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VELOCITY MANUFACTURING COMPANY

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VELOCITY MANUFACTURING COMPANY

Introduction

Background

The Velocity Manufacturing Company is a second tier supplier in the U.S. hydraulic hose and fittings market with annual sales of $10 million. The total 1991 market of $980 million dollars is divided into three segments (industrial, aerospace and military), each of which were serviced by three distribution channels (direct sales to large OEMs, distributor sales to small OEMs, and distributor sales to after-market maintenance and repair). Historically, Velocity Manufacturing has concentrated on direct sales to aerospace OEMs with only 8% of its business coming from sales through distributors.

Table 1 shows that Parker-Hannifin and Aeroquip dominated the hose and fitting market in 1991. They lead the industry in market share, per unit production and distribution costs, and production capacity; and they dictate the industry standards for product variety, quality, customer service and price. Price reductions led by these companies in the mid-1980's have squeezed margins, driven out many small competitors, and steadily eroded Velocity's market share to the point that they now run a single shift operation. Realistically, Velocity has little hope of regaining share on the basis of price. While factory programs begun in 1989 to modernize manufacturing practices have significantly improved profitability, management believes that much more needs to be done. They fear that an anticipated increase in material costs, coupled with another round of price cuts by competitors, might deal a death blow to Velocity.

The Aerospace Product Line

The typical product sold by Velocity to the Aerospace industry is shown in Figure 1. This assembly kit consists of two sections of hydraulic hose, each of which is capped with two metal fittings. The assemblies are designed to snake around engine or machine components in order to connect a hydraulic pump to one or more actuators that it powers. An individual end fitting consists of one of six sizes of machined components brazed to one of three styles of metal tubing. Once fabricated, a hose assembly is painted and labeled for ease of visual recognition, tagged to identify the assembly uniquely, and capped to protect its end fittings.

Aerospace hose assemblies are expensive. The product line differs from related industrial products because of special requirements for light weight, compact size, high strength and heat tolerance. In addition, strict quality and inspection procedures are demanded and component traceability is required. Expensive exotic metals are used to achieve the special performance requirements. Relatively small lot sizes and long production cycle times give rise to low production throughput rates; and, yield problems exist. As a result, the manufacturing cost of an assembly is typically on the order of $2100. While the profit margin varies depending upon the aggressiveness with which a contract is pursued, the average selling price of an assembly in 1991 was $2,215. Table 2 summarizes Velocity's costs and profit margins for the last three years.

Table 1

Comparative Market Share Analysis

Company	% Market Share
Parker Hannifin	33
Aeroquip	30
Weatherhead	17
Imperial	14
Velocity	2
Others	5

Table 2

Margins and Average Cost per Aerospace Assembly (in $)

	1989	1990	1991
Direct Labor	119	123	125
Purchased Material	1,477	1,418	1,389
Fixed Manufacturing Cost	322	365	278
Factory Cost	1,917	1,905	1,792
Sales Price	2,377	2,288	2,215
Gross Margin	460	383	423
SG&A	371	332	298
Interest Expense	76	57	37
Selling Margin	13	-6	88

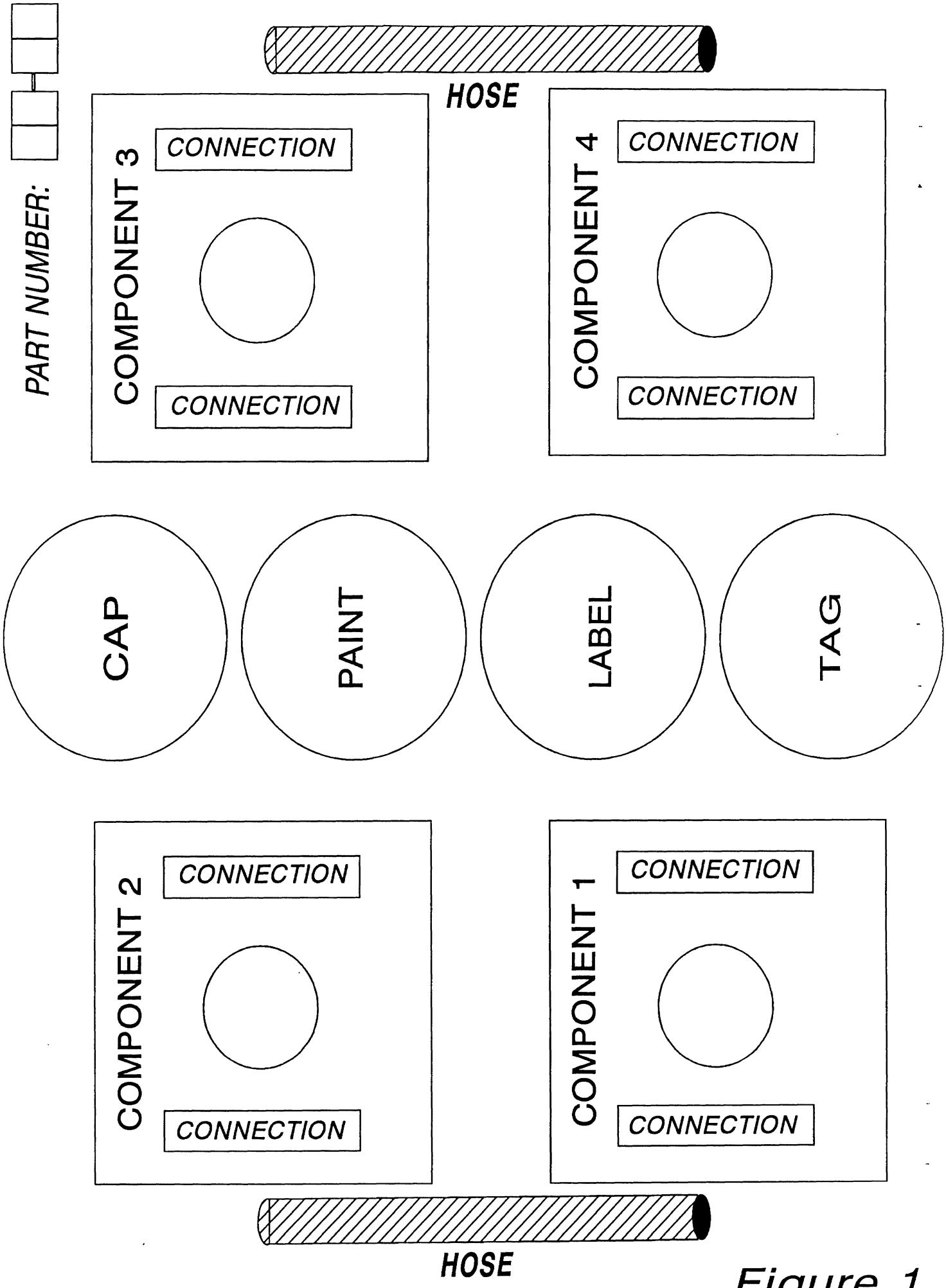

PART NUMBER:
HOSE
COMPONENT 3
CONNECTION
CONNECTION
COMPONENT 4
CONNECTION
CONNECTION
CAP
PAINT
LABEL
TAG
COMPONENT 2
CONNECTION
CONNECTION
COMPONENT 1
CONNECTION
CONNECTION
HOSE

