

## **THE INTERNET AND ITS IMPACT ON BACK-OFFICE ACTIVITIES AND PROCESSES: WHAT USE BRAZILIAN MANUFACTURING COMPANIES MAKE OF THE WEB?**

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# THE INTERNET AND ITS IMPACT ON BACK-OFFICE ACTIVITIES AND PROCESSES: WHAT USE BRAZILIAN MANUFACTURING COMPANIES MAKE OF THE WEB?

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## **ABSTRACT**

This paper deals with the way manufacturing organizations use the Internet and other information technologies in their design and production activities. Special focus is given to the virtualization of activities and business processes. The authors surveyed 665 companies in the state of Sao Paulo, Brazil, questioning them about the impact of the Internet on the way they conduct their businesses. The data that was collected was tabulated and submitted to quantitative analysis, in order to draw conclusions that could, eventually, be generalized to the population of Brazilian manufacturing enterprises.

## **Keywords:**

Internet, design, manufacturing

## **INTRODUCTION**

The Internet's expansion has been responsible for the growth of electronic commerce, affecting the way companies do business with consumers (B2C) and with other companies that are their commercial partners (B2B). The use of the Web for commercial transactions and as a new channel for the communication with suppliers and customers is increasing at large steps, due to its convenience and simplicity, and as an alternative to the traditional ways of trading and communicating along the value chain. Most of the buy-sell front-end activities have been well analyzed by practitioners and academia during the last few years, but the authors of this paper believe that other important effects of the use of the Internet, particularly those concerning back-end processes, may have been overlooked and deserve to be better studied and understood.

This paper presents the results of an e-survey that was carried out with manufacturing companies in order to identify how they use the Internet to improve their businesses. The questionnaire was answered by 665 manufacturers in the state of Sao Paulo, the most important industrial area in Brazil, late in 2003.

### METHODOLOGICAL APPROACH

Companies were contacted through an e-mail message that had an attached MS Word automated form. Although the questionnaire had 75 structured click-on questions and other 60 fields for additional information in textual form, it was conceived in a way that it wouldn't take more than 15 minutes to fill-in, in most cases. That allowed for a good return rate (approximately 7% of the addressed companies returned valid answers).

The structured questions followed a Likert scale, when appropriate. In other cases, they were just check-boxes, which could be easily selected or de-selected, increasing the speed of answering the questionnaire. The authors wanted the questionnaire to be simple enough to be filled in at the time the respondents were checking their e-mail. If it were left to be answered at a later time, the authors believed chances of obtaining an answer would dramatically decrease. In fact, that was noticeable: most reply e-mails arrived in a matter of one or two days. Only a small percentage spread along the next week or so. Very seldom a message took longer than that to be answered. Each company that didn't answer after two weeks was sent a second message, in which the authors asked again for their contribution. The reply pattern for the second message, with respect to the distribution in time, was similar to the one for the original message, but with an amplification effect (see Figure 1). The authors believe that many respondents were willing to answer the questionnaire, but were postponing the task. When they received a second request message, it triggered immediate response.

