then either accept the defaults or edit the item codes and quantities. Then the unit cost and extended cost would be computed by the system. Same with the labor data; you'd enter the worker name, labor code, number of hours, and task, and the system would do the rest."

"I don't know. I usually enter materials right away in the morning and labor data at the end of the day. Could I do that with the screen you're talking about?"

"Sure. You could save the morning data, bring up the incomplete screen at the end of the day, and finish entering data."

"But how would Bill approve the items removed from inventory and how would I sign the form?"

"Oh, I'm sure we could figure something out. Anyway, the main thing is, would such a data entry screen make your job easier and improve the accuracy of the PDW reports?"

"I 'spose so. I'd have to see it in action before I could say for sure."

### Interview with Stan Felton and Keri Yamaguchi

Connie and the consulting team met with Stan Felton to learn more about the purchasing process and his expectations for the system. Keri Yamaguchi was supervising an exceptionally high-priced project and promised to join them as soon as she could get away.

"Formerly, we were incurring unreasonably high procurement and inventory costs because we had no formal process for determining the optimal order and inventory quantities for each item. But, thanks to Connie, I now use a worksheet decision model to help me determine the economic order quantity and economic reorder point for each plant type (see Figure IMS-8). Perhaps Connie can explain this for you."

"Sure, Stan. The economic order quantity (EOQ) is the quantity of a stock item that a firm should order at one time to minimize its costs of both procurement -- the process of ordering and receiving goods -- and storage and to reduce the amount of capital it has tied up in inventory.<sup>1</sup> The economic reorder point (ERP) indicates the stock level at which an item should be reordered to avoid stock-outs.<sup>2</sup> By determining the EOQ and ERP for each plant type, we can more effectively manage our inventory and reduce the costs of purchasing and storing our stock."

Connie continued, "The procurement costs and inventory cost rate<sup>3</sup> (shown in the worksheet) must be known in order to determine the appropriate order and inventory quantities for each plant type. Also needed are the average net cost and annual sales for each plant type (shown in Figures N-2 and N-3)."

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<sup>1</sup> The formula for calculating the EOQ is

$$\text{SQRT}((2 * \text{procurement cost})/\text{inventory cost rate}) * \text{SQRT}(\text{annual unit sales}/\text{unit cost})$$

where *SQRT* indicates the square root.

<sup>2</sup> The formula for calculating the ERP is

$$\text{order lead time} * \text{weekly unit sales}$$

where *order lead time* is the number of weeks from the date of placing an order to the date of receiving it and *weekly unit sales* is the annual unit sales divided by 52.

<sup>3</sup>Inventory Cost Rate is represented as a percentage of the plant type's net cost. For example, if a plant type's net cost is \$100 and the inventory cost rate is 42 percent, its inventory cost is \$42.00.

**INVENTORY MANAGEMENT**  
**DECISION MODEL**

File name: EOQ-ERP.XLS

Plant Code	Net Cost	Annual Sales	Lead Time (wks)	EOQ	Safety Stock	ERP w/SS	ERP no SS
lacco	\$450.00	100	4	7	2.75	10	8
arenga	\$310.00	160	2	11	2.46	9	6
cham	\$300.00	200	4	12	3.88	19	15
cera	\$240.00	175	4	13	3.63	17	13
areca	\$275.00	265	3	14	3.87	19	15
cary	\$140.00	350	3	23	4.45	25	20
phoenix	\$105.00	300	5	25	5.32	34	29
bamboo	\$110.00	225	8	21	5.82	40	35
raphis14	\$350.00	275	4	13	4.55	26	21
spath	\$90.00	350	3	29	4.45	25	20
cory	\$130.00	500	3	29	5.32	34	29
ti char	\$155.00	250	7	19	5.74	39	34
red ti	\$140.00	300	7	22	6.29	47	40
grti7	\$140.00	400	5	25	6.14	45	38
jc	\$55.00	600	2	49	4.76	28	23
grti5	\$92.00	600	5	38	7.52	65	58
raphis3	\$180.00	300	4	19	4.76	28	23
ficus14	\$90.00	500	4	35	6.14	45	38
ficus17	\$240.00	350	4	18	5.14	32	27
margi	\$45.00	500	2	49	7.24	26	19