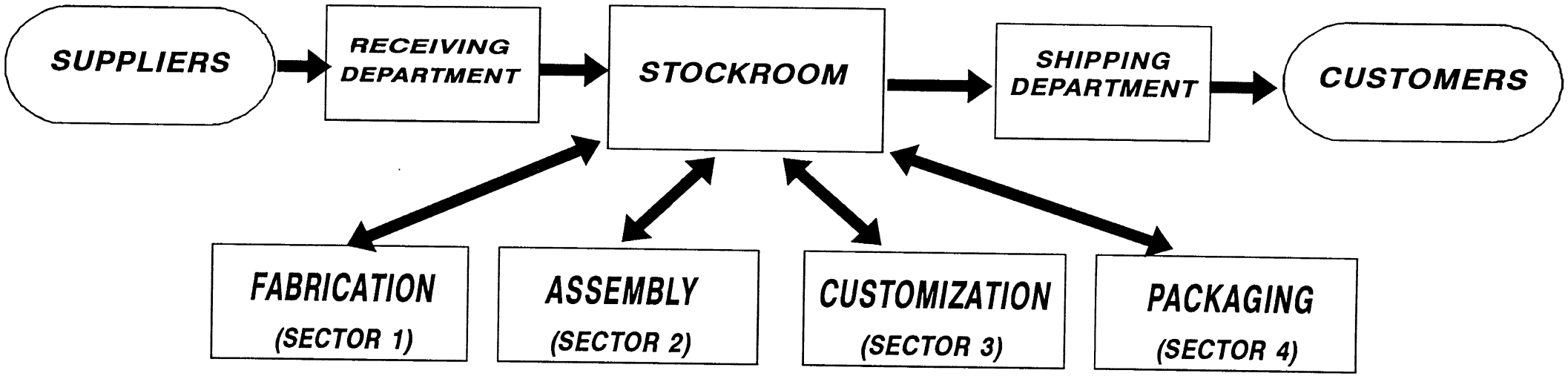
Figure 1.

The Manufacturing and Assembly Process

Figure 2 illustrates the flow of material through the manufacturing process. Components and raw materials are received from suppliers and placed in the stockroom to support a production process which flows through four manufacturing sectors. In the first sector, fittings are machined from blanks, joined with a tube and braze ring, and passed through a braze oven. The resulting end fittings are then inspected and sent to the stock room to await the hose assembly process of Sector 2. Specialized jigs and crimping tools are used in Sector 2 to attach the end fittings to hoses in specified configurations for particular end products. These "raw" hose assemblies are visually inspected and returned to the stockroom to await customization for some specific customer requirement. In the third sector the assemblies are painted and labeled for ease of identification, tagged to identify the specific assembly uniquely, and capped to protect the end fittings. The now customized assembly is inspected for cosmetic defects and returned to stock once more. The assemblies are pressure tested in the Finishing sector; if they pass, they are cleaned, packaged and certified as ready for shipment to a customer. The 1989 valuation of Velocity's manufacturing equipment is given in Table 3; their operating characteristics are summarized in Table 4.

Prior to 1990, factory operations at Velocity were scheduled by a material requirements planning (MRP) system using a six-month demand forecast. Lot sizes were determined using economic order quantity (EOQ) logic and runs of 3 to 12 months of supply were typical. While flow time through the factory was measured in weeks, a "red-alert" job could be moved through in a day or two

MATERIAL FLOWS



110	BLANK MACHINING	210	FITTING/HOSE ASSEMBLY	310	ASSEMBLY CUSTOMIZATION	410	PROOF TESTING
120	TUBING FABRICATION	220	INSPECTION	320	INSPECTION	420	CLEAN AND DRY
130	BRAZING					430	PACKAGING
140	INSPECTION						

FIGURE 2.

VELOCITY'S EQUIPMENT LIST

	OP'N	NAME	PUR-COST	'91-BOOK-VAL	'91 SALVAGE	PUR-YR	LIFE
SECTOR1	110	LATHE1	$400,000	$109,091	$350,000	1986	10
	110	LATHE2	$420,000	$45,818	$320,000	1984	10
	120	FIXTURE	$10,000	$2,727	$25,000	1986	10
	130	BRAZ-OVN1	$150,000	$16,364	$100,000	1984	10
	130	BRAZ-OVN2	$150,000	$16,364	$100,000	1984	10
	140	TESTER	$40,000	$10,909	$23,000	1986	10
SECTOR2	210	OLD-FIX	$70,000	$19,091	$25,000	1986	10
	220	TESTER	$50,000	$13,636	$35,000	1986	10
SECTOR3	310	FIXTURE	$80,000	$21,818	$25,000	1986	10
	320	TESTER	$20,000	$5,455	$20,000	1986	10
SECTOR4	410	TESTER	$50,000	$13,636	$25,000	1986	10
	410	TESTER	$50,000	$13,636	$25,000	1986	10
	420	DRYER	$10,000	$2,727	$2,000	1986	10
	430	PACKAGER	$15,000	$4,091	$15,000	1986	10
		TOTAL	$1,515,000	$295,364	$1,090,000		

TABLE 3,

EQUIPMENT PROCESS RATES AND RELIABILITY

OPERATION	BATCH SIZE	PART	RUNNING TIME (SEC/BATCH)	SET UP TIME (SEC)	MTTF (SEC)	MTTR (SEC)
110 LATHES (2)	1	1	10	25	30	5
		2	11	29		
		3	11	29		
		4	12	34		
		5	12	34		
		6	12	34		
120 ASSEMBLY	1	all	5	5	30,000	3
130 BRAZE OVENS(2)	8	all	60	10	45,000	7
140 INSPECTION	1	1	7	7	75,000	5
		2	7	7		
		3	8	8		
		4	8	9		
		5	8	9		
		6	8	9		
210 ASSEMBLY	1	all	28	5	50,000	10
220 INSPECTION	1	all	21	7	600	25
310 ASSEMBLY	1	all	23	5	80,000	15
320 INSPECTION	1	all	15	8	4,000	180
410 INSPECTION	1	all	17	10	2,000	200
420 CLEAN AND DRY(2)	1	all	45	5	500,000	1
430 PACKAGE	1	all	15	0	500,000	1

Table 4.

under the watchful eye of the plant expeditors. These experienced "fire fighters" met weekly with plant management to decide how best to react to Marketing 's current list of "hot orders," orders that were to be given "special priority" in order to gain or hold a key account.

