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Development of a predictive tool from a study of just in time programs within a manufacturing plant

Richard Bernier

Development Of A Predictive Tool From A Study Of Just in Time Programs Within A Manufacturing Plant

by

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M. S. DEGREE THESIS

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ABSTRACT

This study develops a predictive tool from a study of different Just-in-Time (JIT) programs within a manufacturing plant, with the aim of being able to predict savings and costs of the next series of JIT programs targeted for future implementation.

During the analysis of the original JIT programs, savings were discovered to be greater than anticipated and in areas that were not anticipated. These savings could be related to newer programs. The original thought was to have a limited amount of material on the production floor and none in the warehouse, but other savings were discovered.

The cost details of these programs project even greater savings than anticipated. This paper analyzes the existing programs and uses the analysis as the basis for recommendations for moving into more JIT programs for additional future savings.

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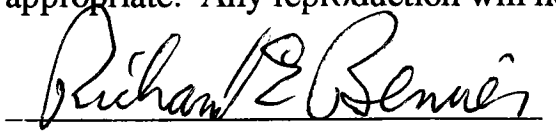

Richard E. Bernier

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Chapter 1 INTRODUCTION -- Background & Problem Statement

Overview Of Manufacturing Plant

The business where the JIT programs analyzed in this study was an old established business. The plant was built in 1976 on a 135 acre site in southern New Hampshire, near major highways and airports. This Digital Equipment Corporation building encloses 589,000 square feet, approximately square, divided into four approximately equal cores separated by firewalls. The 134,000 square-foot warehouse is a separate building connected to the main manufacturing plant by a long, windowed tunnel. The warehouse was added a few years after the manufacturing building was erected. There are 20 dock doors combined between the main building and the warehouse. The building was built during the company's boom years, and was one of many similarly sized buildings.

The building was originally used as a startup manufacturing plant for new products. The new product development engineering teams were located in and near the corporate headquarters about 40 miles away. New products were first built and de-bugged in this plant and then moved to the plant

assigned for the volume production. The floor plans were constantly changing as the new product mix changed. Products ranged from new technology printed wiring boards to dresser-drawer sized boxes to six-foot tall cabinets.

During the years previous to the introduction of the current JIT programs, and for the previous few years, the company had been downsizing. There were dramatic changes in work force and facilities. The workforce was cut in half, and the number of manufacturing plants was reduced to less than half. This was one of the last remaining manufacturing plant in the US. Products were brought into the plant from some of the other closed down plants. These products had been designed and developed for other manufacturing plants and then brought together into this plant as part of the downsizing and consolidation. The warehouse was overwhelmed by the number of different parts that was part of the increased business and the diversity of these businesses.

Today, the plant is divided into three large businesses, plus a few other smaller ones. The large businesses are the SBU, the ABU, and Distribution. Each of these businesses has a business manager or plant manager, and all three report to the Vice President of Manufacturing and Distribution. The

Systems Business Unit (SBU) and Americas Business Unit (ABU) each have their own separate Manufacturing Resource Planning (MRP) software systems, with possible plans to combine in the future. Distribution provides services to both of the other businesses by handling the receiving and shipping to and from different stock rooms that are combined into the one warehouse, and shipments to customers.

The two businesses and their products are similar except one is high-volume/low-mix and the other is low-volume/high-mix. The SBU business is a high volume/low mix manufacturer of three main product lines: small desktop PC-like boxes (24 x 24 inches square and 4-6 inches tall), larger deskside PC-like products (18 x 24 inch footprint, 30 inches tall), and large cabinet (30 inches square, 6 feet tall) products.

The ABU business is a low-volume/high-mix manufacturer of a broad range of custom-designed products ranging from small printed wiring boards to medium-sized boxes and large six foot tall cabinets.

The Distribution business provides shipping, receiving, warehousing and transportation services to all of the businesses in the building.

Problem Statement:

The large number of consolidations of many other plants into this one already crowded plant produced a tremendous amount of overcrowding in the warehouse and on the production floor, and a higher stress level on most employees. Buying to a "forecast" which was inaccurate with erroneous planning Bill of Material (BOM) penetration rates also contributed to the excess inventory eating away at the valuable warehouse space. This situation prompted a study of a number of ways to reduce the overcrowding effects of the additional production schedule. One of these ways was to initiate JIT programs to reduce the amount of material stored in the warehouse and on the production floor and the associated keypunching and computer transactions. Also to use the first few JIT programs to predict the potential savings in rent and cash flow for future and as yet unplanned JIT programs.

JIT Concepts

"JIT is not an inventory reduction system. Rather it is a management philosophy that focuses on eliminating anything that does not add value to the

product. JIT programs are not designed to force the burden of inventory carrying costs back onto suppliers. In fact, JIT works best when a company's suppliers and customers are also committed to the JIT management philosophy" (Solving Business Problems with MRPII, p.10)

One of the problems that companies encounter in implementing JIT is that frequent deliveries of material result in higher transaction processing costs. For example, a company that used to receive one shipment a month may receive daily shipments of material after JIT is implemented. The effort required to perform more receiving transactions detracts from the benefits of JIT (MRPII).

JIT Programs

The following JIT programs were initiated to help reduce inventory dollars, reduce inventory transactions, reduce warehouse space and deliveries from the warehouse to the production floor, and to free up valuable warehouse space for more profitable items.

1. Hardware JIT program

2. Packaging JIT program

3. PC board JIT program

Problem Statement:

The goals of this JIT program are to reduce the number of parts and their associated space in the warehouse, lowering the amount of dollars in inventory (and the associated carrying costs), increasing the cash flow, eliminating the on-floor mess of packaging supplies, and cutting purchasing and transaction costs.

Chapter 2 Hardware JIT Program

- Introduction
- Hardware JIT Program cost savings metrics
- Hardware JIT Program costs
- Hardware JIT Program Conclusions

Introduction

The original Hardware JIT program was started in 1991 for the ABU business only, with the SBU business added in 1995. Before the JIT hardware program was started, all the hardware used in the plant was part of the dollarized inventory system.

After the program started, it was non-inventory, non-dollarized, expensed material. The program began with about 350 different parts, which grew into over 800 a few years later. The parts were originally "P" (Purchased) coded, and were changed to "X" coded (JIT parts) as part of the program. The hardware in this program is typically small size and low cost.

Many parts would fit into a tote bin, but not many dollars. The parts are screws, bolts, washers, nuts, tie wraps, (some metric, some US standard), many screw lengths, many screw-head styles, many washer types and sizes. Each screw would have multiple lengths and multiple head styles. There was also plug buttons, grommets, leveler feet, rivets, spacers, dowel pins, eyelets, inserts, standoffs, wire connectors and many other types of parts.

