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Bar Code Users and Their Performance

A report on information technology and manufacturing productivity

Based on responses from over 1,000 manufacturing plants participating in a study sponsored by:

The National Association of Manufacturers
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The Thomas Walter Center for Technology Management

By:

Paul M. Swamidass, Ph. D.
Professor of Operations Management
Associate Director
Thomas Walter Center for Technology Management
Tiger Drive, Rm. 104
Auburn University, AL
334-844-4333
fax 334-844-1678
swamidp@eng.auburn.edu

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Introduction

This report on bar code use is part of a larger study conducted in Fall 1997 on the use of 17 manufacturing technologies in the United States. The 17 technologies investigated are listed in Appendix II. The complete report on the use of all 17 technologies in U. S. factories is published by the Manufacturing Institute of the National Association of Manufacturers, Washington, D. C. The complete report is titled, *Technology on the Factory Floor III: Technology Use and Training In The United States.* Copies of the report may be obtained by calling the Manufacturing Institute at 203-637-3107.

Background & Methodology

Bar code is a series of alternating bars and spaces printed or stamped on parts, containers, labels, or other media, representing encoded information that can be read by electronic readers for accurate data input to computer systems. Although, the use of bar codes has been increasing each year, they are not used by all manufacturers. In a recently concluded study, the use of bar codes was investigated as one of 17 different manufacturing technologies. It is well understood that bar code technology is an enabling technology that can contribute to manufacturing cost reduction, quality improvement, cycle-time reduction, and improved profitability. The sample and the details of how the study was conducted is described in Appendix I. Data was collected through a questionnaire which was completed by a member of the plant management with responsibility over manufacturing and/or technology.

This study provides evidence from 1,025 manufacturing plants about the use and benefits of bar code under certain conditions. Out of the total of 1,025 plants participating in this study, 505 or 49 percent said that they use bar codes. The study also asked users to indicate if they use bar codes with some skill, moderate skill or extreme skill. While these designations for the use of a technology are not precise yet they capture differences in the use of the technology. For example, those who indicate that they use a particular technology in an extremely skilled manner, must be extremely satisfied with their use of the technology and must feel that they are getting all they could from the use of the said technology.

The performance of the 505 bar code users is summarized in Table 1 below.

TABLE 1

ALL BAR CODE USERS
(n=505; 49.2% of all respondents)

Average	Performance*	
1	Sales per employee	$155k
2	Rejection and Rework (% of manufacturing costs)	3.2%
3	Inventory turns	9.5
4	ROI	17.7%
5	Decrease in Average Manufacturing Costs	11%
6	Decrease in average cycle time	17.4%
7	Percent reporting decreased manufacturing costs	82.4%
8	Percent reporting decreased cycle time	84.3%

*NOTE: The survey gathered data on the use of 17 different technologies including bar codes. The benefits may be the cumulative result of more than one technology.

The performance of 520 non-users is summarized in Table 2.

TABLE 2

NON-USERS OF BAR CODES
(n=520; 50.8% of all respondents)