The operating impact of this "customer focus" within the plant was disastrous. When scheduling production it seemed that everything was promised yesterday. As the production controller rushed past-due jobs to completion, in-process jobs were interrupted often making them late as well. While the company in 1989 maintained 107 days of inventory and absorbed $85,000 in express transportation charges, customer service, as measured by order fill rate, was only 60%. (The unofficial sales motto read: "If we have it, you don't want it; and if you want it , we don't have it".)

Customers were irate but had little recourse. Pulling an order from a supplier to give to another supplier once you discovered that the order was late would only make it later. Switching the next order to a new supplier as a penalty for late delivery occurred sometimes; however, the problem of late deliveries was endemic to the industry so switching suppliers often accomplished little. All a customer could really do was to maintain safety stock on critical parts, and/or pad delivery dates for future requirements, and/or request "immediate delivery" of any requirement that was within the normal delivery lead time. Velocity's customers typically did all three. Velocity as a result knew relatively little about the real demand and needs for their products.

The "Born Again" Revitalization Project

In mid-1989, Velocity had realized that this industry wide delivery "problem" was actually an opportunity to differentiate itself in the market place. Management reasoned that if they could promise customers fast delivery and consistently deliver on that promise, then they might capture market share or command a premium price, or both. With this strategic objective in mind, they set off to "re-engineer" their manufacturing and distribution operations. They focused on aerospace OEMs which were the most important portion of their business. Rallying around the banners of "Worldclass Customer Service" and "Total Quality Management," they began experimenting with electronic data interchange (EDI) with customers, just-in-time (JIT) delivery scheduling from suppliers, and pull manufacturing of small lot sizes driven by KANBANs in a focused factory. Some changes were accomplished quickly; others were taking forever; some were easy; and, others were painful.

It was clear to everyone in 1989 that inventory was a problem that needed immediate attention. There was $2.6 million invested in inventory, but it never seemed to be what the customer needed. A multi-functional task force was formed to study the problem in September of 1989. Three major recommendations emerged to reduce raw materials, work-in-process and finished goods inventories.

First, a "vendor partnership" program was instituted to reduce raw material stocks. There were two primary reasons for the inventories: large cycle stocks resulted from large "economic" reorder quantities, and large safety stocks were

maintained to protect against variations in delivery lead time and product quality. Velocity decided to strike exclusive and long term contracts with suppliers who were willing to work with them to find opportunities to reduce Velocity's material cost. Eventually, the number of vendors was cut by half. Those who remained had agreed to a "4-2-2 price reduction" program for 1990-1992. In addition, they had agreed to ship materials in smaller lots, with higher frequency and shorter lead times than they had historically. The "agreement" was starting to founder, however. The preferred suppliers were balking at the final 2% price reduction for 1992, and claimed that in fact they should be asking for a 6% increase in 1992 in order to make a "fair" profit from Velocity's business.Table 5 provides current raw material prices and lead times for the vendors.

Work in process and finished goods were also reduced through smaller lot sizes within the plant. While reluctant at first, factory management agreed to a two year experiment with a modified version of Just-in-Time manufacturing. Starting in January of 1990 they were to produce no more than two weeks of supply for any A-item (high volume) component or product and no more than four weeks supply of anything else. The program had dramatically increased the number of machine setups, thereby reducing the time available for production and consuming nearly all of the factory's reserve manufacturing capacity. Manufacturing management felt that a sudden surge in demand at this point in time would bring the plant to its knees. Production control had warned management that to run the factory reliably beyond the two year trial period, either more equipment and operators or the resumption of a second shift would be necessary if the small lot scheduling were to continue.

VENDOR PRICES AND LEAD TIME DATA

BLANKS (SQUARES)	VENDOR NAME	DISTRIBUTION IN DAYS 1	2	3	4	5	AVERAGE (days)	PRICE ($)
RED	*A		1/4	1/4	1/4	1/4	3.5	184.00
	B		1/2	1/2			2.5	193.20
	C		1				2	196.90
BLUE	*A			1/3	1/3	1/3	4	220.80
	B		1/3	1/3	1/3		3	234.00
	C		1				2	238.50
ORANGE	*A				1/2	1/2	4.5	294.40
	C		1				2	338.60
YELLOW	*A			1/3	1/3	1/3	4	257.60
	B		1/4	1/4	1/4	1/4	3.5	273.10
	C		1				2	278.20
WHITE	*A			1/3	1/3	1/3	4	276.00
	B			1/2	1/2		3.5	292.60
	C		1				2	300.8
PINK	*A				1/2	1/2	4.5	368.00
	C		1				2	415.80

* PRIMARY VENDOR

MATERIAL	VENDOR	DISTRIBUTION IN DAYS 2	3	4	5	6	7	8	AVERAGE	PRICE
DOTS:R, B, G *0, 90, 45 degree* *END FITTING*	* D		1/5	1/5	1/5	1/5	1/5		5	$ 49.80
	E		1/2	1/2					3.5	$ 54.70
BASE PLATES *HOSE KIT*	* F	1/4	1/4	1/4	1/4				3.5	$ 211.50
	G	1							2	$ 228.40
DOT:1 *CAP*	* H				1				5	$ 6.22
DOTS:2 & 3 *RED PAINT* *GREEN PAINT*	* I				1/4	1/4	1/4	1/4	6.5	$ 12.44
	J				1/2	1/2			5.5	$ 12.81
DOTS:4 & 5 *CUSTOM LABEL* *STANDARD LABEL*	* K		1/3	1/3	1/3				4	$ 12.44
	L	1/2	1/2						2.5	$ 13.06
DOTS:6 & 7 *METAL TAG* *PLASTIC TAG*	* M		1/5	1/5	1/5	1/5	1/5		5	$ 12.44
	N				1				5	$ 12.93

Table 5.