The hardware is identified on each product Engineering Parts List and MRP Bill of Material. These parts lists were created over the course of many years by many product designers for many different manufacturing plants. When all of this was put together into one plant, the confusion and problems began with receiving and issuing these parts. Even when there was standardization within a previous plant, when these products were moved into this one single plant the standardization was completely thrown into chaos. Before the Hardware JIT Program could begin, the JIT team had to identify all hardware in the business on BOMs of the MRP system. The JIT team was made up of representatives of Engineering, Manufacturing and Production. This was done with a sub-routine program within the MRP system that could be customized to print out the forecasted usage, material on hand, and past usage for the previous year. The team identified which parts to add to the

program. Parts with no forecast, no past usage, and no material on hand were marked either for scrap or to keep for substitutions. The team determined that such parts would be purchased from one vendor instead of several. The material to be picked was bagged, labeled and issued in small quantities from the warehouse to individual work orders on the production floor. Orders could be as small as a lot size of one. The warehouse was full of many small parts, a large quantity inventory with very low dollar value. There was a small number of receipts with a large numbers of pulls. For each part pulled or put away, there was a computerized inventory transaction and a paper trail for record keeping.

The program changed from many vendors to one. Racks were set up on the production floor and all hardware material was taken out of the warehouse to fill the racks (Figure 2-2). The savings was estimated at $26,000 per month, or $312,000 per year, based on eliminating data entry and small quantity issues and returns (Table 2-1). The information generated in the table was gathered during the month of March 1991 and annualized using the March figures. The parts went from previous invisibility in the warehouse, to high visibility on the production floor. It then became possible to consolidate and standardize the parts once these products were

consolidated into the one plant in Salem, New Hampshire. Once the JIT program was initiated it became more obvious that many parts could be consolidated into few, and ECOs were written to standardize. Opportunities still exist for more ECOs.

The Hardware JIT Program was quoted out to a handful of potential suppliers. Quality Components was the name of the chosen single source supplier. It was called the "breadman" program; after the fashion of a breadman who delivers daily to the grocery store, keeping the shelves full. The supplier helped to set up four 8-foot racks on the production floor, with 4 or 5 shelves each and 12 totes per shelf. Each tote bin is marked with the appropriate part number, and small hardware parts are glued to the face of the tote bin for even easier identification. See Figure 2-2 for drawing of shelving and tote bins.

The Quality Components JIT sales representative has a Digital picture badge identifying him as a contract employee, giving easy entrance to the building. Parts are delivered twice weekly by Quality Components and put into totes in the JIT area. There is no warehouse inventory because of these deliveries to racks on the production floor. The concept is based

consumption delivery. The supplier has a constantly updated list of parts with min/max quantities to keep on the shelves.

Assemblers in production lines pull small quantities to each workbench. There are no more warehouse receipts. There is reduced purchase order activity and associated costs. The changed source code from "P" (purchased inventory) to "X" (JIT, non-inventory) reduced warehouse material transactions, reduced warehouse labor reduction, freed up warehouse floor space by eliminating the large quantity infrequent shipments. The plan changed to small quantity, very frequent shipments with no warehouse put aways and no warehouse pulls.

Hardware JIT Program Costs

The costs associated with implementing the Hardware JIT program were very little, just some shelves on the production floor to hold the material. This consisted of four 8-foot shelves plus the aisle space, or approximately 128 square feet at $11.80 per square foot per year equals $1510. See Figure 2-2 for picture of shelving and tote bins.

Now that the program is five years old, it has grown to 400 bins, 400 part numbers, 400 square feet of floor space. Today, the value of the material is $25 - $500 per bin, depending on value of parts; averaging $100 per bin $10,000 - $200,000 total value; averaging $40,000 total value. Quality Components is still the JIT supplier, and the cost savings identified by them are as follows:

- Incoming receiving costs
- Inspection costs
- Purchase Order Administrative costs
- Internal material handling costs
- Freight costs

Figure 2-1 Hardware Program Savings

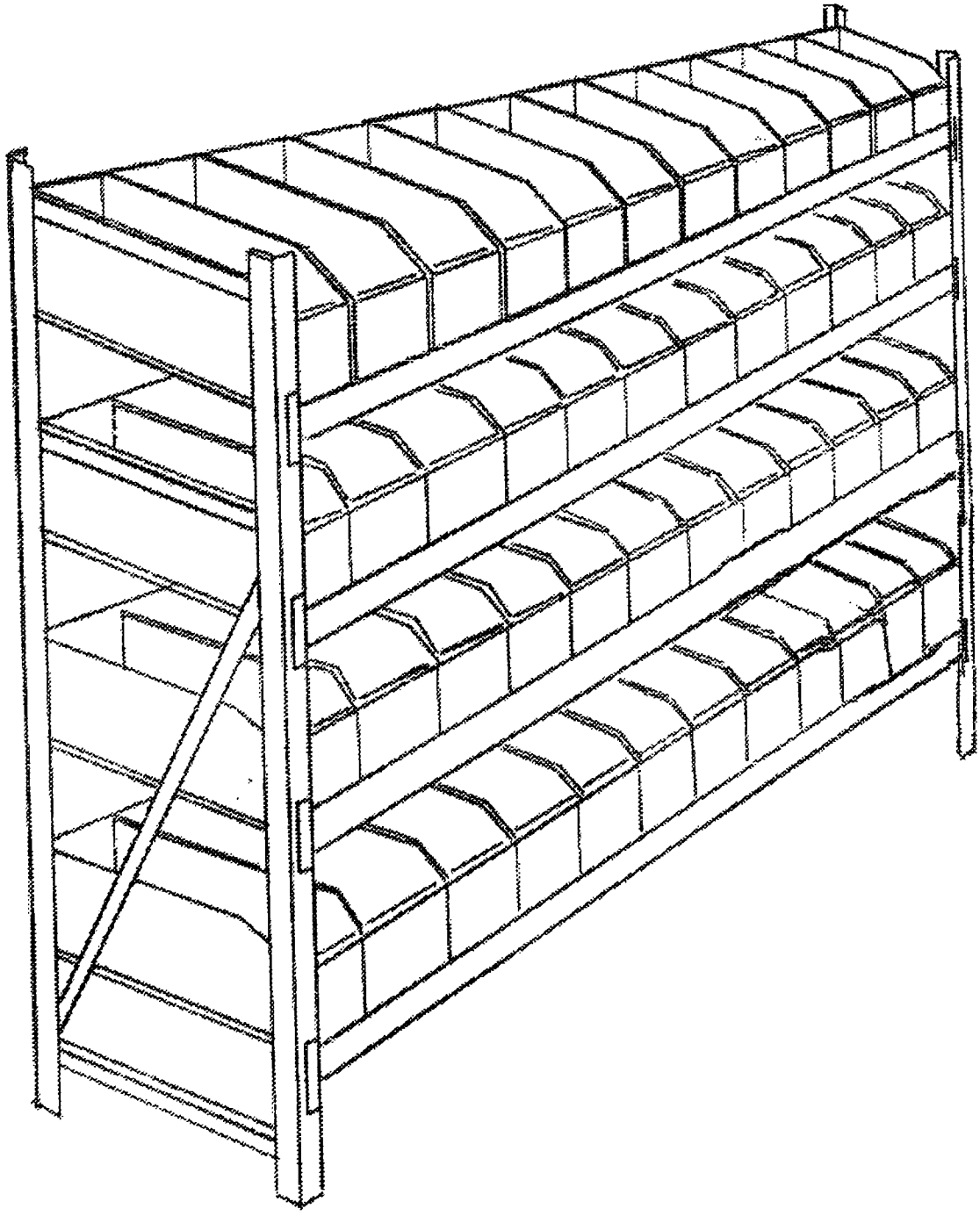
MONTH OF MARCH 1991					
Issues from Warehouse to Production Floor	Cost	Quantity	Old Cost	New Cost	Total Monthly Savings
Cost to Pick	$2.29	4979	$11,402	$000	
Cost to Keypunch	$0.31	4979	$1543	$000	
Total Savings from Issues				$000	$12,948
Returns from Production Floor to Warehouse					
Cost to Restock	$5.26	1149	$6044	$000	
Put Away Cost	$3.61	1149	$4148	$000	
Audit Cost	$2.31	1149	$2654	$000	
Keypunch Cost	$0.31	1149	$356	$000	
Total Savings from Returns				$000	$13,202
Total Monthly Savings Issues & Returns				$26,147	
Inventory Carrying Cost; 8%	$4,000	$	$20,000	$2,000	$3,600
Monthly Savings					$29,750
Annualized Savings					$357,000