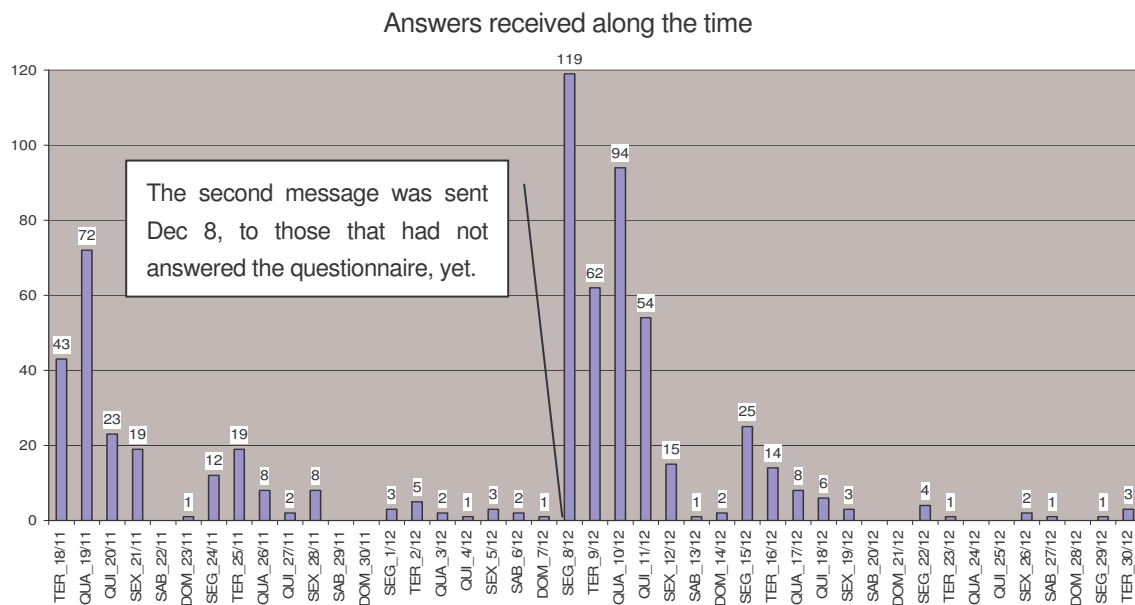


Figure 1

Figures 2 and 3, below, show examples of questions that were built as drop-down fields in the MS Word form, in order to save space and allow for faster answer. A drop-down field is one that has to be clicked on, in order for the alternatives to appear.

Figure 2 shows an example of a drop-down field used in the survey for questions about the intensity of use of several different communication tools made available by the Internet, e.g., e-mail, chat, video-conferencing, web-forums, discussion lists etc.

Figure 3 shows an example of a drop-down field used for questions about the impact of the Internet and other IT on the company's processes and activities, over the last three years. Such questions referred to the purchase of direct and indirect materials, logistics coordination, supply chain integration, design of products and processes, pre-sale and after-sale support, configuration and customization of products and services, among others.

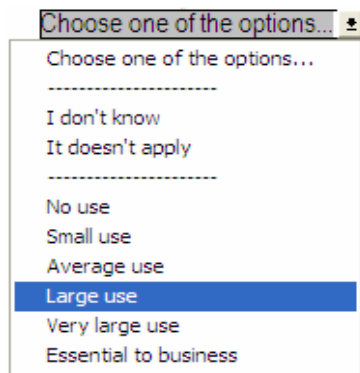


Figure 2

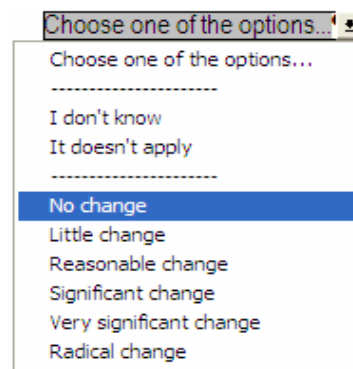


Figure 3

There were also questions about technologies, methods and techniques that the company intended to use in the near future, based on the infrastructure made available by the web.

A "digital questionnaire" like the one that was used for this e-survey also has another important advantage: it is easy to compile and tabulate the data, making the whole process cheaper and faster, and reducing the incidence of errors.

### ***Pre-test***

The questionnaire was pre-tested, with respect to the content, having been presented to a group of executives working in the field, who happened to be taking a course at FGV-EAESP. They gave important contribution in order to make the questions more accessible and understandable to the "real" participants in a later stage. With respect to the format, the authors randomly chose one hundred companies from the database to which the questionnaire was sent a month in advance. No changes in format were necessary, after the pre-test answers arrived, except for the decision to send a Word 95 version of the form, instead of a Word XP version, as originally intended. The reason for that was that users of Word XP and other more recent versions of the word processor would still be able to read the survey, while users of Word 95 would not be left out. Another advantage of having carried out this pre-test survey was that, by the time the larger group of companies was invited to participate in the survey, the researchers already had a reasonable idea of the return rate that they could expect for the questionnaire.