A third initiative to reduce inventory had been simple to execute, but difficult to sell. A detailed analysis of 1989 inventories by the task force revealed that $480,000 of current stock was in product that had experienced no sales activity in the past 12 months and was not likely to have any ever. While the auditors had been willing to turn their eye to the condition, these materials were accruing significant holding costs (15 percent/year plus working capital expense) and the task force recommended that they be scrapped. Because of the impact that such a write-off would have on current earnings and shareholder equity, management resisted. Eventually a compromise was reached. Any product "with no activity in the past 24 months and little prospect of sale in the future" would be scrapped. A total of $295,000 was written-off in 1990.

The work force to date had been reasonably supportive of changes required to reduce Velocity's labor costs. Process redesign and job reclassification suggestions made over the past two years, by the Employee Involvement Program and Corrective Action Teams, had already increased factory productivity by more than 30 percent. The additional work load created in purchasing, receiving, inspection and accounts payable because of the increased number of vendor deliveries had added two new staff positions. Simultaneously, however, seven positions had been eliminated in inspection and expediting by expanding the responsibilities of other jobs. And, the individuals in these positions had been retrained for other jobs available from normal turnover.

Factory overtime had been reduced from nearly 20% to less than 1% by reorganizing the manufacturing sectors into focused workcells. By cross training workcell members in shop floor operations, materials handling, sector stock management, work releases and shop floor data collection, it was possible to shift resources around during the day as needs or backlogs occurred. Current staffing levels and salaries for the plant are summarized in Table 6.

Any attempt, at this point, to further reduce manufacturing cost by cutting back on the labor force would be both painful and potentially counter productive. Management decided to move carefully in this area for three reasons. First, it was important that everyone in the plant be committed to and supportive of the changes taking place; second, their ideas and energy would be required to make change happen; and finally, if "Born-Again" succeeded as hoped, even more people would be needed to handle the expected increase in manufacturing volume.

By most measures, "Born-Again" had been a resounding success. The financial statements in Tables 7 a, b, c together with the summary performance statistics of Figure 3 and Table 8 reflect the dramatic improvements that had occurred during the past two years. Inventories had been slashed to 34 days; manufacturing costs had dropped by 7%; unit cost was down by 10%; and even with a price reduction of 7% (led by the competition), selling margins had increased by 600%. With the improvement in profit and the reduction in inventory, RONA (return on net assets), the internal measure upon which management bonuses were paid, had jumped from 7% to 18%. Projecting the current business conditions forward, it was estimated that by simply holding

VELOCITY'S STAFFING LEVELS AND SALARIES

TITLE	SALARY	ADMIN	SEC1	SEC2	SEC3	SEC4	BASE	BENEFITS	TOTAL
GenMngr	50000	1					50000	20000	70000
FactoryMngr	50000	1					50000	20000	70000
Marketing	39000	3					117000	46800	163800
Sales/Order	27000	4					108000	43200	151200
Engr/Rsch	40000	2					80000	32000	112000
Acct	30000	2					60000	24000	84000
ProdCntl	35000	4					140000	56000	196000
MtlMngr	35000	1					35000	14000	49000
Procure	30000	1					30000	12000	42000
Rec/Stk/Shp	25000	5					125000	50000	175000
Maint	30000	2					60000	24000	84000
Mach/Asmbr	34000		5	2	2	3	408000	163200	571200
							1263000	505200	1768200

TABLE 6.

VELOCITY MANUFACTURING'S BALANCE SHEET

*** BALANCE SHEET ***		1989	1990	1991
ASSETS		$6,396,499	$4,961,667	$3,783,158
CURRENT ASSETS		$4,016,378	$2,969,970	$2,134,530
CASH		$122,350	$139,055	$150,000
ACCOUNTS RECEIVABLE		$1,313,713	$1,254,517	$1,212,048
INVENTORY		$2,580,315	$1,576,399	$772,482
RAW MATERIAL		$944,298	$538,771	$133,244
WORK IN PROCESS		$622,149	$524,755	$427,360
FINISHED GOODS		$1,013,868	$512,873	$211,878
LONG TERM ASSETS		$2,380,121	$1,991,697	$1,648,628
PROPERTY		$325,000	$325,000	$325,000
PLANT		$1,620,667	$1,371,333	$1,139,810
EQUIPMENT		$434,455	$295,364	$183,818
LIABILITIES		$4,461,299	$3,444,285	$2,425,368
CURRENT LIABILITIES		$3,043,413	$2,107,094	$1,366,145
SHORT TERM DEBT		$2,322,284	$1,418,759	$695,234
ACCOUNTS PAYABLE		$544,052	$518,207	$506,842
PAYROLL DUE		$80,248	$75,488	$70,728
OTHER ACCRUALS		$96,830	$94,640	$93,341
LONG TERM LIABILITIES		$1,417,886	$1,337,192	$1,059,223
LONG TERM DEBT		$1,417,886	$1,337,192	$1,059,223
SHAREHOLDER EQUITY		$1,935,200	$1,517,382	$1,357,790

TABLE 7a

VELOCITY MANUFACTURING'S INCOME STATEMENT

*** INCOME STATEMENT ***	1989	1990	1991
REVENUES	$10,947,608	$10,454,306	$10,100,400
SALES	$10,947,608	$10,454,306	$10,100,400
EXPENSES	$10,889,365	$10,484,003	$9,699,720
MANUFACTURING COSTS	$8,829,687	$8,705,699	$8,172,979
VARI MANUFACTURING COSTS	$7,348,998	$7,037,358	$6,906,726
MATERIAL	$6,800,646	$6,477,582	$6,335,526
DIRECT LABOR	$548,352	$559,776	$571,200
FIXED MANUFACTURING COSTS	$1,480,689	$1,668,341	$1,266,253
MANAGEMENT	$67,200	$68,600	$70,000
PRODUCTION CONTROL	$188,160	$192,080	$196,000
MATERIALS MANAGEMENT	$47,040	$48,020	$49,000
PROCUREMENT	$40,320	$41,160	$42,000
RECEIVE/STOCK/SHIP	$96,000	$135,500	$175,000
UTILITIES/TAXES/INSUR	$289,550	$298,237	$307,184
DEPRECIATION	$433,779	$388,424	$343,069
INSPECTION/EXPEDITING	$238,000	$119,000	
MAINTENANCE	$80,640	$82,320	$84,000
OBSOLETE INVENTORY		$295,000	
SELLING AND ADMINISTRATION	$1,708,884	$1,516,897	$1,358,247
ADMINISTRATION	$67,200	$68,600	$70,000
MARKETING	$157,248	$160,524	$163,800
SALES/ORDER ENTRY	$145,152	$148,176	$151,200
ENGINEERING/RESEARCH	$107,520	$109,760	$112,000
ACCOUNTING	$80,640	$82,320	$84,000
INVENTORY HOLDING COSTS	$387,047	$236,460	$115,872
EXPEDITED FREIGHT	$85,325	$62,890	$35,150
LIABILITY/WARRANTEE	$678,752	$648,167	$626,225
OPERATING INCOME	$409,037	$231,710	$569,174
INTEREST EXPENSE	$350,794	$261,407	$168,493
SHORT TERM INTEREST	$209,006	$127,688	$62,571
LONG TERM INTEREST	$141,789	$133,719	$105,922
INCOME BEFORE TAXES	$58,242	($29,697)	$400,680
INCOME TAXES(AT 40%)	$23,297	($11,879)	$160,272
NET INCOME	$34,945	($17,818)	$240,408
DIVIDENDS PAID	$400,000	$400,000	$400,000
INCREASE IN RETAINED EARNINGS	($365,055)	($417,818)	($159,592)