**INV COST RATE:**

Maintainance	20%
Depreciation	8%
Insurance/Tax	5%
Interest	9%
Inv Rate	42%

**Safety Level:**

95%

Safety Level	Multiplier
10%	-1.28
20%	-0.84
30%	-0.52
40%	-0.25
50%	0
60%	0.25
70%	0.52
80%	0.84
90%	1.28
95%	1.65
98%	2.05
99%	2.33

**PROCUREMENT COSTS:**

Communications:	\$5.00
Labor:	\$35.00
Supplies:	\$2.50
Miscellaneous:	\$3.00
Total	\$45.50

Figure IMS-8: EOQ/ERP Worksheet

"What you should notice here," Stan explained, "is that our inventory cost rate is exceptionally high, largely because of the high cost of maintenance. Someone has to take care of the plants in inventory on a daily basis -- water, fertilize periodically, remove dead leaves, inspect for disease, whatever. We keep a full-time botanist on staff not only to recommend plants for certain settings but also to inspect and treat our inventory of plants. And, of course, any plants that 'die' in our care are a total loss unless we can trace the disease back to the supplier, in which case the supplier may agree to replace the diseased plant."

"Your procurement costs also seem rather high," one of the consultants noted. "I imagine the labor cost is primarily the cost of your time to review inventory levels, consult the worksheet, and then complete a purchase order."

"That's right," Stan responded. "If we could reduce procurement costs, the EOQ would be lower. Thus, we could order fewer plants more often, in turn reducing our maintenance costs. What I'd like you to do is to set up the system so that each plant type has an assigned reorder point. When the quantity in stock is equal to or less than the reorder point, the system should automatically alert me to place an order for that plant."

"That's quite feasible," a consultant explained. "In fact, that's the key to reducing your costs. In some ways, what you need is a just-in-time inventory system. If a plant is received from the supplier within 24 hours of the time it is to be installed in a landscape project, your inventory maintenance costs would be minimized."

"Yes, but, as you can see, most of our suppliers require at least a 2-week lead time."

"Right," the consultant agreed. "So the trick is to figure out how to reduce that lead time. That goal should be feasible, especially with local suppliers. I mean, you're in California, for Pete's sake! There must be a number of nurseries that could guarantee over-night delivery."

"That's true ...." Stan paused in thought. "Maybe my real problem is that I haven't been demanding the level of service I need. I'm a pretty easy-going guy; I tend to take what I'm given. When we were just starting out, that was necessary. But we've grown into a pretty large operation, so I should have some leverage with my suppliers. I mean, I'm doing in excess of \$100,000 a year with many of them."

"From what we've heard, though, some of your suppliers aren't very dependable."

"What gave you that idea?" Keri interrupted, joining the group. "Sorry to be late. Unfortunately -- or perhaps I should say 'fortunately' -- a mega-bucks project takes precedence! Anyway, our suppliers would not be 'preferred' if they weren't dependable."

"Thanks for making time for us," a consultant said and then explained, "Bill Johnson noted problems with receiving unordered items or receiving the right item but the wrong quantity."

"Bill. He's just never been able to forget the time we placed an emergency order with a new supplier who messed up the order and cost us a project. That was a once-in-a-blue-moon incident that Bill insists on blowing way out of proportion," Keri laughed. "If you learn anything during this interview process, you should learn that Bill's view of things should not be taken too much to heart!"

"Then do you think it's feasible to reduce lead times?" Stan asked. "That's what we were discussing when you came in, Keri."

"I'm pretty sure of it. In fact, I've recently begun hinting to several of our suppliers that we can't continue to operate competitively if they have a strangle-hold on the availability of our plant stock."

"Great," a consultant concluded. "Then, we'll pursue this further with you, Keri. For now, let's talk more generally about your expectations for the new system. What business goals do you expect the system to achieve?"

Stan replied, "We've just enumerated a number of them in our discussion: reducing procurement and inventory costs, reducing supplier lead times, making us more competitive -- if our costs are lower, we can offer our clients lower prices. Overall, we simply need to be able to provide better service to our clients. Clients want a wide choice of plants, pottery, and materials; many of them also want immediate implementation."

"How immediate is 'immediate'?"

"Some clients plan ahead and get the process moving as much as six months before they expect implementation to begin. A few expect us to begin implementing as soon as the ink is dry on their bid signature. In general, we need to begin implementing within four -- at most, six -- weeks of bid approval. Longer than that and we risk losing the bid."