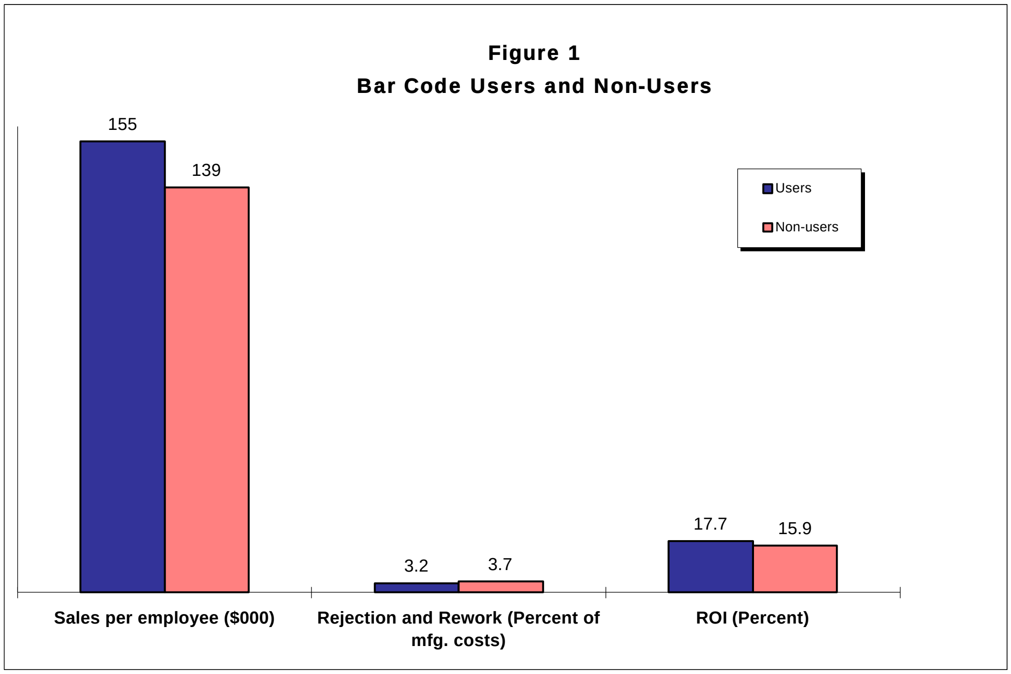
Average	Performance*	
1	Sales per employee	$139k
2	Rejection and Rework (% of manufacturing costs)	3.7%
3	Inventory turns	10
4	ROI	15.9%
5	Decrease in Average Manufacturing Costs	10%
6	Decrease in average cycle time	15%
7	Percent reporting decreased manufacturing costs	68.1%
8	Percent reporting decreased cycle time	70.2%

*NOTE: The survey gathered data on the use of 17 different technologies including bar codes. The benefits may be the cumulative result of more than one technology.

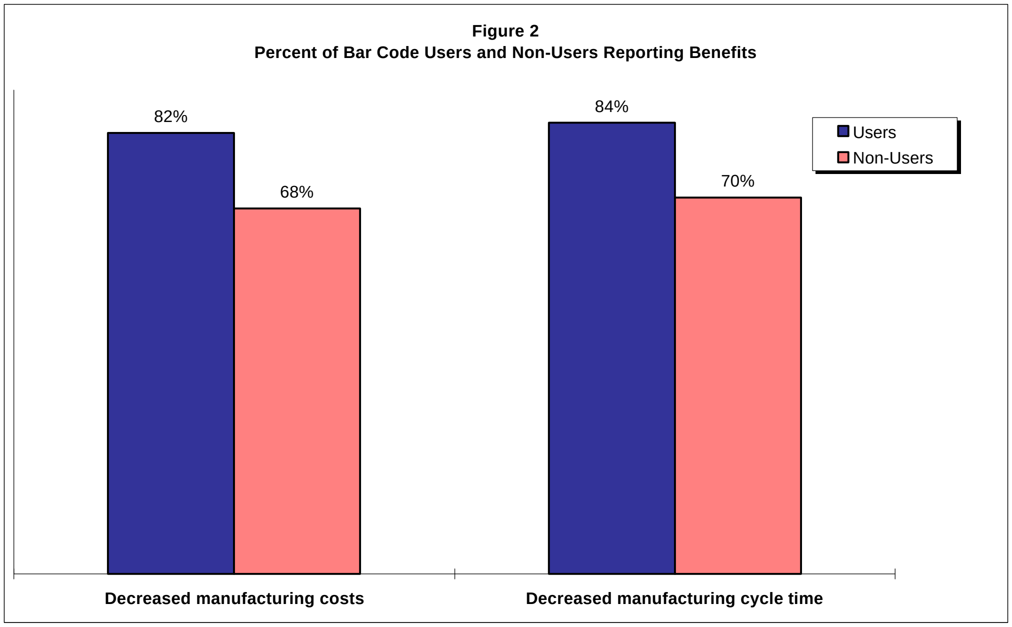
In reading the two tables, the reader must be aware that the study covered the use of 17 different technologies listed in Appendix II. While one may argue that the benefits of using bar codes are blended with the benefits accruing from the use other technologies, the averages across several hundred users reveal a pattern of benefits that can be assigned to a particular technology use such as bar codes.