### ***Convenience sample***

The Federation of Manufacturers of the State of Sao Paulo (FIESP) had a database containing contact information for 15279 manufacturing companies in the state. Approximately 75% of those had an e-mail address in the database. Cohen (2003) had previously used that database for an e-survey and had found that more than 10% of the e-

mail addresses were wrong. In spite of that, he could still obtain a return rate of ca. 4%, which he considered good for a reasonably long questionnaire and after having had problems with the mailer software, which may have prevented some companies from receiving his original message. Cohen's previous work provided an idea of the number of responses that one could expect if addressing the companies in the same database. His advice was also important to even improve the good results he had already achieved with his e-survey. In spite of the deterioration of the quality of the database (30% of the e-mails were found to have changed, by the time this survey was released), 665 responses were finally obtained, representing ca. 7% of the number of messages that went through.

A  $\chi^2$  test was performed, confronting the proportions of "small", "middle size" and "large" companies that answered the survey (sample) with the companies with an e-mail address in the database (population).  $\chi^2$  was found to be 0,906, with p-value=0,636, indicating excellent fit.

### ***Data statistic handling***

A preliminary analysis of the tabulated data was carried out with MS Excel, consisting in using Pivot Table features to count the number of occurrences of each possible answer, for each of the questions, so that bar and pie graphs could be drawn (available at request).

After that, tabulated data were handled with Minitab, in order to achieve a better view of the observed reality and, eventually, to point out patterns that were typical of a specific sector, or of companies of a certain size or which had some common characteristic. Up to the current stage of the research project, which hasn't been concluded yet, the researchers have been able to find out important relationships among size and intensity of use of the Internet and other technologies and methods it supports.

The next section will use box-plots to show the results of the survey. Box-plots (also known as *box & whisker* graphs) are a strong visual representation of information about a collection of data, because they allow for immediate acknowledgement of quartiles, median and outlier observations, with respect to a particular sample. The "whisker" above the central box represents the 1<sup>st</sup> quartile of data, the upper part of the box represents the 2<sup>nd</sup> quartile, the lower part of the box represents the 3<sup>rd</sup> quartile and the lower "whisker" represents the 4<sup>th</sup> quartile. An asterisk, either above the 1<sup>st</sup> quartile or below the 4<sup>th</sup> quartile, indicates the existence of one or more observations that were not included in the diagram because they are too different from the others. The box-plots discriminated small, middle-size and large companies. As they weren't evenly represented in the sample<sup>1</sup>, the generated boxes were narrower for the representation of large companies (fewer observations in the sample) and wider for small companies (present in a greater rate in the sample).

### **ANALYSIS OF THE RESULTS**

The first thing that needed to be understood was the way companies accessed the web. There are several possible ways of doing that. The most basic and less costly is the dialed connection through a regular telephone line, using a free or a paid provider. Dialed connections are slow to an extent they become unacceptable for companies that make intensive use of the Internet. ISDN, xDSL and cable are alternatives to a dialed connection. All of them provide a faster connection, usually known as "broad band".

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<sup>1</sup> The responses of 22 large companies, 146 middle size companies and 443 small companies were taken into consideration for the construction of most of the box-plots.

It was found that the majority of the organizations that answered the survey had broad band access to the web. There is currently a trend of replacement of slow connection arrangements by broad band services, in Brazil. According to Chiarini (2003), users of broad band services, who were 53 thousand in 1999, were close to a million in July 2003.

Figure 4 shows that only ca. 20% (1.7% + 18.4%) of the participants in the survey use dialed connections to have access to the web.