Hardware JIT Program Conclusions

The real cost savings from this program has been the elimination of costs associated with the receiving, stocking, restocking, keypunching and delivering of parts to the production floor; and the freed up warehouse and production floor space and increased cash flow by $216,000 annually (($20,000 - $2,000) x 12 = $216,000).

Gross Cost Savings	=	$357,000
Gross Costs	=	$1500
Net Cost Savings	=	$ 355,500

Figure 2-2 Hardware JIT Storage Rack on Production Floor



Chapter 3 Packaging JIT Program

- Introduction
- Packaging JIT Program cost savings metrics
- Packaging JIT Program costs
- Packaging JIT Program net cost savings
- Packaging JIT Program Conclusions

Introduction

The beginnings of the packaging JIT program began when the manufacturing plant in the Southwest closed down and their products transferred into the Salem, New Hampshire plant. When the large-cabinet product was in the Southwest, the packaging material was in pallet-load quantities on the production floor in three-high warehouse-type racks. The local packaging supplier was on a JIT program, but the program delivered mostly pallet loads of materials, not a quantity equal to the production

schedule. There was one double deep rack and another single rack, 8 pallets long and 3 pallets high.

Each part number had a pallet load of material, regardless of how much or how little was used on a regular basis. There was usually too much of something, and often not enough of other things. Anything on the second or third shelf had to be loaded with a fork truck and hand unloaded from a large, wheeled, slope ladder. The extra material was stored in the warehouse and ordered by the Purchasing department per the requirements generated by the MRP system.

Management didn't like the messy looks of the three-high warehouse racks on the production floor, but nothing had been done about it, either. To make matters worse, it was on a main aisle where everyone walked by on the way in and out of work. Everyone could see it, and everyone complained of the eyesore and the mess, and the amount of production space taken up with the messy-looking packaging materials. Everyone wanted it gone, but no one knew how, until one day someone suggested putting the corrugated material into something like the organizer on a desk that hold files vertically. It was an idea that no one thought of before, but everyone contributed to the spark that generated it. A container was built (Figure 3-4) for the corrugated which

would hold more than one part number in the space of one pallet position. Now the container could hold six part numbers in the space that one used to take. A standard 48 inch x 40 inch pallet with 2 inch x 4 inch stringers was used. It was built with vertical 3/4-inch plywood side walls along the 48 inch dimension. The remaining 40 inch deck space was divided into six equal spaces of a little over 6 inches wide, using more vertical plywood panels separated by 2 inch x 6 inch nominal lumber. Each of these 6 cells could hold a single part number of corrugated material. Each cell would take 10 double-wall cartons or 20 single-wall sheets.

The concept started out with a couple of these JIT pallet containers and reduced the amount of material in the warehouse racks. Later, more containers were built, and it was time to tear down one set of warehouse racks. Most of the material was corrugated cartons and sheets, but some of it was foam cushioning. After a time, higher sidewalls and a top shelf were added (Figure 3-5) to hold the foam cushions. Then there was corrugated on the bottom and foam on the top: both materials were usually required to pack a single product. Finally, all the warehouse racks on the production floor were torn down and all the packaging materials were in wooden JIT pallet containers.

Pallet loads of material were still being ordered from the JIT suppliers and pallet loads of material were pulled from both the warehouse and the suppliers to replenish the floor. The next step was to have the suppliers deliver daily and fill the wooden JIT pallet containers as they saw them emptying. There were, finally, daily deliveries with no mess, no warehouse pallet racks, and no pallets. Each wooden JIT container would hold corrugated & foam in pre-established Kanban quantities. The standard quantities of material became the visual signal to the supplier's JIT drivers. At the busiest times, the end of month, end of quarter and end of year, there would be overstock and aisles filled with material. The excess material was worked off at the beginning of each month or taken back by the suppliers and the areas continued to look reasonably neat, certainly much neater that ever before. The same concept of consolidation continued throughout the production floor as the individual product production lines were consolidated into family production lines and regained more of the production floor for production use and less for material storage space. Production is what makes money in manufacturing, not inventory space.

There are five JIT suppliers, supplying a total of 255 separate part numbers for packaging materials: see Figure 3-1.

- one for molded and fabricated foams; 22 parts
- one for corrugated and fabricated foams and some pallets; 56 parts
- one for corrugated and fabricated foams; 124 parts
- one for general purpose wood pallets and cushioned pallets; 8 parts
- one for distribution materials; 45 parts (Figure 3-1).

JIT Packaging Suppliers

Figure 3-1 Packaging JIT Program Supplier & Part Numbers

Quantity of Part Numbers by Supplier and Work Area						
	Day Lumber	Eastern	Pacific	Tenneco	Tuscarora	Totals
DeskTop	1	3	6	14	8	33
DeskSide	4	24	8	11	10	57
Data Center	3	7	14	51	3	78
Options	0	22	16	124	1	87
Totals	8	56	45	124	22	255

One supplier qualifies as one of our minority/woman-owned businesses for governmental regulations. The distribution supplier handles materials such as static shielding poly bags, static dissipate poly bags, clear poly bags, plastic strapping, carton sealing tapes, angleboard, stretch film and bubble wrap. The distribution supplier also acts as the preventive maintenance

supplier for our packaging equipment: carton sealers, strappers and stretch wrappers.

When the Albuquerque plant closed down, their plant JIT program transferred from its local supplier to the supplier sister plant near the Salem, New Hampshire plant. Because the Packaging JIT program was transferred in as part of the business, there was no "before" to compare the "after" to. The Albuquerque plant had justified the JIT program on strictly a warehouse space basis. Either plant would have run out of warehouse space if it tried to stock the packaging materials in the warehouse. The JIT program was a survival tactic, much less costly and much more desirable than building another warehouse.