TABLE 7b

VELOCITY MANUFACTURING'S CASH FLOW STATEMENT

*** CASH FLOW STATEMENT ***	1989	1990	1991
CASH FROM OPERATIONS	$196,270	$1,400,924	$1,412,439
NET INCOME	$34,945	($17,818)	$240,408
DEPRECIATION	$433,779	$388,424	$343,069
DECLINE IN RECEIVABLES	($32,490)	$59,196	$42,469
DECLINE IN INVENTORY	($270,350)	$1,003,917	$803,917
INCREASE IN PAYABLES	$23,650	($25,845)	($11,364)
INCREASE IN ACCRUALS	$6,735	($6,950)	($6,060)
CASH PROVIDED BY FINANCING	($317,465)	($1,384,219)	($1,401,494)
INCREASE IN S-T DEBT	$17,535	($903,525)	($723,525)
INCREASE IN L-T DEBT	$65,000	($80,694)	($277,969)
LESS DIVIDENDS PAID	($400,000)	($400,000)	($400,000)
CASH USED BY INVESTMENT			
NET CASH FLOW	($121,195)	$16,705	$10,945

TABLE 7c

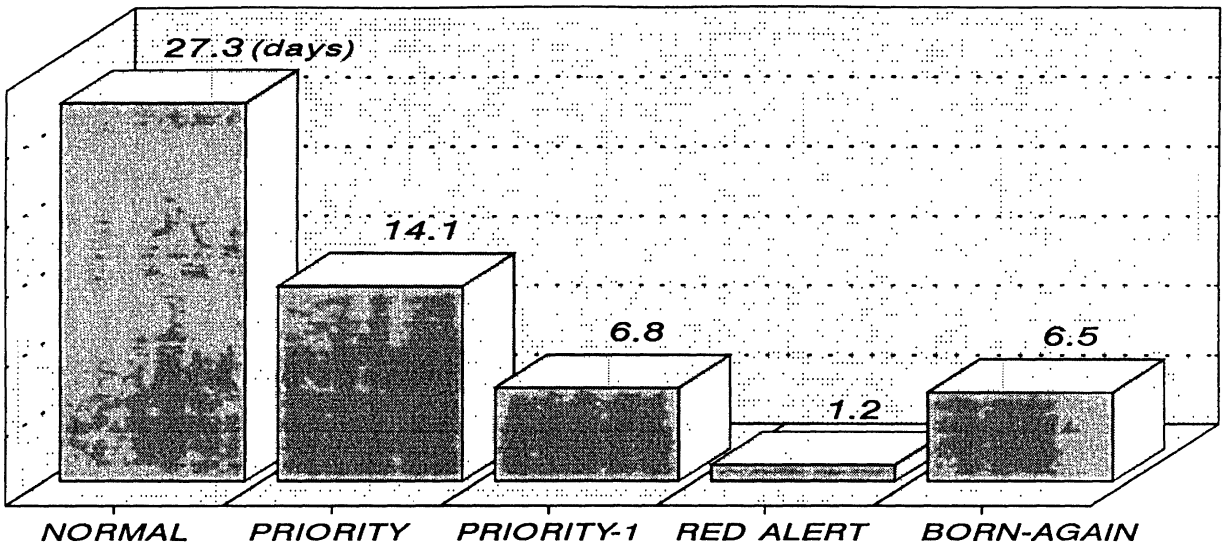
VELOCITY MANUFACTURING'S PERFORMANCE STATISTICS

	1989	1990	1991
NET INCOME/TOTAL ASSETS (ROA)	0.01		0.06
OPERATING INCOME/NET ASSETS (RONA)	0.07	0.05	0.18
LIABILITIES/OWNERS EQUITY (D/E)	2.31	2.27	1.79
NET INCOME/OWNERS EQUITY (ROE)	0.02	-0.01	0.18
INVENTORY TURNS (INV/COGS)	3.4	5.5	10.6
INVENTORY DAYS (365/TURNS)	107	66	34
UNIT PRICE	$2,377	$2,288	$2,215
TOTAL SALES	$10,947,608	$10,454,306	$10,100,400
DIRECT LABOR COST/UNIT	$119	$123	$125
MATERIAL COST/UNIT	$1,477	$1,418	$1,389
VARIABLE COST/UNIT	$1,596	$1,540	$1,515
FIXED MNFT COST/UNIT	$322	$365	$278
FACTORY COST/UNIT	$1,917	$1,905	$1,792
GROSS MARGIN/UNIT	$460	$383	$423
SGA/UNIT	$371	$332	$298
INTEREST EXPENSE/UNIT	$76	$57	$37
UNIT COST	$2,365	$2,295	$2,127
SELLING MARGIN/UNIT	$13	($6)	$88
SELLING MARGIN(%)	0.5%	-0.3%	4.1%

