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Comparing Manufacturing Practices in North America and Western Europe: Are There Any Surprises?

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Abstract
This research tests the broad hypothesis (using data from the Global Manufacturing Research Group) that there are few significant differences in the manufacturing practices of Western Europe and North America. The hypothesis holds for the stringent test used in this paper to disclose the differences. In general, no surprises were uncovered, but knowledge of the differences that were found could be of importance to some firms.

1. INTRODUCTION

The Global Manufacturing Practices Project began in 1986. It involves gathering and analyzing data on manufacturing practices around the world. The data comes from companies in two industries: non-fashion textiles and small machine tools, industries found virtually everywhere in the world. Information obtained from surveys in North America, Australia, Chile, the People's Republic of China, Finland, Hungary, Japan, Mexico, Korea, the former USSR (Russia) and Western Europe is now contained in the project's data base.

A continuing theme in the analysis of the data is the comparison of practices between various regions, although many other questions have been raised [1]. Most of these comparisons have involved regions expected to be quite different (Korea and Europe [2] or Korea and China [3], for example). This paper reports a comparison of manufacturing practices in North America with those in Western Europe, two regions that are highly developed, quite industrialized, and are very close to each other culturally.

2. THE DATA

The North American data analyzed in this paper was gathered in four regions of the United States and in Canada. Canada and the Western U.S. region, are slightly under-represented, but the remainder of the sample distribution is similar to the population distribution of firms. The Western European sample comes from 10 countries, all from the most developed northern part of Western Europe. Thus, it is not representative of all of Western Europe. The distribution of the sample by region and industry is provided in Table 1.

Table 1
Distribution of the Sampled Companies by Region and Industry Group

Region	Machine Tool	Textile	Total
North America	45	50	95
Western Europe	34	24	58
Total	79	74	153

The questionnaire used for gathering the data on manufacturing practices contains 65 questions, mainly concerned with material planning and control. There are 95 original variables and others were derived for the study. Some of the derived variables describe relationtionships between original variables (for example, sales per employee or inventory turnover). Others result from individually analyzing each possible response of a multiple response question (e.g., how do you increase capacity?, overtime, hire, etc.). The variables are associated with the five sections of the questionnaire, as shown in Table 2.

3. STRUCTURE OF THE ANALYSIS

The research reported in this paper uses an analytical framework specifically developed for bilateral comparisons using the project's data base [4]. The procedure starts by analyzing the two regions within an industry (e.g., comparing the North American machine tool (textile) companies with the Western European machine tool (textile) companies). The statistical differences between the responses were tested using the procedure appropriate to the nature of the variable.

The procedure requires a "pure effect" to declare a significant difference between the two regions. There is a pure regional effect present for a variable if there are significant (.07

Table 2
Distribution of the Variables by Section of the Questionnaire

Questionnaire Section	Total Variables	Number Significant
Company Profile	16	3
Sales Forecasting	15	0
Production Planning	27	2
Shop Floor Control	47	4
Purchasing and Materials Management	14	0
Total	119	9

or less) differences in *both* industries and the differences are in the *same* direction for each. For example, a pure regional effect exists if a variable's mean value is significantly higher in North America than in Western Europe for both industries or if the proportion of responses for a certain practice is higher for one of the regions in both industries.

Applying this stringent test to the data means that only nine variables are determined to have different responses between the regions. The distribution of those variables among the sections of the questionnaire is shown in Table 2. Only those nine variables are discussed here. The complete statistical analysis can be found in [5].

4. RESULTS

The results of the analysis will be presented in the order presented in Table 2. The first section contains general data on the companies. All these variables are ratio scaled suggesting use of the Student's t-distribution to assess significant differences between mean responses. The normality and homoscedasticity assumptions required for the t-test aren't met, so a Kruskal-Wallis nonparametric one way analysis of variance was used instead. The results for the three variables that have a pure regional effect are shown in Table 3.

The Western European companies' export sales are greater, on the average, than the North American ones (e.g., NAM < WEM *and* NAT < WET). Similarly, a higher portion of total sales is exported by Western European firms than those in North America. The Western European export activity is greater than the North American. The capacity utilization is higher in Western Europe as well.

There was both an ordinal and nominal variable that was significant for the production planning section of the questionnaire. The Kolmogorov-Smirnov test was used for analyzing the differences in the variables measured on an ordinal scale. For the nominal scale variables two methods were used. If the assumptions were met, the chi-square test of homogeneity was used. If not, the binomial test was used to evaluate the differences in the proportions of responses for an individual response category. Both tests required combining responses for some choices into an "other" category in order to make the comparison.

Table 3
Kruskal-Wallis Significance and Mean Values for the Significant General Data Variables

Variable	NAM	WEM	SigM	NAT	WET	SigT
Export Sales (Million $)	2.81	24.10	0.013	2.12	9.55	0.021
Export Sales/Total Sales	0.143	0.367	0.001	0.118	0.271	0.023
Capacity Utilization (%)	71.40	76.93	0.051	76.43	81.96	0.006

Note: NAM and WEM are North American and Western European machine tool, NAT and WET are textile. SigM and SigT are significance levels for the differences in each.