In Salem, the JIT material transferred from one supplier plant to another and supplier production kept up with the transferred products. The cost comparison in Figure 3-2 compares the costs savings if the material had originally been in the warehouse and then moved to a JIT program. Figure 3-3 shows a gross comparison between the cost of the JIT program and the non-JIT program.

Of the 255 different part numbers, there is a wide range of part sizes and parts per pallet load to be stored in the warehouse. Poly bags are

supplied 100 - 300 per box or per roll, with enough boxes to make a pallet load equal to 3000 - 5000, enough bags to last a month. The pallet load is depleted one carton at a time on a daily basis and the pallet load refilled about once a month and weekly deliveries to the production floor. There are also larger parts like the cushioned pallet with 5 pallets to a stack. The warehouse would be required to keep 5 to 10 pallet positions filled all the time with twice daily deliveries to the production floor. Molded foam parts might only have 50 - 60 pieces per pallet load with a usage of 2 per production unit, or 25 - 30 finished goods products per pallet load; these could also have twice daily deliveries to the production floor and multiple warehouse locations.

Twice daily pulls; all of Day Lumber & Tuscarora = 8 + 22 = 30

1/2 Tenneco, 1/2 Eastern = 62 + 28 = 90

= 30 + 90 = 120 x 2 = 240 daily pulls

6 pallet loads per part number = 120 x 6 pallet positions

per part number = 720 total pallet positions

daily pulls, 1/2 Tenneco, 1/2 Eastern = 62 + 28 = 90 daily pulls

6 pallet loads per part number = 90 x 3 pallet positions

per part number = 270 total pallet positions

weekly pulls, all of Pacific = 45 = 45 / 5 = 9 daily pulls

1 pallet load per part number = 9

a total of about 1000 pallet positions of packaging material in the warehouse at any given time.

Figure 3-2 Packaging JIT Program Cost Savings Metrics

Packaging JIT Program Cost Savings Metrics					
Issues from warehouse to production floor	Cost	Quantity	Old Cost	New Cost	Total Annualized Savings
Receiving Cost	$3.92	1000	$3,920	$000	$47,040
Put Away Cost	$2.45	1000	$2,450	$000	$29,400
Data Entry Cost	$0.74	339 x 21.66	$16,815	$000	$201,780
Pull Cost	$1.23	339 x 21.66	$2,276	$000	$27,312
Cycle Count	$0.98	1000	$980	$000	$11,760
Ship	$3.18	1000	$3,180	$000	$38,160
Storage Cost	$4.70 per pallet per week	1000 x 4	$18,800	$000	$225,600
Inventory Carrying Cost	8 %	$170,000	$170,000	$30,000	$112,000
Total Monthly Savings				$48,421	
Total Annualized Savings					$900,252

The JIT program has savings, but it also has costs. The savings is in not using the warehouse to store material, and the suppliers ability to make longer production runs. The costs are primarily the costs associated with delivery of the material on a JIT basis; the cost of a truck and driver for each supplier. The plant is down to three suppliers doing deliveries. The distribution supplier does not charge any more for the weekly deliveries and the pallet supplier delivers in truckload quantities to one of the corrugated suppliers, which in turn does the daily deliveries along with the other material. The plant usually works on a two-shift basis; 6:00 AM to 2:30 PM and 2:30 PM to 11:00 PM. At the end of the quarters, or at year end, there is usually a third shift or extended hours of each shift to approximate three shifts. The distribution supplier came in about once each week. The other suppliers began with a once a day schedule, which evolved into twice a day, or once per shift, and then to twice per shift. All the JIT deliveries are through the dock doors closest to the production floor. They are used instead of the warehouse receiving docks to reduce the travel distance for the JIT drivers. Material is delivered directly to the point of use by the JIT drivers.

The JIT drivers, and their backup drivers, are each assigned a picture badge, similar to the regular employee picture badges. The JIT drivers are

allowed to use our fork trucks and other power trucks to deliver their material from the dock to our point of use area. Because the JIT drivers are allowed to use the powered company trucks, they are required to get fork truck training and certification from our training program. The program includes a physical, classroom training, and instructor training. The license badge is good for two years, and must be renewed.

There is still some amount of extra "Just in Case" material and trash on the production floor, but it is dramatically reduced from the pre-JIT days and management is much happier with the new look. Management will be even happier when the change is made to twice-per-shift deliveries, and reducing the JIC material to zero. The extra material is due to the inability of the system to predict exactly when product will be ready to pack.

If the production floor were to be level loaded, that is if production were to produce the same amount of product each week, the amount of material needed on the floor would be to divide the quarterly production load by 13 weeks and by 5 days per week. This formula would result in dividing by 65; for example, 1000 divided by 65 equals 15 parts per day. With the typical quarterly skew, the divisor is more likely to be 40 making the quantity 25 parts per day. This business has a heavy skew toward the end of each

quarter, making the latter formula more realistic to calculating the Kanban quantities required for the production floor.

JIT usually calls for a level loaded production floor to give the suppliers and their suppliers visibility. This plant does not level load the floor and does not know from day to day what is actually going to be built. The signal to the supplier is the toughest problem.

The definition of JIT that calls it a continuous improvement process is exactly right. There is continual improvement in the JIT process and it will continue to improve as time goes on. Each time an improvement is made, it looks like the end of improvements, but the continuous understanding of the process points out the next series of things to be changed to make the whole process better again.

Packaging JIT Program Costs

The costs of administering this packaging JIT program are substantial

- Wooden JIT container
- Production floor space
- JIT deliveries; truck & driver

There was a one-time cost of the wooden JIT containers at about $300 each x 50 containers = $15,000.

Production floor space for 50 pallet size containers at 16 square feet per container = 800 square feet, plus another 800 square feet of aisle space, totaling 1600 square feet at $11.80 per square foot per year = $18,880

JIT deliveries, truck & driver costs. The estimate for truck lease was $50,000 per year and another $50,000 per driver for wages and benefits totals $100,000 per supplier x 3 suppliers = $300,000 per year.

Total cost of JIT program = $15,000 plus $18,800 plus $300,000 = $333,800

Conclusions

The costs of the program are outweighed by the savings by $602,000 annually. The primary savings come from not using the warehouse and all the expenses related to it. The second greatest cost is the truck and driver expense for deliveries. Plans are now underway to decrease the number of deliverics by keeping a small amount of extra material, over and above the floor stock, near the production area to reduce the number of extra and off hours deliveries.