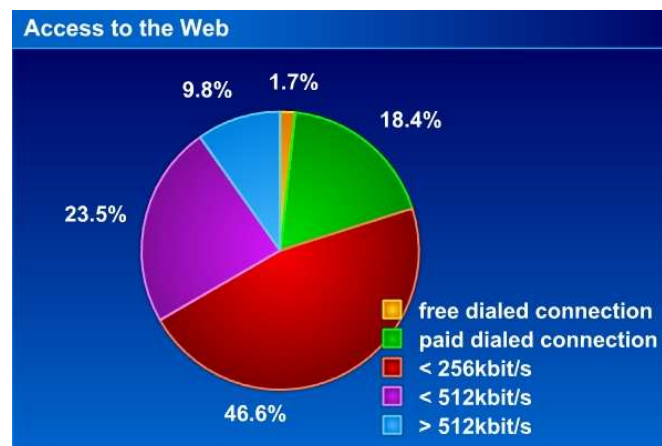


Figure 4

The type of access to the web varies a lot and is related to company size. Small companies tend to use slower connections, while larger companies have broad band connections in a higher rate.

Figure 5 shows a box-plot diagram summarizing the information on the type of access to the web, based on the company's size, which has proven to be important in determining the company's type of access to the web. 100% of the large companies use broad band connections, with high concentration of observations at the top of the scale (note that the box-plot's upper whisker doesn't even show, indicating a very high concentration of companies with fast connections). On the other hand, the distribution is more disperse among small companies.

#### ***Existence of a web site and an Internet domain***

Companies were requested to state if they had a web site and where it was hosted. The researchers also wanted to know if the companies had their own e-mail server, i.e., if the e-mail addresses of their personnel were followed by @name\_of\_the\_company. The existence and use of the intranet and extranet were also questioned.

It was also important to know the size of the company. Although 42% of the small companies already have an intranet, among large companies, that service is available in almost all cases (91% of the observations). Extranets are also more popular among large companies than small, although there is plenty of improvement opportunity for companies of all sizes. Among large companies, 100% have their own e-mail server. Small companies also perform well, with respect to that matter: 76% of them have an e-mail address that takes the name of the company after the @ symbol. A large percentage of companies have their own domain (88% of the total) where they convey their web sites.