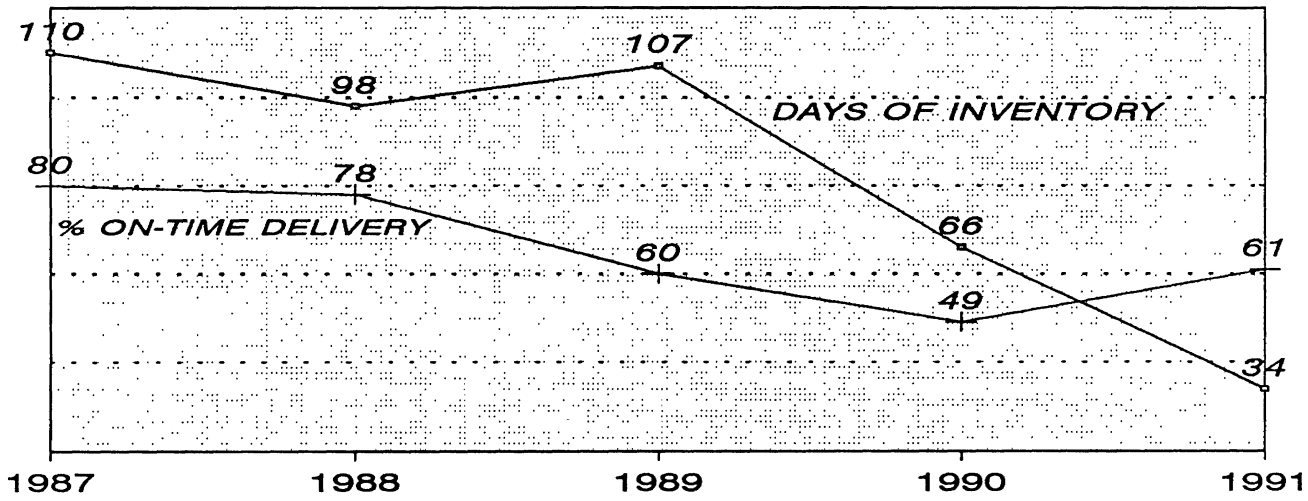
TABLE 8

VELOCITY PERFORMANCE

FLOW TIME FOR RELEASED ORDER



INVENTORY and FILL RATE



PROCESS YIELD and CUSTOMER RETURNS

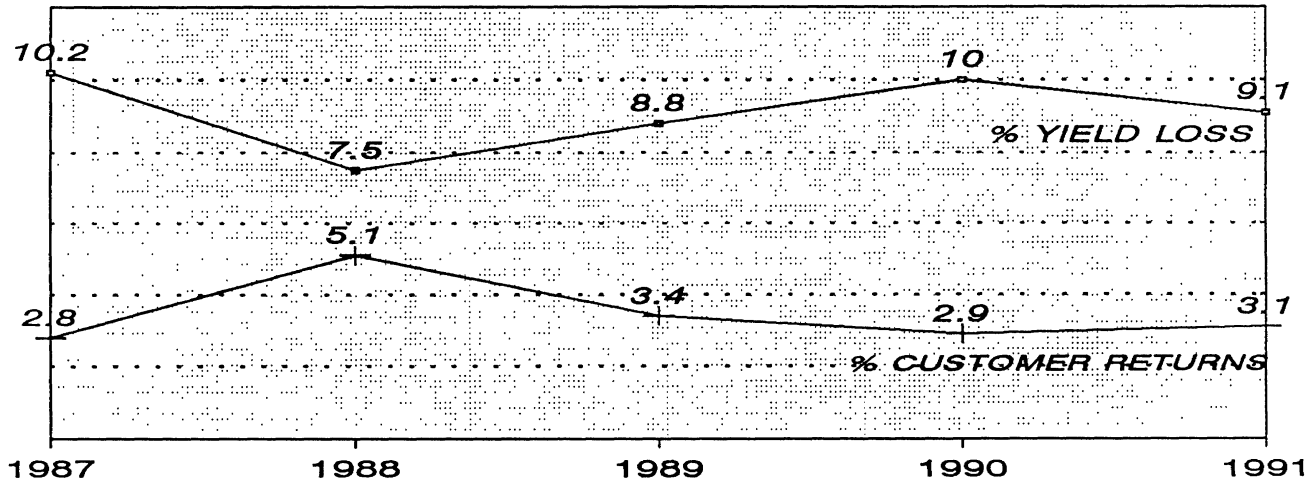


Figure 3.

course, the natural depreciation of plant and equipment over the next few years would allow management to exceed their RONA goal of 24%. There was a tendency by many to relax. There was pressure, however, from some to do much more.

Tougher Decisions Ahead

The resident skeptics observed that Velocity management to date had simply picked the low lying fruit. The changes over the last two years had been relatively obvious and largely self-funding. They had inconvenienced no one, with the possible exception of the vendors (who had traded margin for volume) and seven shop floor employees (who had switched positions for job security). Proposed changes now on the table were more problematic. Capital investment would be needed; everyone's job might change; and jobs could be eliminated.

In searching for methods for improving current operations, the task force had focused on two separate goals. An acceptable proposal could either reduce the current cost of an activity or operation (thereby reducing total cost to increase profit margin), or enhance the customers' perception of the product (thereby improving margin through a higher price, or improving total profit through increased market share). Six of the nine current proposals involved investments in process equipment.

When the task force's process engineers completed their analysis of the Velocity plant, they concluded that Sector 1 was the process " Herbie," that is,

the bottleneck activity that gated the speed of material flow through the rest of the factory. If the pace of production through the plant was to improve, then work needed to begin in this sector. There were five sets of proposals to increase the production rate of Sector 1.

1. Increase the running speed of the current equipment thereby producing more units per hour.
   a) By adjusting the speed and feed rates on the lathes, it was estimated that production rate could be increased by 10% while yield would drop by 3%.
   b) By modifying the current lathes at a cost of $100,000 each, it would be possible to run them at a 25% faster rate with no additional yield loss. Setup for the modified equipment, however, would take 15% longer.

2. Reduce setup time of the current equipment, thereby increasing the number of hours for production.
   By buying an additional fixture ($1,000) for each lathe it would be possible to setup for the next part while the equipment was running. This would reduce the run time lost to setup by 80%.

3. Reduce the hours of breakdown and repair on current equipment, thereby increasing the number of hours for production.
   Changes to the equipment maintenance plan (executed during the off-shift) could reduce the break down frequency of Sector 1 lathes by 75%. The change effort would have a fixed cost of $40,000 per

lathe plus a recurring incremental maintenance cost of $5,000 per lathe per year.

4. Improve the yield rate of the current equipment thereby reducing the number of run hours required to produce a given order.

   a) Data show that 26% of yield losses are due to process control problems on the lathes in Sector 1. A new $70,000 control added to each lathe could reduce the failure rate to 1 per 5,000 processed pieces.

   b) Data also show that 21% of Sector 1 failures are caused by process variations in the oven. With a proper combination of temperature cycle, cycle length and cool down period, process defects could be virtually eliminated. Improved operator training ($2,000) and a new control ($9,000) are needed.