Program gross costs	=	$333,800 plus space costs
Program gross savings	=	$581,052
Program net savings	=	$247,252
Increased Cash Flow	=	$1,680,000

Figure 3-3 Packaging JIT Program Cost Benefits

PACKAGING JIT PROGRAM				
COST BENEFITS OF JIT VERSUS NON-JIT				
	non-JIT	non-JIT cost	JIT	JIT cost
warehouse inventory	yes		no	
# parts	many		same #	
receiving	many		none	
suppliers	five		five	
warehouse deliveries	few		none	
warehouse receipts	many		none	
floor deliveries	many		twice daily	
# warehouse puts aways	many		none	
# warehouse pulls	many		none	
# warehouse comp transactions	many		none	

Figure 3-4 Packaging JIT Program; Wooden Bin Box, Corrugated Only

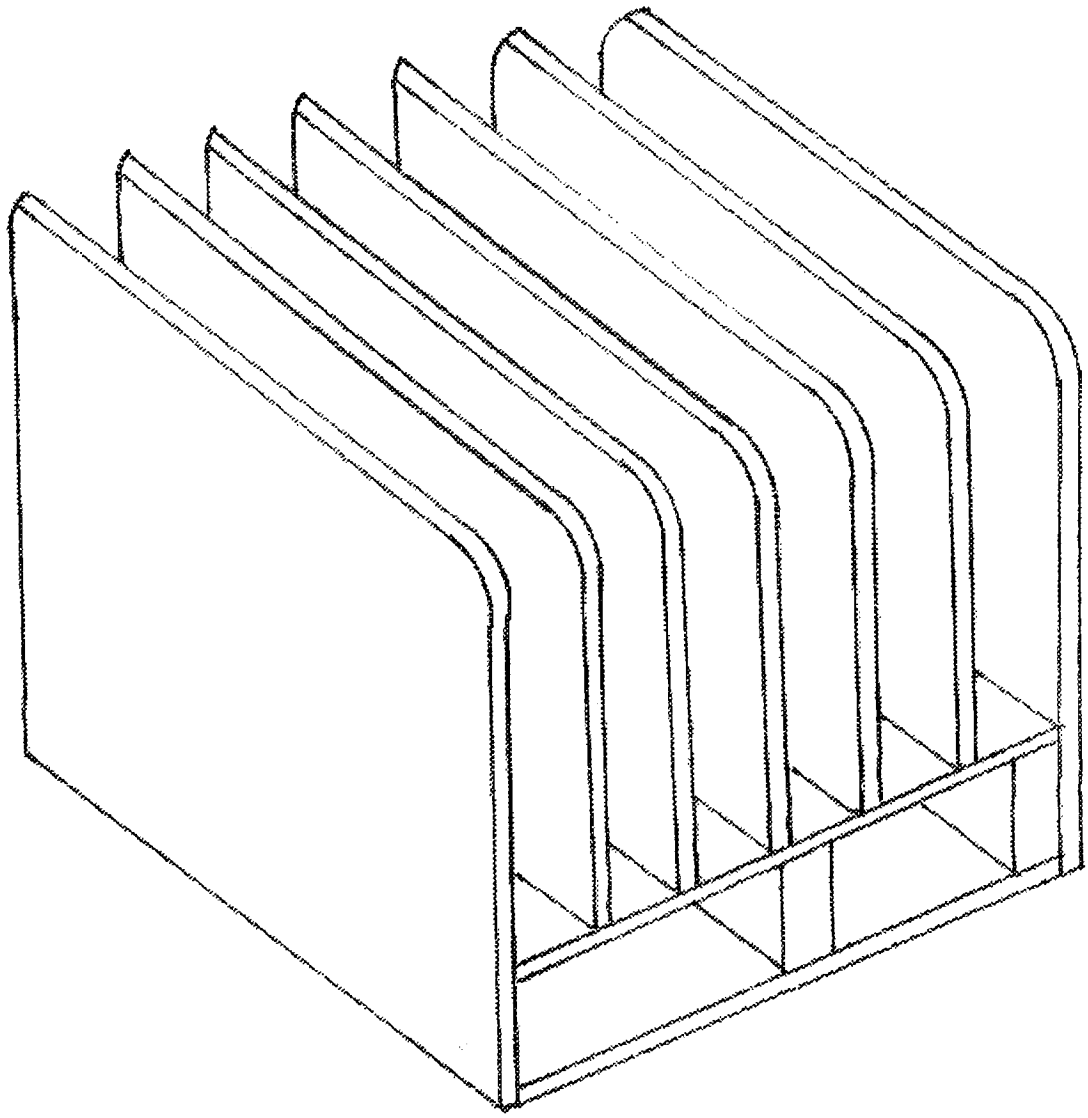
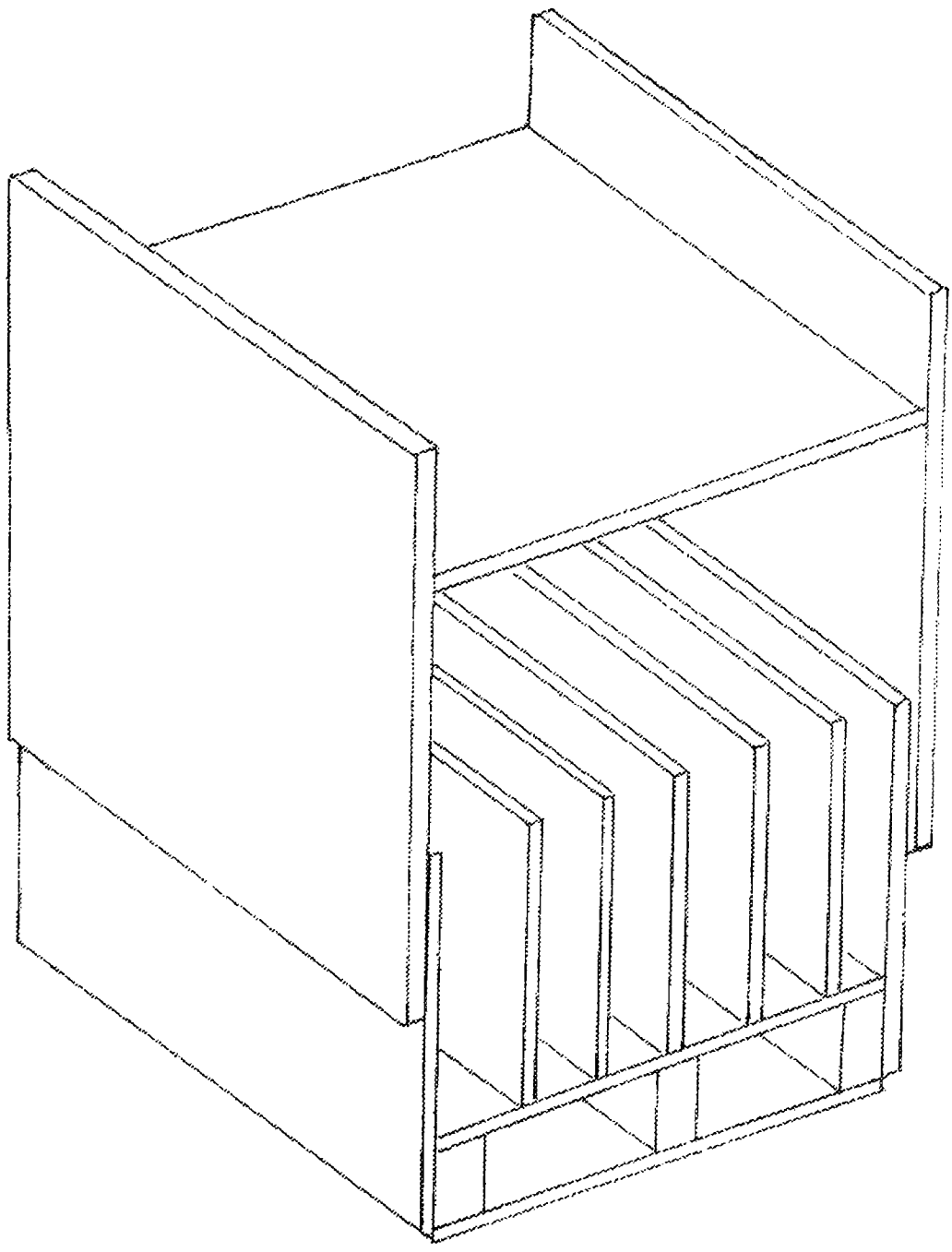