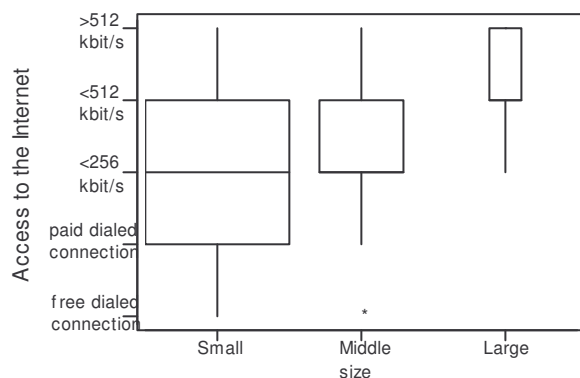
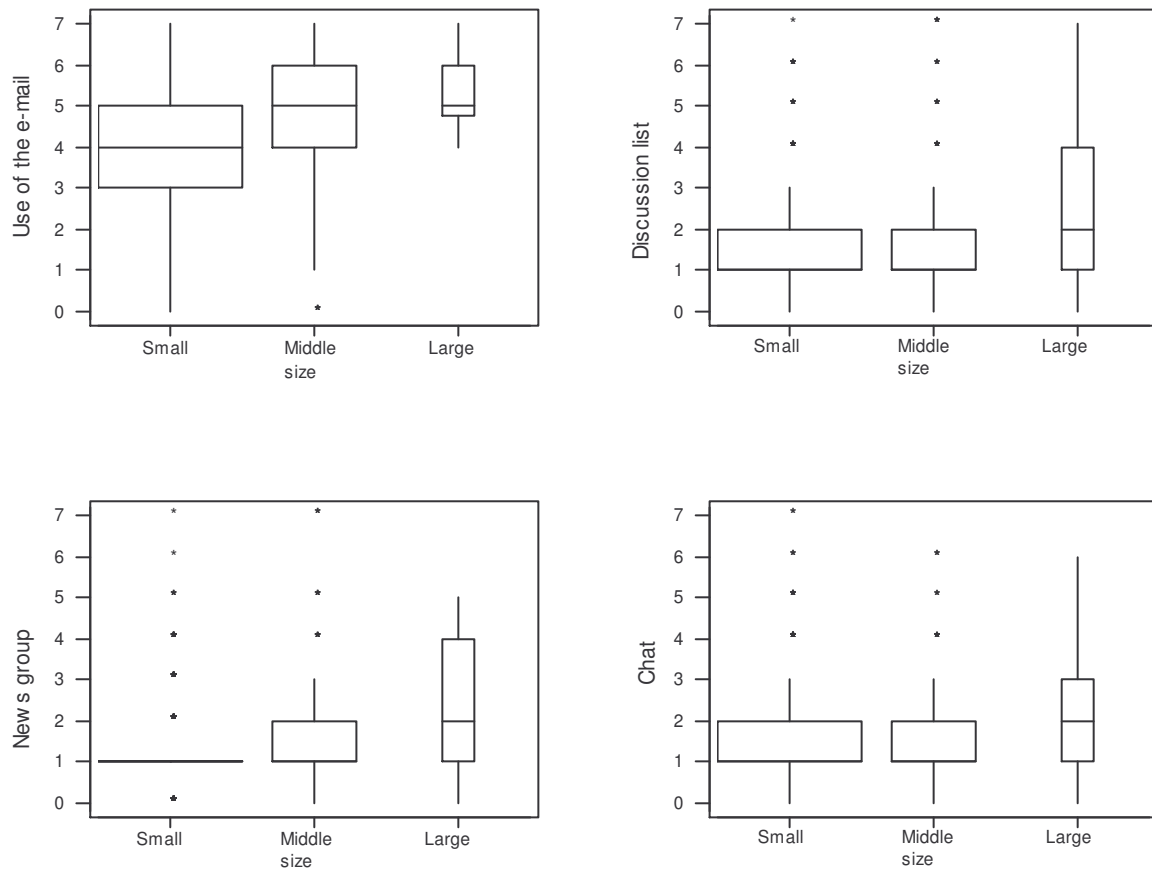


Figure 5

Albertin (1999) stresses the fact that one of the first things a company does, when it creates its web site, and prior to knowing how to benefit from the Internet's potential, is to use it to present the company's products and services. In that initial stage, according to Graeml, Graemle and Steil (2001), the web sites work more as "windows" to display products than as "cashiers" to execute transactions. Many companies that participated in the survey are still in this initial stage of adoption of the new technology. Respondents use their sites to build the institutional image of the organization and to advertise products (85.1% and 80.8%, respectively). That same behavior had already been depicted by Graeml, Beer and Csillag (2003), when they surveyed software companies in California, and by Vidal (2003), when he studied manufacturers in Sao Paulo. According to Brown (2003), companies' web sites become meaningless, from the revenue generation transactions' perspective, when they over-emphasize the presentation of institutional data and product advertisement. Only in a later stage companies start conceiving more effective strategies to integrate the web site to their processes and business practices.

Large companies have shown more concern about the use of the web site to provide (after-sale) user support and to get feedback from customers. Vidal (2003) had already detected a trend towards that. The organizations should, however, be paying more attention to the matter. The authors believe that providing more and better service to customers through the web is an effective weapon to differentiate the company's product from the competition's and achieve a competitive edge.