Table 4
Modal Responses and Significance Levels for Significant Production Planning Variables

Variable	NAM	WEM	SigM	NAT	WET	SigT
Production Planner's Education	College	High School	0.000	College	High School	0.000
Two Uses of the Production Plan	Manpower, Inventory Planning & Operation Scheduling	Facility Planning & Operation Scheduling	0.000	Operation Sched. & Inventory Planning	Subcon-tracting & Facility Planning	0.000

Table 4 shows the two variables, their modal responses and the significance levels for the appropriate test. North American firms have more production planners with college training than Western European companies. This result is likely a workplace reflection of the differences between the European and the American formal education systems. Another difference is the European apprentice system which places some young people in a program of practical skills training and work experience as preparation for a job in a manufacturing company. People from this program would be classed as primary or, at best, high school graduates, which could greatly understate their manufacturing skills.

There are also regional differences in what the firms consider the two most important uses of the production plan. (For this variable, a binomial test was required since the assumptions were not met for the Chi-square test.) In North America, operations scheduling is combined with inventory or manpower planning while facility planning is combined with subcontracting or operations scheduling in Western Europe. Strengthening the pure regional effect is the observation that the combination of subcontracting and facility planning is not mentioned by North American firms while being the modal choice for the Western European textile (WET) firms.

The shop floor control section of the questionnaire had four significant variables. The modal choices for all of these are indicated in Table 5. A Kolmogorov-Smirnov test was used for each of the comparisons. Even though the modal choices are the same, the Western European firms have a higher percentage of product costs based on time standards. Again, it's hard to tell from the modal response, but the accuracy of the time standards is higher for Western European firms as well.

Two questions in this section had more complicated responses than any others in the questionnaire. One of these had to do with the factors that changed priorities once an order was being produced, the other with means for changing capacity. The responses gave an importance weight for several alternatives. For these questions, the distribution of weights for each of the possible responses was analyzed separately for each alternative.

Table 5
Modal Responses and Confidence Levels for the Significant Shop Floor Control Variables

Variable	NAM	WEM	SigM	NAT	WET	SigT
Costs Based on Time Standards	90+%	90+%	0.034	90+%	90+%	0.068
Accuracy of Time Standards	Sometimes	Sometimes	0.016	Sometimes	Close to actual	0.023
Due Date Changes Change Shop Priorities	High	Low	0.067	Medium	Medium	0.050
Lay Off Extra Workers to Change Capacity	High	Not Useful	0.031	High	Not Useful	0.001

Only one factor that affected priority on an order (once production has started) was significant, changes in delivery date. Table 5 gives the modal weights (high, medium or low) for the variable's influence on priorities. The delivery date changes have a heavier weight in changing the priorities in North American firms than in Western European ones.

The modal weights (high, moderate, not useful) for laying off workers to increase or decrease capacity are also shown in Tables 5. It is an important alternative in the North American firms, while it is not useful in the Western European ones.

5. SUMMARY AND DISCUSSION

Perhaps the most important observation, using the pure regional effect criterion, is that fewer than 10% of the 119 variables analyzed were found to be significantly different between the regions. Furthermore, of the nine significant variables, three come from the General Data section and four come from the section of the questionnaire covering the most detailed aspects of manufacturing practices, Shop Floor Control. No differences at all were found for any of the variables in the Sales Forecasting or the Purchasing and Materials Management sections. Thus the manufacturing practices of Western Europe and North America are much more similar than different.

Never-the-less, the differences that were found could be of importance to firms trying to establish joint ventures or other forms of manufacturing cooperation. They seem to reflect three general attributes that may be more important in many other respects than manufacturing practices. Those attributes are external orientation, asset (including human) utilization and management of details.

With regard to external orientation, it is not surprising that the Western European firms have both higher proportions and absolute levels of exports sales. This focus on international markets is a product of geographical proximity to other countries, small domestic

markets and a long history of international commerce among the European nations. Given this, it is surprising that the North American firms are significantly better at letting external events impact internal operations by giving more weight to delivery date changes in setting priorities on the shop floor. American managers will find potential European partners more experienced and sophisticated in dealing internationally, but perhaps more reticent to let "outsiders" influence manufacturing.

European firms have always had a concern for the design, maintenance and use of capital equipment. This is illustrated, for example, by the historical quality image of European machine tools. This concern apparently extends to human capital as well. In North American firms, plant utilization is lower and the inclination to lay people off is higher than in Western Europe. European managers may find their American counterparts more callous than they would be in this regard.

The apparent openness to external markets and a more closed internal manufacturing orientation among Western European firms is underscored by their attention to manufacturing detail. Both the accuracy of time standards and their use for product costing are higher there than in North America. While the production plan is used for inventory planning in both regions, in Europe it is also used for facility planning and subcontracting. In contrast the North American firms use the production plan for short-term internal operational concerns, like scheduling and manpower planning. Those internal details are worked out by manufacturing in the Western European firms. Even the background of the planner is different in the two regions. The planner is more likely to have a college degree in the American firms, while a high school degree (with knowledge of the manufacturing details) will suffice in Europe. American managers should expect their European counterparts more willing and able to deal in the details of manufacturing than they would be.

6. REFERENCES

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