Figure 3-5 Packaging JIT Program; Wooden Bin Box; Corrugated & Foam



Chapter 4 Printed Wiring Board JIT Program

- Introduction, pre-JIT
- Introduction JIT
- PWB JIT program cost savings metrics
- PWB JIT program costs
- PWB JIT program net cost savings
- PWB JIT program conclusions

Introduction, pre-JIT

The Printed Wiring Boards come into the Salem, New Hampshire computer manufacturing plant from two main sources: a high volume board manufacturing plant in Canada and another high volume board manufacturing plant in Scotland.

Before the JIT program, both plants used the boards that they manufactured in their own computer manufacturing plant, plus shipping in bulk and single packs to the US computer manufacturing plant and to the

Scotland computer manufacturing plant. They both also shipped in single packs to both the US and European Field Service warehouses. See Figure 4-1 for flow chart of Printed Wiring Boards flowing from plant to plant. See Figure 4-2 for pre-JIT program packaging materials and carton types.

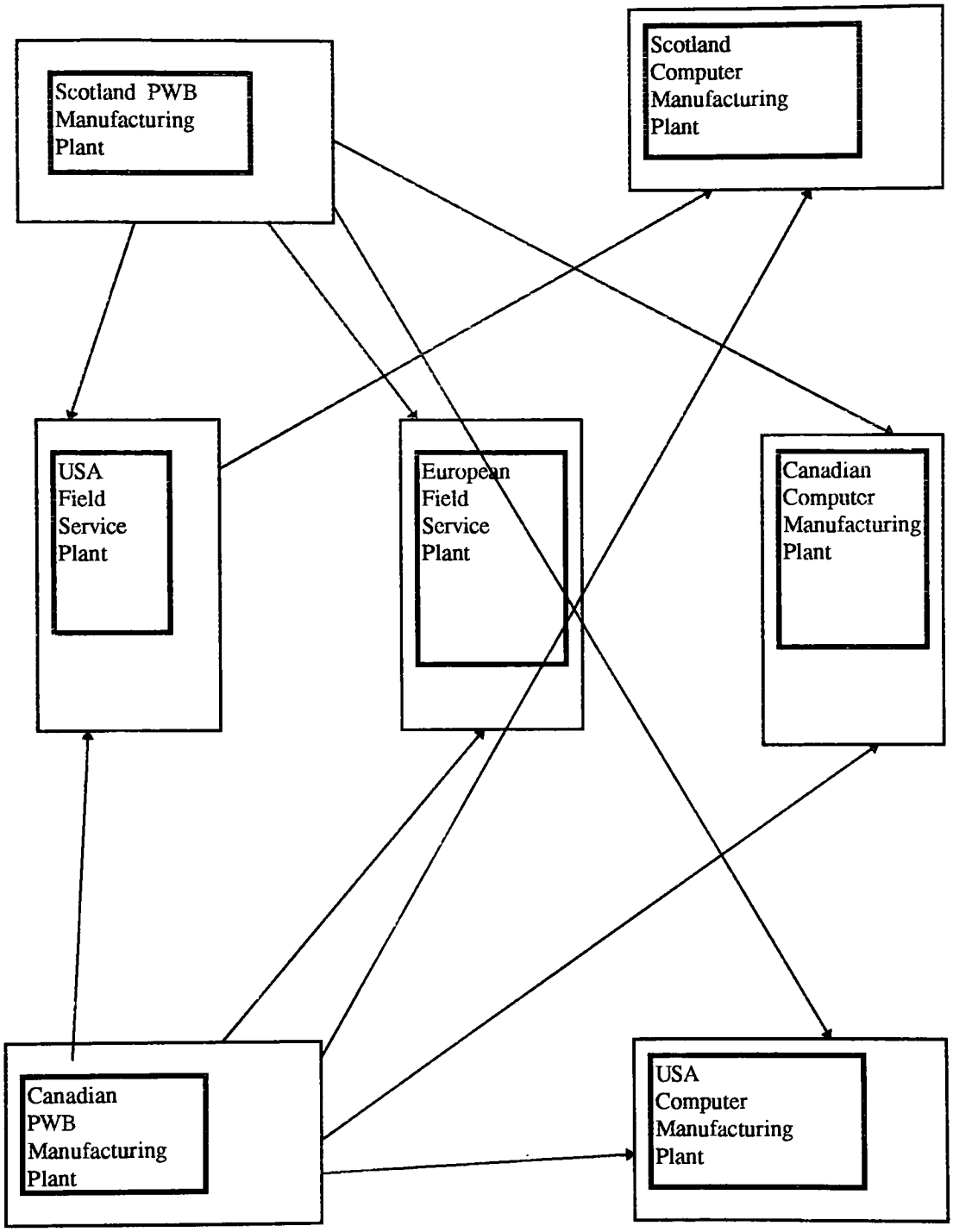
Material and labor are being wasted by both board manufacturing plants when they ship boards in single packs to the using computer manufacturing plants. The computer manufacturing plants also waste material and labor and warehouse space and production floor space when they have to unbox the PWBs and throw away the single pack material.

See Figure 4-1 for packaging before JIT program

Figure 4-1 PWB JIT Program

PWB Shipments before JIT Program					
	Canada Manufacturing	US Manufacturing	Scotland Manufacturing	US Field Service	European Field Service
Canada Manufacturing	No Pack	Bulk Packs Single Packs Throwaways	Bulk Packs Single Packs Throwaways	Single Packs Throwaways	Single Packs Throwaways
Scotland Manufacturing	Bulk Packs Single Packs Throwaways	Bulk Packs Single Packs Throwaways	No Pack	Single Packs Throwaways	Single Packs Throwaways

Figure 4-2 PWB Total Material Flow Chart



Introduction PWB JIT Program

The PWB JIT program has as its goal to use only bulk packs to ship to both computer manufacturing plants and both field service plants; and to have the shipping cartons be reusable and returned to both board manufacturing plants. The JIT program is still in the planning and implementation stage, but the other part of the program is to use the same reusable and returnable cartons to both field service warehouses. The field service warehouses have for years bought their PWBs in single packs because they in turn ship individual packs to their customers.