5. Add additional equipment to the sector, thereby increasing the number of hours available for production.

   a) Add a new $300,000 CNC lathe whose run speed is 50% longer than that of the current equipment, but whose setup time is nil. Maintenance cost on the lathe would be $15,000 per year; however tooling costs should be reduced by an equivalent of $1.10 per unit produced on this type of lathe.

   b) Purchase a $50,000 robot to insert the tube and braze ring into the machined components in preparation for their loading into the oven. The robot's run time is 2 seconds per unit and its

setup time is effectively zero. Annual maintenance costs are estimated at $4,000.

c) Buy a new test station for $13,000 that reduces test time per piece in Sector 1 by 20%.

A sixth proposal was made by a task force assigned to investigate the causes of yield loss. They discovered that the test equipment in Sector 4 was much less reliable than realized. The process was producing both Type I and Type II test errors. Approximately 3% of units shipped were being returned by customers as defective. In addition, a careful laboratory analysis of a large sample of scrapped parts revealed that 7% of them actually functioned properly. Expensive ($50,000) new test equipment now on the market could virtually eliminate both types of error. While the preventative maintenance cost for the equipment is high ($5,000 per year), the unit is very reliable and fast to repair if properly maintained. While the new test procedure would take 10% more time to process each piece, the cleaning operation of Sector 4 could be eliminated with this new equipment.

This task force also uncovered a separate alarming fact. Nearly 48% of all yield loss in Sector 1 could be traced to defects in the machining blanks supplied by the "preferred" Vendor A. This fact was discovered by accident. Three times in the past two years Vendor A was unable to meet production requirements and Velocity was forced to pay the premium prices of Vendor C. Each time there was an unexpected increase in yield several weeks later as Vendor C's material was drawn from stock. A connection between these events had not been made until the task force studing the root causes of scrap, rejects

and returns had discovered it. On the basis of their findings, the task force proposes that all new orders for machining blanks be given to Vendor C, whose defect rate is 1 per 1000 units.

The eighth recommendation was put forward by the Data Processing task force. In an effort to simplify purchasing, production control and warehousing operations and in order to increase inventory record accuracy, they proposed development of a computer system which would provide production controllers with on-line access to inventory data. The present production scheduling system relies upon the production controllers' recollection of yesterday's stock levels and scheduled replenishments. The actual availability of material is confirmed only after a tentative schedule is developed and translated into its required components using a bill of materials "explosion" and consolidation process. Typically, the daily schedule must be redrawn before it can be released, and this iterative process has delayed the start of a shift on several occasions. Moreover, the task force estimates that 40 percent of past due orders can be traced to hasty decisions made by production controllers as they sat "under the gun" to release work for the start of a shift. The problem is compounded as these past dues escalate to "red alert" status: scheduling becomes more complex and time consuming; components are withdrawn from stock without inventory record update; capacity is lost to unplanned setups; and finally, interrupted jobs themselves become late and create the next "red alert."

It is hoped that by using the new system to "informate" the decision process and to provide expert advice to the production controllers, this cycle of problems can be broken. An outside consulting firm will design and implement

the new system for $125,000 and they estimate that annual maintenance and operating costs will run about $25,000.

A ninth and final recommendation was delivered by the marketing task force who had been charged with developing a two year marketing strategy to increase market share. This team analyzed historical sales by customer and product (summarized by Figure 4) and commissioned a market survey of current and potential customers. They concluded that Velocity would not gain market share with price reductions which could be matched easily by competitors. They found, however, that customers were very sensitive to delivery, reliability and speed improvements, which if achieved, would be much harder for competitors to duplicate. Their report (summarized in Table 9) concludes that if, for example, Velocity were to:

a) improve on-time delivery performance to 95%,

b) guarantee one-day production lead times, and

c) reduce current prices by 5%,

then Velocity should be able to increase unit sales by 32% next year and then grow at about 12% per year for the next four years.

This last proposal is considered the most radical of the nine . It will require substantial investments in capacity, inventory, quality, and information systems, while simultaneously reducing prices. Moreover, for the plan to succeed, Velocity will have to take market share from aggressive competitors who might attempt to hold share by additional price reductions. Serious consideration by Velocity's management committee would require a complete analysis of the

total manufacturing system needed to support such a proposal. The analysis would have to contain, at a minimum, the following items:

1. Plant Layout
2. Equipment Plan
3. Production Control System
4. Inventory Plan (WIP,FIN, RAW)
5. Yield Analysis (1st pass yields)
6. Information System
7. Performance Measurement System
8. Manpower Plan
9. Vendor Plan
10. Projected Financial Statements
11. Projected Cash Flow Analysis
12. Projected Performance Statistics.

Your assignment is to develop an action recommendation for Velocity's management committee and then to prepare a detailed analysis with which to explain and justify your proposal.