Companies were questioned about the intensity of use of several communication tools made available by the Internet. E-mail was, by far, the most disseminated tool (see Figure 6). Other communication tools that also rely on the Internet's infrastructure and that were evaluated by the respondents were discussion lists (only the top quartile is over moderate use, and that is only in the large companies' case), news groups, conference and chat (all of which presented very low levels of use).



0 – does not apply; 1 – no use; 2 – very little use; 3 – little use; 4 – moderate use; 5 – large use; 6 – very large use; 7 – essential to the business.

Figure 6

### ***Impacts of the Internet and other IT on the design of the product and the production process***

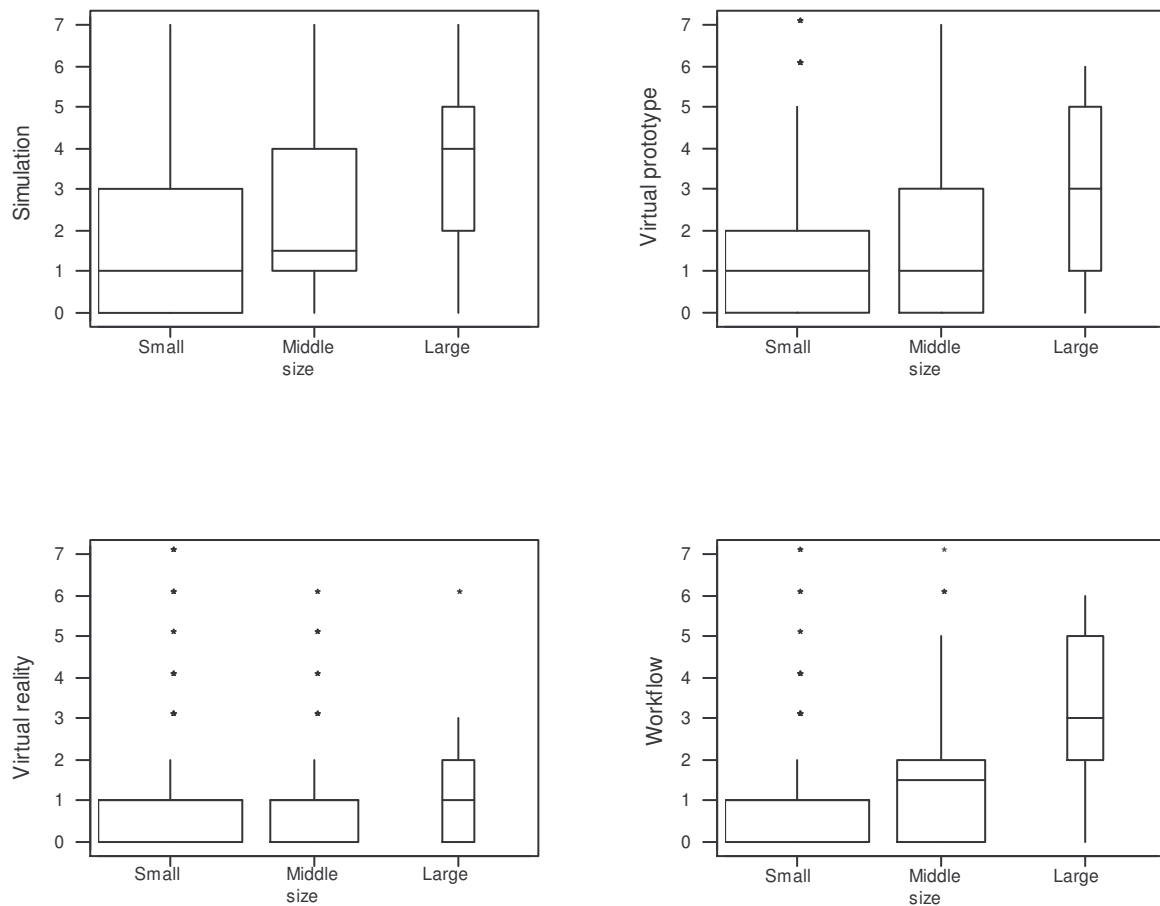
An important activity with which manufacturing companies are often involved is the development of new products. Kroo (1996), Jons (1997), Goldin, Venneri and Noor (1998), Boswell (1998), Ford and Sterman (1999), Kirkman *et al.* (2002), among others, discuss the possibilities and the advantage of developing collaborative design, carried out by teams of engineers using CAD and other software tools that allow for the creation of virtual models, prior to the execution of "physical" prototypes. Virtual prototyping, virtual reality and other techniques can be used to simulate situations that used to demand real models and mock-ups to be created. When these digital techniques are applied, computer files are generated with design information, which can be distributed through the Internet or other computer network. It becomes possible for team members to work together in a project, regardless of their physical location. That represents an important contribution of the Internet to improve product design, using simultaneous engineering (GRAEML and CSILLAG, 2003).