A broken computer needs only one board, not a bulk pack of a dozen boards. If enough savings can be generated for the whole corporation, maybe the field service operations can be persuaded to accept bulk packs and repack into single packs for their customers. If they are not convinced, then both board manufacturers may have to continue to ship in both single and bulk packs. See Figure 4-3 for flow of JIT Printed Wiring Boards, also, see Figure 4-4 for PWB JIT Program packaging types

The present method of shipment from both plants is mixed loads, bulk and individual. Often, loads do not fit pallet, truck, or flow racks. There is

messy detrashing, much trash to be detrashed and put into totes to fit flowracks on production floor. The JIT program started with a list of boards with weights and dimensions and carton system design constraints: the size and weight restrictions of the flow racks, pallet size, truck size and weight limitations.

- 40 pound maximum carton weight
- 48 x 40 inch pallet
- pallet to fit hand pallet truck
- pallet to fit walkie rider pallet truck
- cartons to fit pallet with minimum underhang and no overhang
- cartons must fit 58.5 inch opening and 60 inch depth of flow racks
- cartons must be capable of multiple trips

The new cartons would be sized to fit the standard 48 x 40 inch pallets, with opening size to fit hand pallet trucks and electric walkie rider pallet trucks and 58.5-inch wide flow racks, and also to limit the weight to 40 pounds maximum to protect people from lifting injuries.

The first step was to start with corrugated bulk packs to replace individual packs. This would reduce trash by changing from single trip, individual to multiple-trip bulk packs. The second phase would be to change from single-use corrugated bulk packs to reusable, returnable corrugated bulk packs, with the returnable system set up with the distribution department. The final reusable, returnable bulk pack would be a telescoping corrugated carton with single wall replaceable outer carton with hand holes and double wall inner carton with corrugated dividers or hanging holders for the printed wiring boards. The carton would be sealed as it left the Canadian plant and go through customs. When the carton got to the production floor, it would be opened and the single wall outer HSC would be taken off and placed upside down under the inner double wall carton and placed into the flow racks.

Figure 4-3 Flow of Printed Wiring Boards

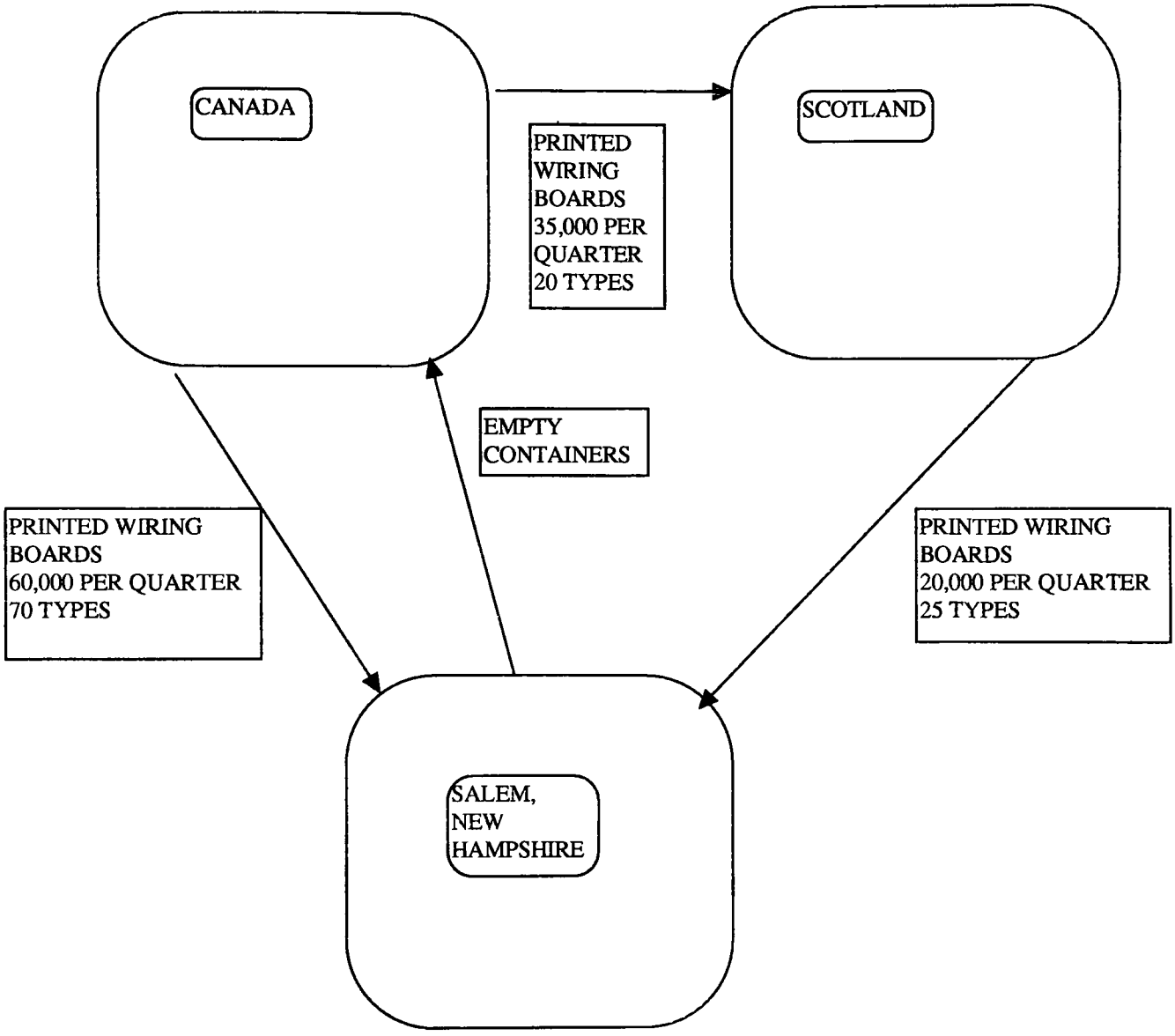


Figure 4-4 PWB JIT Program Shipments

PWB Shipments after JIT Program					
	Canada Manufacturing	US Manufacturing	Scotland Manufacturing	US Field Service	European Field Service
Canada Manufacturing	No Pack	Bulk Packs Returnable	Bulk Packs Returnable	Bulk Packs Returnable	Bulk Packs Returnable
Scotland Manufacturing	Bulk Packs Returnable	Bulk Packs Returnable	No Pack	Bulk Packs Returnable	Bulk Packs Returnable

Figure 4-5 Print Wiring Board Cost Metrics

Printed Wiring Board JIT Program Cost Metrics					
Issues from warehouse to production floor	Cost	Quantity	Old Cost	New Cost	Total Monthly Savings
Receiving Cost	$3.92	600 x 4	$9408	$000	117,696
Put Away Cost	$2.45	600 x 4	$5880	$000	70,560
Data Entry Cost	$0.74	600 x 4	$1776	$000	21,312
Pull Cost	$1.23	600 x 4	$2952	$000	35,424
Cycle Count	$0.98	600 x 4	$2352	$000	28,224
Ship	$3.18	600 x 4	$7632	$000	91,584
Storage Cost	$4.70 per pallet per week	600 x 4	$11,280	$000	135,360
Inventory Carrying Cost	8 %	25,000	$125,000 ,000	$28,500, 000	$7,220,000
Total Monthly Savings				41,680	
Total Annualized Savings					500,160

PWB Program Net Cost

See Figure 4-6 and 4-7 for costs associated with starting up the program and how the costs compare to the savings.

