MANUFACTURING COMPANIES' PERCEPTION ON THE INTERNET'S IMPACT: FIVE MAJOR DRIVERS OF CHANGE

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Manufacturing Companies' Perception on the Internet's Impact: Five Major Drivers of Change

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Abstract

This paper reports the results of a survey about the perception of Brazilian manufacturers on the impacts of the Internet on the way they carry out their businesses. The authors attempted to relate the use of the Internet to the introduction of other practices and methods that, along side, contribute to the modification of the products and services that are offered to customers and the production processes that are used to achieve them. Data from over six hundred companies were analyzed, which responded to an electronic survey that was sent to the participants via e-mail. The answers were received back late in 2003 and early in 2004, having been tabulated and submitted to an exploratory factor analysis procedure, from which the authors identified the existence of 5 major drivers for Internet adoption, according to the perception of the participants: *customer orientation*, *customers' retention*, *logistics coordination*, *design virtualization* and *reverse auction*.

Keywords:

Internet, e-business, business/process change, manufacturing industry

Introduction

The e-business hype is over. Organizations have become much more conservative in their evaluation of Internet investments. Traditional financial targets are now associated with any new project from the beginning. A silent, much deeper revolution is, however, under way. Now that companies have a clearer idea of the miracles that the Internet can perform – and of those that should not be expected –, they have grounds on which to redesign their processes, their structure and the value chains they are a part of, in order to take better advantage of the Internet's features.

There have been many studies and reports on the use of the Internet to improve companies' business propositions and overall results. Most of them, however, were contaminated by the e-commerce hype and focused on the possibility of selling products on-line. The authors of this paper believe that, when used in a synergistic way with other practices, methods and technologies that are available to the organizations, Internet adoption may provide gains that are much greater than those originally thought of, related to several different value adding activities that need to be performed by manufacturing companies.

The analysis of the survey data has shown that participants consider that the Internet can be used to support or improve many other activities than just those related to the sell-side of their value chains. Manufacturers relate several of the isolated benefits of Internet adoption to each other, grouping them in five major Internet adoption drivers: *customer orientation*, *customers' retention*, *logistics coordination*, *design virtualization* and *reverse auction*. The survey demonstrated that they believe that the Internet can help them make their businesses more customer-oriented, increasing customers' loyalty. They also think that the Web may help them to improve coordination along the value chain and the efficiency of procurement activities, through reverse auctions and market-places. Finally, manufacturers expect gains related to the fact that design activities can be virtualized to a greater extent than in the past, as design files can be shared and distributed to design team members, regardless of where they are physically located.

PREVIOUS WORK ABOUT THE IMPACTS OF THE INTERNET AND OTHER IT ON MANUFACTURING

Many researchers have concerned themselves with isolated benefits that the Internet and other IT can bring to the manufacturing industry. Jons (1997) claimed that virtual environments would allow for the virtualization of design activities. Duarte and Barberato (2003), on their turn, acknowledged that CAD tools and the 3D features they now provide resulted in a design unprecedented qualitative leap, allowing for the replacement of many physical mock-ups by virtual simulations. Pires and Prates (2003) consider that even concurrent engineering techniques have benefited from increased use of the Internet, intranet and other virtual communication tools by the organizations. When engineers get in contact with virtual design environments, they are capable of developing or changing projects in real time, checking the effects of their actions on the project as a whole (GOLDIN, VENNERI e NOOR, 1998), which makes virtual prototyping an important research field, according to Deviprasad (2003). After a virtual prototype is generated, it can be electronically distributed to all members of the design team, including shop floor personnel, designers and machinery manufacturers (BAPAT, 2002). The integration of the contribution of all interested parties can be aggregated to a master model, which is then made available to the group, by means of visual representations and sharing of the required data for the everyone's work. Organizations can use their best resources, with respect to specific knowledge, in the development of new products and production processes through the Web, regardless of where they are physically located (KIRKMAN *et al.*, 2002).

According to Keenan *et al.* (2002), the Web may help finding huge contingents of customers who would be glad to purchase made-to-order products. However, restructuring a plant to produce thousands of different variations of a product, in order to respond to individual wishes, is not an easy task. Design efforts to make customization feasible are not trivial. The product and the process need to be conceived from scratch with that purpose in mind. Ruddy (2002) reminds us that, at the same time mass customization means, to the customer, that specific needs will be taken into account, to the manufacturer, it means having to develop a sophisticated infrastructure, involving suppliers, the company itself and its customers as co-developers of the desired products. Keenan *et al.* (2002) are enthusiastic when they say that products can now be customized to an extent that was not possible before Internet times. However, those who embrace this new opportunity will have to prepare in advance, adopting techniques and practices that improve their ability in manufacturing made-to-order products, but with low delivery lead-time, among which production and logistics' just-in-time methods (such as kanban, milk-run and cross-docking) play a big role, in addition to concepts as modularization and postponement, which make push-pull production schemes feasible (GRAEML e GRAEML, 2005). For a product to be customizable during manufacturing without great efficiency loss, it needs to have been developed for that purpose. The production process also needs to have been thought of in a way to provide a good balance of inventory, equipment and labor, allowing for a build-to-order environment, instead of a buid-to-stock situation (TREBILCOCK, 2004).