Findings

According to Figure 1, bar code users report $16,000 more (or 11 percent better) in sales per employee over non-users, fewer rejection and rework, and about 10% better



return on investment. Additional comparisons in Figure 2 reveals that significantly more bar code users report decrease in manufacturing costs and cycle time. Thus, on five



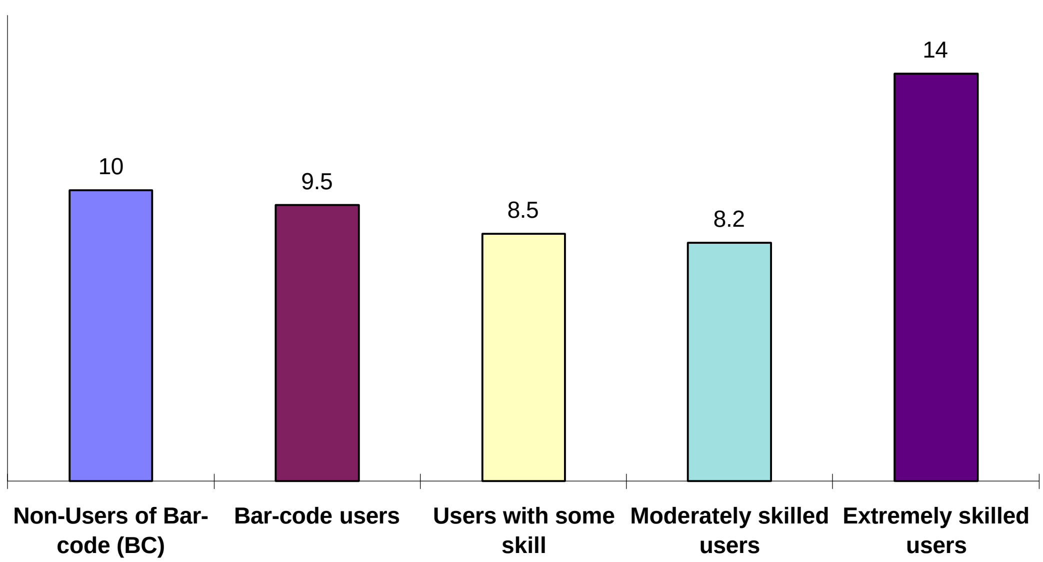
vastly different measures, bar code users are reporting superior performance over non-users. This should be taken as rather strong evidence that bar code users are indeed reaping benefits from the use of this technology.

Skilled Use Pays Off

Technology use is often not similar across factories; some factories may use a technology with moderate or limited skills while others may use it with extreme skill. It is logical to expect extremely skilled users of a technology to enjoy more benefits than those who use the same technology with lesser skill. But, do they?