Figure 4-6 Printed Wiring Board Packaging Costs

PRINTED WIRING BOARD PACKAGING COSTS				
AVERAGE COST OF 460,000 BOARDS PER YEAR				
	SINGLE PACK	SINGLE PACK	BULK PACK	BULK PACK
	$ PER BOARD	$ PER YEAR	$ PER BOARD	$ PER YEAR
MATERIAL	$2.25	1,035,000	$1.25	$575,000
PACK LABOR	$0.50	$230,000	$$0.10	$46,000
DETRASH	$0.10	$45,000	$0.00	$0.00
WAREHOUSE	$0.12	$55,000	$0.12	$55,000
TOTAL	$2.97	$1,640,000	$1.47	$676,000
TOTAL OPPORTUNITY EQUALS $964,000 PER YEAR OR $1.50 PER BOARD				

Figure 4-7 PWB JIT Program

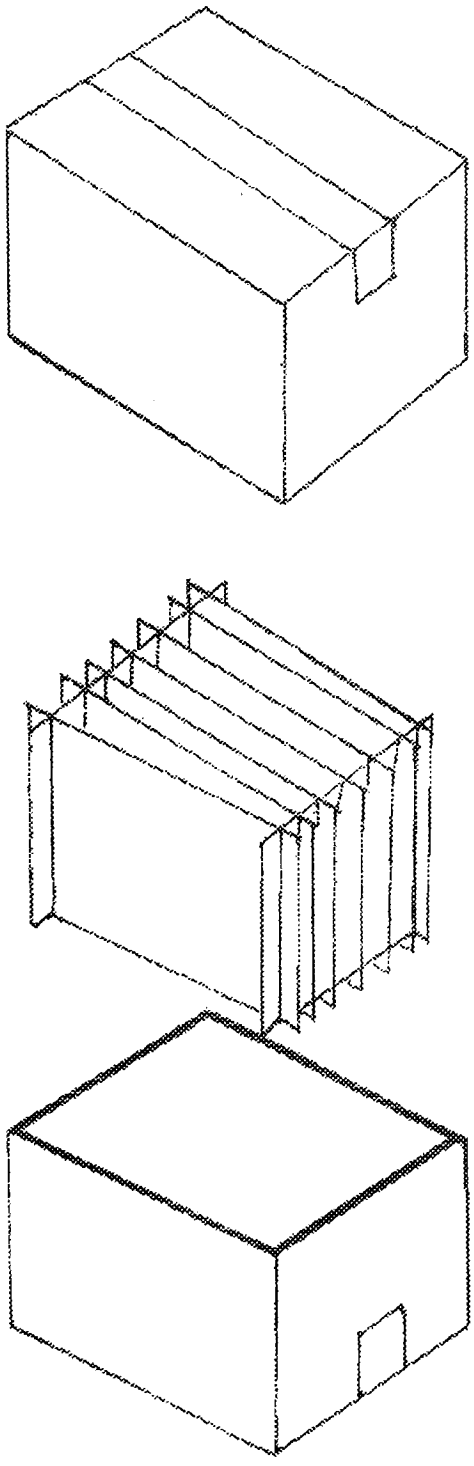
PRINTED WIRING BOARD JIT PROGRAM				
COST BENEFITS OF JIT VERSUS NON-JIT				
	non-JIT	non-JIT cost	JIT	JIT cost
warehouse inventory	yes		no	
# parts	many		same #	
receiving	many		none	
suppliers	many		one	
warehouse deliveries	few		none	
warehouse receipts	many		none	
floor deliveries	many		many	
# warehouse puts aways	many		none	
# warehouse pulls	many		none	
# warehouse comp transactions	many		none	

PWB Program Conclusions

The costs of the program compared to the cost savings show that the program will pay for itself in a short time. There is also an increase in cash flow of $96,500,000.

Program gross costs, new material	=	$45,300
Program gross savings from warehousing	=	$500,160
Program net savings from material	=	$964,000
Program net savings	=	$1,418,860

Figure 4-8 PWB JIT Program, HSC Carton & Dividers



Chapter 5 Methodology

The method will be to understand the existing JIT programs well enough to determine the costs and savings and other benefits and compare them from program to program and also to use these numbers to predict the comparable costs and savings for proposed new JIT programs.

Figure 5-1 PWB JIT Program

JIT PROGRAMS - COSTS & BENEFITS			
	HARDWARE JIT PROGRAM	PACKAGING JIT PROGRAM	PWB JIT PROGRAM
PRODUCT COST	LOW $	MEDIUM $	HIGH $
MATERIAL SIZE	SMALL	LARGE	MEDIUM
WAREHOUSE TRANSACTION COSTS	HIGH $	HIGH $	HIGH $
SUPPLIER CHARGES	LOW $	HIGH $	LOW $
WAREHOUSE SPACE REQUIRED	LOW	HIGH	HIGH
VENDOR	EXTERNAL	EXTERNAL	INTERNAL
# OF DELIVERIES	WEEKLY	TWICE PER SHIFT	TWICE PER WEEK
PRODUCTION FLOOR SPACE REQ.	LOW	MEDIUM	MEDIUM

Chapter 6 Results

The results are presented in tabular form and extrapolated for the newer programs.

JIT PROGRAM COSTS AND SAVINGS			
	HARD WARE JIT PROGRAM	PACKAGING JIT PROGRAM	PRINTED WIRING BOARD JIT PROGRAM
TOTAL COSTS	$14,000	$315,000	$45,000
TOTAL SAVINGS	$314,000	$581,000	$1,460,000
NET SAVINGS	$300,000	$266,000	$1,419,000
WAREHOUSE SAVINGS	$314,000	$355,000	$365,000
STORAGE SAVINGS	NA	$225,000	$135,000
MATERIAL SAVINGS	NA	NA	$964,000
INVENTORY CARRYING COST			

Chapter 7 Conclusions & Recommendations

The previous table (Figure 7-1) shows the costs and savings for each of the three JIT programs. The cost savings associated with each program are primarily costs related to shipping, receiving, warehousing and storage functions. Any future JIT program should take this into consideration. Any method of implementing a JIT program which eliminates the warehousing functions can show tremendous savings. On the other hand, the costs associated with these programs include production floor space which is always at a premium and delivery costs as evidenced in the Packaging JIT program.

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Chapter 9 About the Author

The author was born in Virginia. He graduated from high school in Maynard, Massachusetts. After four years in the Navy, he attended Northeastern University in Boston, Massachusetts, where he received an Associate Degree in Mechanical Engineering and also a Bachelor's Decree in Mechanical Structural Engineering, both with Honors.

He is now working as a Packaging Engineer for Digital Equipment Corporation in Salem, New Hampshire. He has previously worked for Digital in their corporate headquarters in Maynard, Massachusetts and also in the printer manufacturing plant in Phoenix, Arizona. He is a CPP certified active member and treasurer of the New England chapter of the Institute of Packaging Professional.