DEMAND BY PRODUCT BY CUSTOMER

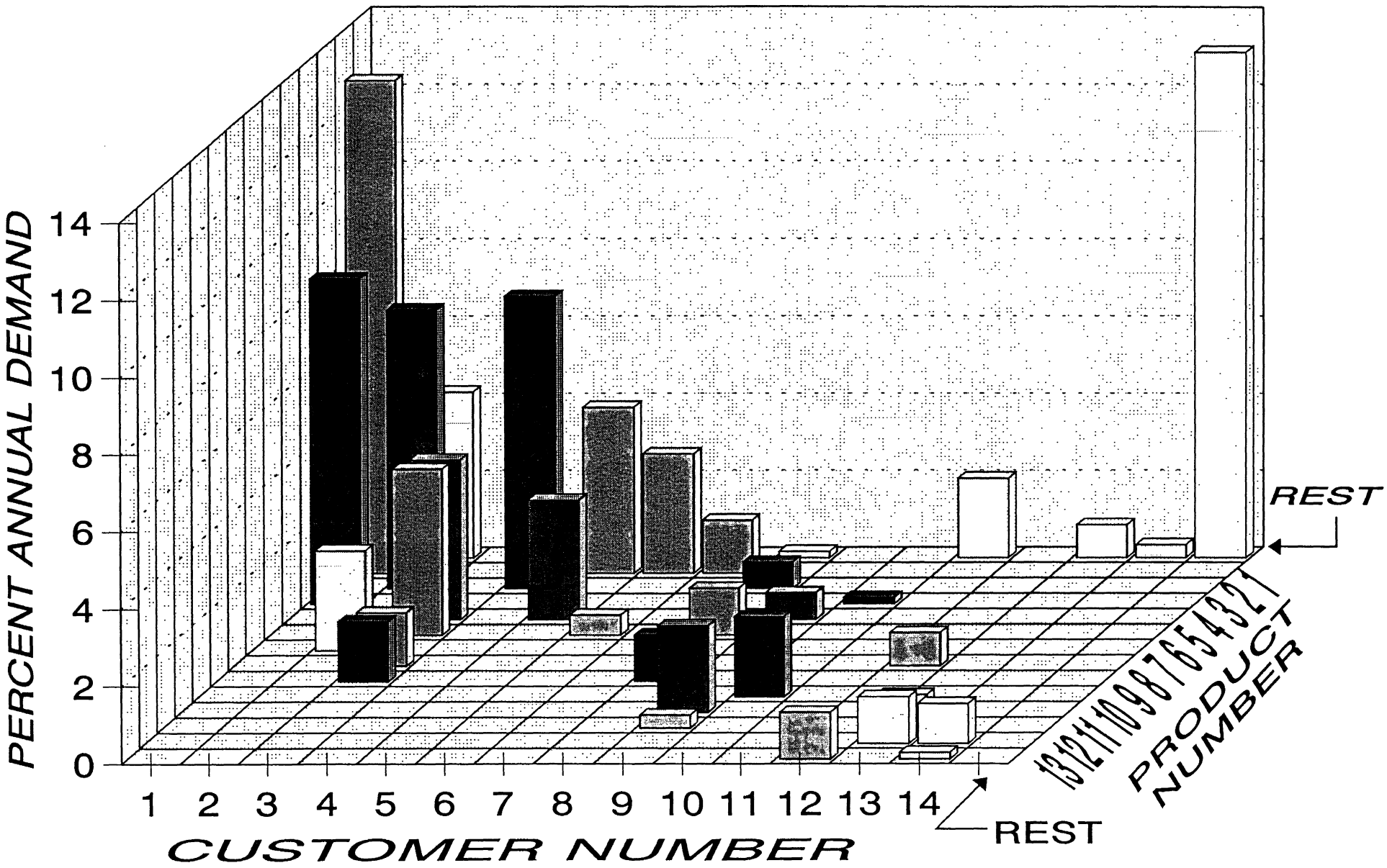
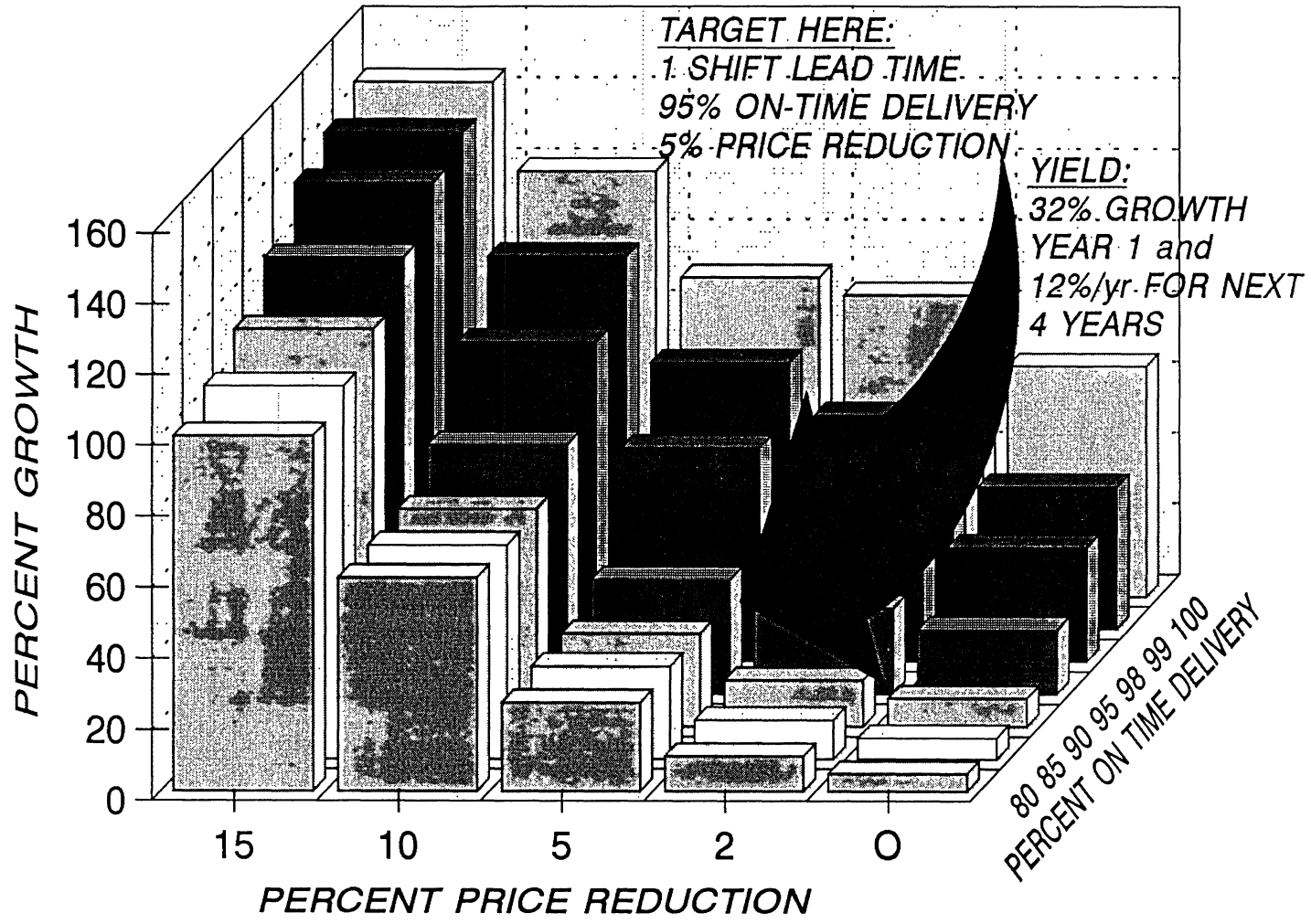


FIGURE 4.

HOSE and FITTING MARKET ANALYSIS

(SENSITIVITY TO PRICE AND DELIVERY W/ 1-SHIFT LEAD TIME)



% GROWTH
YEAR 1

ON-TIME DELIVERY (%)

% PRICE REDUCTION	80	85	90	95	98	99	100
0	5	6	8	18	32	40	65
2	10	11	13	24	39	60	85
5	25	26	26	32	60	75	90
10	60	60	61	70	90	105	120
15	100	105	112	123	135	140	145

% GROWTH
YEARS 2 to 4

ON-TIME DELIVERY (%)

% PRICE REDUCTION	80	85	90	95	98	99	100
0	5	5	6	9	12	14	20
2	7	7	7	10	14	19	25
5	10	11	11	12	19	23	26
10	19	19	19	15	27	30	34
15	29	30	32	35	38	39	40

Table 9.