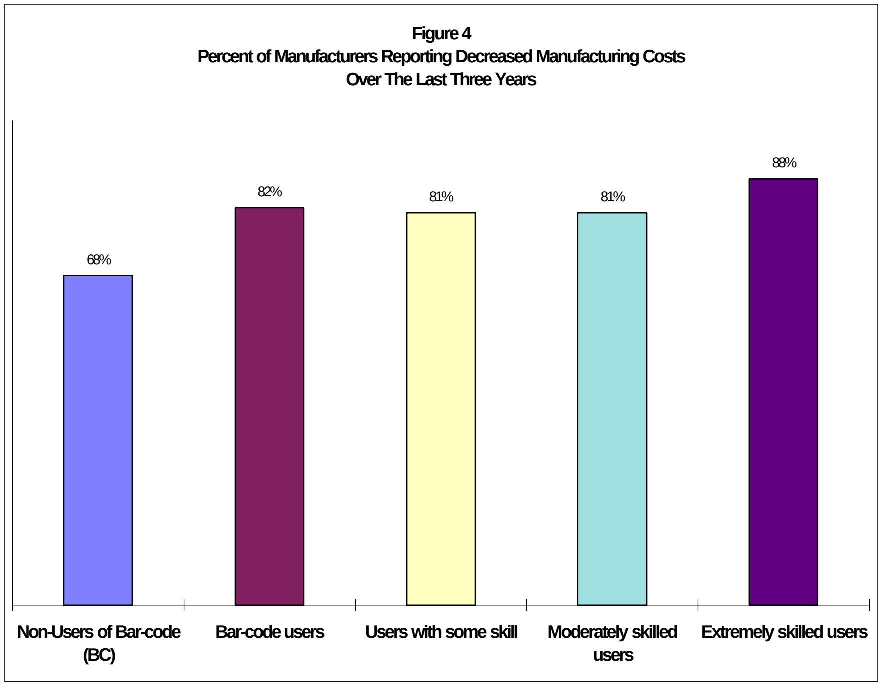
Inventory Turns. In Figure 3, we see that extremely skilled users of bar code technology report inventory turnovers of 14 while non-users report 10; 40 percent better. It is notable that non-users report better inventory turns than those who use

Figure 3
Extremely Skilled Use Boosts Inventory Turns



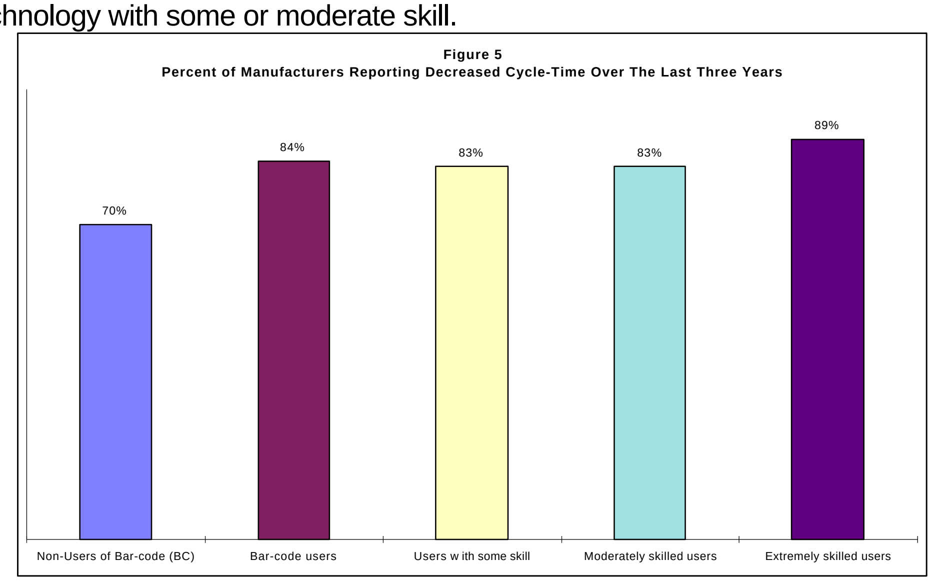
bar codes with some or moderate skill. In interpreting this finding, the following should be considered. Bar codes being enabling technologies, the use of bar codes enables the implementation of technologies such as JIT, SQC, CIM, automated inspection, CAD, CAM and many hard and soft technologies. Thus, if bar codes are not used with extreme skill, the use of several other technologies may suffer and inventory turns may not improve. The conclusion to draw here is that, factories using bar codes must consider using it with extreme skill, that is, use it in such a manner as to get the most out of its use.