When questioned about the changes caused by the Internet and other IT to product and process design, about one fourth of the respondents claimed there was no change, whatsoever. On the other hand, 5% of the participants said change was very significant or even "radical". It will be important to monitor the evolution of this scenario, in order to see if that figure increases over time. Influence of size was not noticeable.



The percentage of participants claiming that they are not going to use any of the digital tools and techniques contained in the survey for their design activities (at least over the next 3 years) was also ca. 25%. Curiously, the incidence of “does not apply” responses increased in a considerable way, for the part of the questionnaire that dealt with specific techniques. It was around 15% for the generic questions and jumped to ca. 30% when questions addressed particular techniques such as “simulation”, “virtual prototyping”, “virtual reality” and “workflow” (see Figure 7). The incidence of “I don’t know” and blank responses also increased in a substantial way.

Analyzing the graphs on Figure 7, one notes that large companies have a better performance, but there is still a lot to be done, in order to explore the full potential of the new technologies. It is important to note that values 0 and 1 in the vertical scale refer to “does not apply” and “not going to use (next 3 years)”. Therefore, small and middle size companies have no experience with “virtual reality”, neither have small companies with “work flow”.



0 – does not apply; 1 – not going to use (next 3 years); 2 – will use over the next 3 years;  
 3 – very little use; 4 – little use; 5 – moderate use;  
 6 – large use; 7 – essential to the business.

Figure 7

**Impact of the Internet and other IT on manufacturing**

Manufacturing processes can be impacted on several different ways. Customers can customize products, choosing the configuration that best fits their needs, among those made available through the company’s web site. As a result, some methods and techniques that have been around for quite some time become more relevant, now. Tools and methods that contribute to production customization, agile manufacturing and just-in-time delivery should be looked at with special interest. They will help companies improve mix flexibility, speed and reliability, all of which are performance criteria that Slack *et al.*(1999) claim to be valued by customers.

Figure 8, shows the intensity of use (3 to 7 in the vertical scale), or the intention to use in the future (0 to 2) of some methods and techniques, included in the survey after the bibliography review or based on the authors’ experience. Once again, it is noticeable that the intensity of use of modularization, postponement and customization is related to the size of the company.

*Box-plots* of Figure 8 show that companies make limited use of such techniques and methods if compared to their actual possibilities. That reduces their capability of getting full benefit from the adoption of the Internet and other IT.