"Absolutely," Keri agreed. "We've lost some projects because we couldn't implement the landscape as quickly as the client wanted. We had innovative designs, a ready labor force, but we couldn't get the desired plants quickly enough."

"I'm reminded of my mother's favorite quotation," one of the consultants mused. "Something to the effect that 'For lack of a nail, the horse was lost; for lack of a horse ....' I don't know, basically the kingdom crumbled. Anyway, your situation seems to be 'for lack of a plant, the project was lost.'"

"You've hit the 'nail' on the head," Keri responded. "Our whole business hinges on the availability of plants. We've worked out all the other details: creative, personable designers who create fabulous designs and who interact famously with clients; hard-working, dependable

production workers who do a quality job implementing the designs; and so on. But there just isn't any landscape without plants."

"Amen," a consultant said. "On that note, we'll let you get back to work. And we'll get to work 'saving the kingdom.'"

### Interview with Connie Nguyen

"OK, Connie. It's time for you to submit to our interrogation."

"Please be gentle," Connie joked.

"Yeah, right," one of the consultants said. "What we most need from you at this point is an explanation of how plant costs and prices are calculated. We understand that these tend to be more volatile than pottery or material prices. Stan said something about your maintaining the average cost and computing the selling price from that. Could you explain, please?"

"Sure, it's pretty simple. Each shipping list indicates the quantity, unit cost, and extended cost of the plants received. Whenever I receive a shipping list, I add the quantity of each plant to the total annual quantity of that plant; I also add its extended cost to the total annual cost of that plant. Then I divide the total annual cost by the total annual quantity, giving the average cost. To calculate the selling price, I multiply the average cost by 1.665, which means that we have about a 67 percent mark up on plants."

"Isn't that a little high?" one of the consultants asked.

"No, in fact, it may be a bit low. You have to remember that the labor costs of preparing the design bid are factored into the selling price of plants. The only time we charge up-front for pre-bid-approval design labor is when the project is exceptionally complicated, thus requiring a significant investment."

"Okay, I understand the rationale. So, for example, if we look at the inventory report (see Figure IMS-2), the average cost (AveNet\$) for lacco is \$450; multiplying that by 1.665 gives a list price (List\$) of \$749. Currently, you do this manually, right?"

"That's partially true. I compute the totals manually, but I use the Excel spreadsheet (see nbd-inv.xls, specifically the YTD-Qty and YTD-Cost columns) to calculate the average cost and the list price."

"Okay, that's pretty clear. Just one more question. We have a pretty clear idea of how you maintain the QIS, IS/OB, QOO, OO/OB counts, tedious as it must be for you."

"Truer words were never spoken!" Connie interrupted. "Sometimes I feel completely bonkers by the time I finish all those machinations."

"I can believe that," the consultant responded. "So you must go totally off the deep end when you receive a bid that lists plants whose in-stock and on-order quantities are already on bid. In other words, all in-stock and on-order plants are already spoken for. What do you do then? There's no place on your spreadsheet to deal with on-bid but neither in-stock nor on-order quantities."

"Fortunately, that seldom happens because designers know that the likelihood of actually being able to use those plants is almost nil, unless, of course, the project won't be implemented for a few months. Anyway, when that does happen, I run to Stan, begging him to place an order immediately, if for no better reason than so that my spreadsheet will make sense. But Stan's pretty sharp. He's probably already noticed that all current and on-order stock is on-bid, so he's probably in the process of ordering or just hasn't forwarded his order to me yet."

"Good," the consultant summed up. "Let's hope the new system saves both you and Stan some of these headaches."

"Hope?" Connie mocked. "You'd better do more than hope if you plan to earn your consulting fees!"

"How immediate is 'immediate'?"

"Within two weeks," the consultant replied. "It's really too early to place an order, but we'll have to bid on the plant request being offered, otherwise it will be scheduled with bidding that has a 4-6 week lead time. Many of them also want immediate implementation."

"That's fine. We'll bid on the plant request being offered, and we'll submit with it a bid for an extra month's delivery so we can have it ready to go by the time Stan needs it. We'll bid on the plant request being offered, otherwise it will be scheduled with bidding that has a 4-6 week lead time. Many of them also want immediate implementation."

"Something's gone wrong with Stan's bid. I don't know what it is, but I think it's something to do with the availability of plants. We've worked out all the other details—creative, personable designs—to create the kind of look he wants, but there's something missing. I'm not sure what it is."