Decreased Manufacturing Costs. In Figure 4, we see that 82 percent of bar code users report decreased manufacturing costs where as only 68 percent of non-bar code users experience decrease in manufacturing costs. Notably, 88 percent of



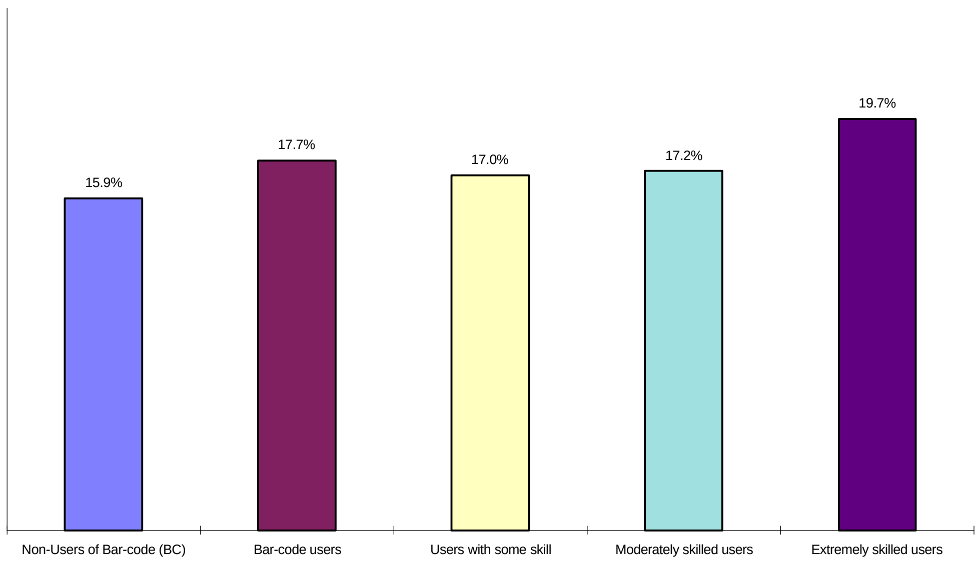
extremely skilled users of bar codes report decrease in manufacturing costs. This confirms the above finding that extremely skilled use of bar codes leads to better performance.

Decreased Cycle Time. Once again, Figure 5 confirms that extremely skilled users of bar codes experience decreased cycle time more often than those who use the technology with some or moderate skill.



Return On Investment. Finally, bar code users report better return on investment than non-users (Figure 6). But, extremely skilled users report far superior return on investment than those who use the technology with some or moderate skills.

Figure 6
ROI Improves With Skilled Use



Additional information on bar code users with varying skills is provided in Tables 3 through 5. The evidence in Figures 1 though 6 very convincingly favor the use of bar codes with extreme skill. The reward for extremely skilled use of bar codes is reflected in five different performance measures.

TABLE 3

BAR CODE USERS WITH SOME SKILL
(n=202)

Average	Performance*	
1	Sales per employee	$157k
2	Rejection and Rework (% of manufacturing costs)	3.5%
3	Inventory turns	8.5
4	ROI	17.0%
5	Decrease in Average Manufacturing Costs	10%
6	Decrease in average cycle time	18%
7	Percent reporting decreased manufacturing costs	81.2%
8	Percent reporting decreased cycle time	83.2%

*NOTE: The survey gathered data on the use of 17 different technologies including bar codes. The benefits may be the cumulative result of more than one technology.

TABLE 4

BAR CODE USERS WITH MODERATE SKILL
(n=190)

Average	Performance*	
1	Sales per employee	$151k
2	Rejection and Rework (% of manufacturing costs)	2.7%
3	Inventory turns	8.2
4	ROI	17.2%
5	Decrease in Average Manufacturing Costs	11.2%
6	Decrease in average cycle time	18.0%
7	Percent reporting decreased manufacturing costs	80.5%
8	Percent reporting decreased cycle time	82.6%

*NOTE: The survey gathered data on the use of 17 different technologies including bar codes. The benefits may be the cumulative result of more than one technology.