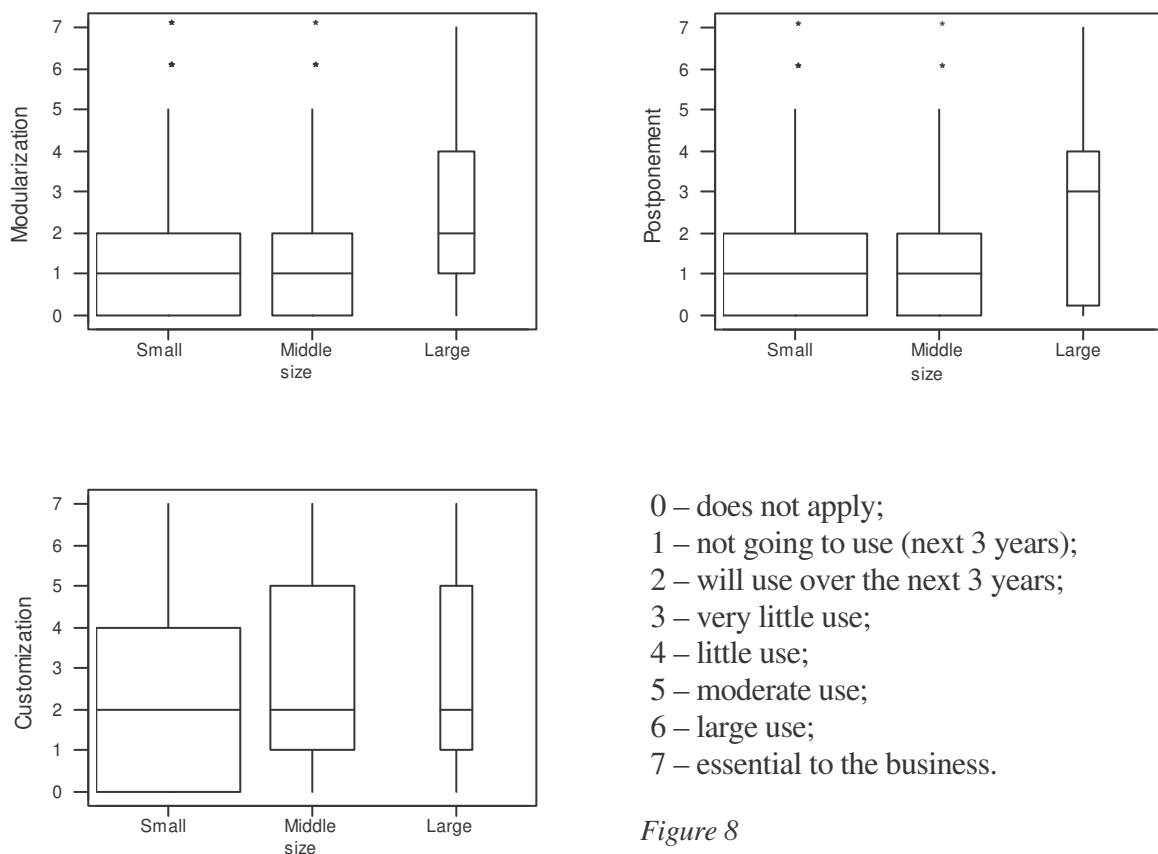


Figure 8

**MANAGERIAL IMPLICATIONS AND CONTRIBUTION TO THE FIELD**

The research project focused on depicting the impacts of the Internet and other IT on manufacturing, particularly those related to the virtualization of design activities and production customization. Statistics techniques were used in an attempt to find evidences of such effects building up. The researchers believed that if any of these effects were actually

present, it could represent the beginning of an “e-revolution” in the manufacturing sector, comparable to the B2C e-commerce hype of previous years, although probably more discrete. The managerial implications of the transformations caused by the Internet in the manufacturing industry are only now starting to become evident. Manufacturers are becoming concerned with the possibility of involving their customers and partners in the development of their own products and are integrating to suppliers and customers in a more thorough way. This survey has shown, however, that there is still a long way to go. Manufacturing organizations don't use the web to their benefit to the extent they could, as shown in the various box-plots, all of which are much closer to the bottom than to the top of the scale.

Although the major objective of the paper was to show how Brazilian manufacturing companies actually use the Internet to their advantage, trends were pointed out that may lead to the development of different products/services, different production processes (internal organization) and even different ways of relating to business partners (external organization), benefiting from the Internet's potential as a powerful communication and integration platform.

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