TABLE 5

EXTREMELY SKILLED USERS OF BAR CODES
(n=113)

Average	Performance*	
1	Sales per employee	$157k
2	Rejection and Rework (% of manufacturing costs)	3.5%
3	Inventory turns	14.0
4	ROI	19.7%
5	Decrease in Average Manufacturing Costs	11.6%
6	Decrease in average cycle time	15.2%
7	Percent reporting decreased manufacturing costs	87.6%
8	Percent reporting decreased cycle time	89.3%

*NOTE: The survey gathered data on the use of 17 different technologies including bar codes. The benefits may be the cumulative result of more than one technology.

Appendix 1

DATA COLLECTION

The sample

This is a study of individual manufacturing **plants**, **not** a study of manufacturing **firms**. The questionnaire in Appendix II was sent in late June 1997 to 6,123 member firms of the National Association of Manufacturers (NAM) presumed to manufacture goods complying with SIC industrial classifications 3400 through 3899; some responses showed that the plants did not belong to this range of industry. A letter from Jerry Jasinowski, the president of NAM, explaining the purpose of the study accompanied the survey questionnaires. The second mailing was sent six weeks later to those who did not respond to the first mailing. A week after each mailing one phone call was made to remind the recipients.

Response

Responses from SIC 3400-3899	1,025 (usable)
Responses from wrong industries	122 (10.63% not useable)
Total responses	1,147
Questionnaires sent	6,123
Projected wrong industries	-650 (10.63% of 6123)
Declined to participate over the phone	-624
Declined to participate through mail	-57
Late (after Oct. 20, cut off date)	-6
Potential number of responses	4,786

Response rate	1025/4786 = 21.4%

Split Sample

To examine the validity of the responses, we compared the responses to the first and the second mailings. After mailing the questionnaire followed by a phone call, we received 428 usable responses; this formed the first "half" of the split sample. To increase the responses and to acquire the second "half" of the sample, we sent the entire questionnaire again to those firms that did not respond to the first mailing or declined to participate. The second mailing followed by a phone call resulted in 597 usable responses. Thus, the total usable response is 1025; the resulting response rate being 21.4 percent.

In Table A1, we present the averages for nine major variables from the two samples for comparison. The similarity of the averages is an indication the lack of significant bias in the total sample. **All subsequent analyses were performed by pooling the two split samples into one pooled sample of 1,025.**

Table A1

Statistics For The First And Second Samples

	First	Second	Total	Sample
Sample size (usable)	428	597	1025	
1. Sales ($000,000)*	38.4 (n=396)**	31.7 (n=542)	34.5	(n=938)
2. Employment*	157.9 (n=414)	173 (n=584)	166.7	(n=998)
3. Sales/employee ($000)	156 (n=389)	140 (n=537)	147	(n=926)
4. Rejection (%)	3.9	3.2	3.5	
5. Inventory turns	10.6	9.3	9.7	
6. Product lines	30.5	28	28.8	
7. Average lead-time (weeks)	8.0	7.1	7.4	
8. Direct labor cost as percent of sales	19	20.3	19.8	
9. Return on investment (%)	16.8	16.8	16.8	
10. Training budget as percent of payroll	4.9	5.1	5.0	
11. Design and shop floor computer integration (%)	47.8	49.2	48.4	

* Averages exclude outliers.
** Averages based on the number of firms (n) reporting.

Distribution by plant size (employment): Table A2 below compares the distribution of plants by size in the split samples. The two samples are very similar on the basis of this comparison; no particular bias is evident.

Table A2

Distribution of Respondents by Size in the Split Samples
(Excluding outliers and miscellaneous manufacturing)

Employment	Sample 1 Respondents	%	Sample 2 Respondents	%	Total Respondents	%
Less than 100	243	58.6%	327	55.9%	570	57.1%
100-499	145	35.0%	214	36.6%	359	36.0%
500+	26	6.3%	43	7.4%	69	6.9%
Total Providing Employment Data	414	99.9%	584	99.9%	998	100.0%
Total Responding	**428**		**597**		**1025**	

Data Validation: The industries covered by this study are identical to those covered by a Bureau of Census (BOC) study published in 1994. The BOC study estimated the total number of plants in the U.S. with 20 or more employees in each industrial classification covered by the study. Table A3 compares the distribution of plants in this study with the distribution of plants in the BOC study on the basis of size (employment). The NAM study is slightly biased towards larger plants. The distribution of plants in the NAM 101 is closer to the BOC sample. It is important to note that plants with 0-99 employees are the largest sub-group in all samples considered. The 1997 sample is closer to the BOC sample than the 1993 sample.

Table A3

Distribution by Size

Employment	All firms 1993 Survey	All firms 1997 Survey	NAM 101 1997	Bureau of Census*
Less than 100 Employees	53.2%	58.2%	64.4%	71%
100 or more Employees	46.8%	41.8%	35.6%	29%

*Source: Bureau of Census, *Manufacturing Technology: Prevalence and Plans for use 1993*. Current Industrial Reports SMT (93)-3, November 1994.

NOTE: There is a small chance that some of the small plants participating in the study belong to larger firms. The chance of the opposite, that is, larger plants from small firms participating in this study, is even smaller; if a small firm had larger plants, the firm would have been classified as a larger firm. **Throughout this report we mention separate figures for small and larger plants for the benefit of both groups. As expected at the termination of the last study, the response from small firms has grown in this iteration of the study because firms of all sizes can see and appreciate the relevance of the results published here.** Small plants use technologies less often than larger plants but **small plants do use most technologies, and this report demonstrates that it is worth studying technology use and trends in plants of all sizes**.

Industry: In Table A4 below, we compare the distribution of plants by SIC classification with the BOC study serving as the reference. Table A4, shows that the distribution of manufacturing establishments in the U.S. is roughly comparable to the distribution of the respondents to this study with a slight bias towards SIC 34 (metal fabrication industry) in the NAM sample. The industrial composition of NAM 101 is closer to the BOC sample than the entire sample.

Table A4

Industrial affiliations of all respondents and the NAM 101

Industry	1997 All Respondents	NAM 101	Bureau of Census*
34-Metal Fabrication	46.2%	37.6%	30.7%
35-Machinery	28.2%	43.6%	33.1%
36-Electrical	12.2%	9.9%	17.4%
37-Transportation	8.7%	5.0%	9.6%
38-Instruments and Photo	4.7%	4.0%	9.3%

*Source: Bureau of Census, *Manufacturing Technology: Prevalence and Plans for use 1993*. Current Industrial Reports SMT (93)-3, November 1994.

Appendix 2

List of Technologies Covered by the Study

Hard technologies investigated

The Technology		*Explanation Where Needed*
1.	Automated inspection	
2.	CAD ...	Computer aided design
3.	CAM ...	Computer aided manufacturing including programmable automation of single or multi-machine systems.
4.	CIM ...	Computer integrated manufacturing.
5.	CNC ...	Machines with computerized numerical control
6.	LAN ...	Local area networks
7.	FMS ...	Flexible manufacturing systems; automated multi-machine systems linked by an automated material handling system.
8.	Robots	All kinds of robots.

Soft technologies investigated

1.	Bar Codes	
2.	Concurrent Engineering	
3.	JIT ...	Just-in-time manufacturing
4.	Manufacturing cells	
5.	MRP ...	Material requirements planning
6.	MRP II …	Manufacturing resource planning
7.	SQC ...	Statistical quality control
8.	Simulation and Modeling	
9.	TQM ...	Total quality management.