Fisher (2000) believes that one of the greatest contributions of the Internet to industrial companies is the possibility of purchasing goods and materials over the Web. He considers that the benefits of e-procurement are related to lower direct costs, but also to the increased efficiency of procurement activities it provides. Ozer (2003) says that the Internet can help a company locate a possible supplier in a much shorter period of time. The Web also generates more competition among potential suppliers, when reverse auctions or exchanges are used for procurement (OZER, 2003; MENEZES, SILVA e LINHARES, 2004). As reverse auctions emphasizes the price, this kind of purchase only suits items for which there is no great variability in quality and when there are many possible suppliers.

Sometimes, companies are willing to buy for the smallest possible price, usually when there is no great difference among products offered by potential suppliers. In other situations, primarily those in which there is a quality or availability issue, companies would like to increase the level of coordination and cooperation with key suppliers, which are then treated as business partners. That is important to improve the efficiency of the value chain and has led organizations to carry out massive investments in technology. The ideal scenario, in this case, would (or will) be having access to real time end customer sales information, in order to guide future manufacturing actions (COTTRILL, 2003). One of the technologies that is adopted with that intent is EDI, which can now work over the Web, as reminded by Marques and Di Serio (2000), making it economically feasible for companies of any size to achieve electronic integration with business partners, not just large enterprises. EDI over the Web only requires the use of a Web navigator and the installation of basic client software, which significantly reduces transaction costs (SLIWA, 2004). According to Meta Group (BEDNARZ, 2004), EDI over the Web transactions expands at a rate of 50 to 60% a year, while traditional EDI, based on VANs, has stagnated. Post of sale information can be shared with suppliers in order to reduce distortions and delays along the value chain, according to Sterman (apud SAAB e CORRÊA, 2004). But VMI, another technique used to increase agility in responding to customers' demand goes far beyond that, as its philosophy is to allow the manufacturer to manage the whole supply chain down-stream, determining the amount of goods to be delivered to each site and eliminating the need for customers to place orders. With VMI, instead of the retailer monitoring its own inventory levels, it transfers that responsibility to the supplier (SAAB e CORRÊA, 2004). One global movement that attempts to stimulate the adoption of technologies and practices that provide for greater information flow and interaction along the value chain is ECR. This movement preaches that the participants of a value chains should "work together to develop common standards and more efficient processes that minimize costs and optimize productivity in their relationships" (ECR BRASIL, s.d.).

Next section presents the methodological approach used for this study, mentioning the previous treatment that was needed in order to prepare the collected data for the statistics' multivariate analysis procedure that had been intended.

METHODOLOGICAL APPROACH

As the amount of data to be analyzed was huge (633 valid questionnaires with 37 structured questions in a Likert format), the authors decided to use multivariate statistical tools in the analysis, with special emphasis to exploratory factor analysis. This was considered to be a good technique for the case, because it allows for the identification of correlation among the variables that are associated to a specific phenomenon, grouping them in factors that keep some capacity of explaining the facts.

The authors expected that, when they ran the factor analysis for the data that were generated from the survey's tabulated answers, factors would be generated that could explain several variables together, thus indicating that the respondents considered such variables either complementary or as distinct forms of dealing with the same issue. This actually happened, as will be shown later on in this paper.

In order to perform the factor analysis, a few methodological procedures were required, which are mentioned below:

a) elimination of the variables with high incidence of missing values

Among all different practices, methods and technologies for which the respondents indicated their current level of usage (or intention of usage in the future), some presented a higher percentage of missing values, possibly due to being less well known to the participants than others. The variables with higher incidence of missing values were eliminated from the analysis. The criterion that was adopted to choose the variables that would be left out was those which had a missing value rate higher than 30%. The variables that were eliminated due to such criterion were *ViralMarketing*, *Postponement*, *Cross-docking* and *ReverseLogistics*. See **Figure 1**, which shows the missing value rate for each of the several questions that were proposed to the participants. Variables presented in red are the ones that were left out.

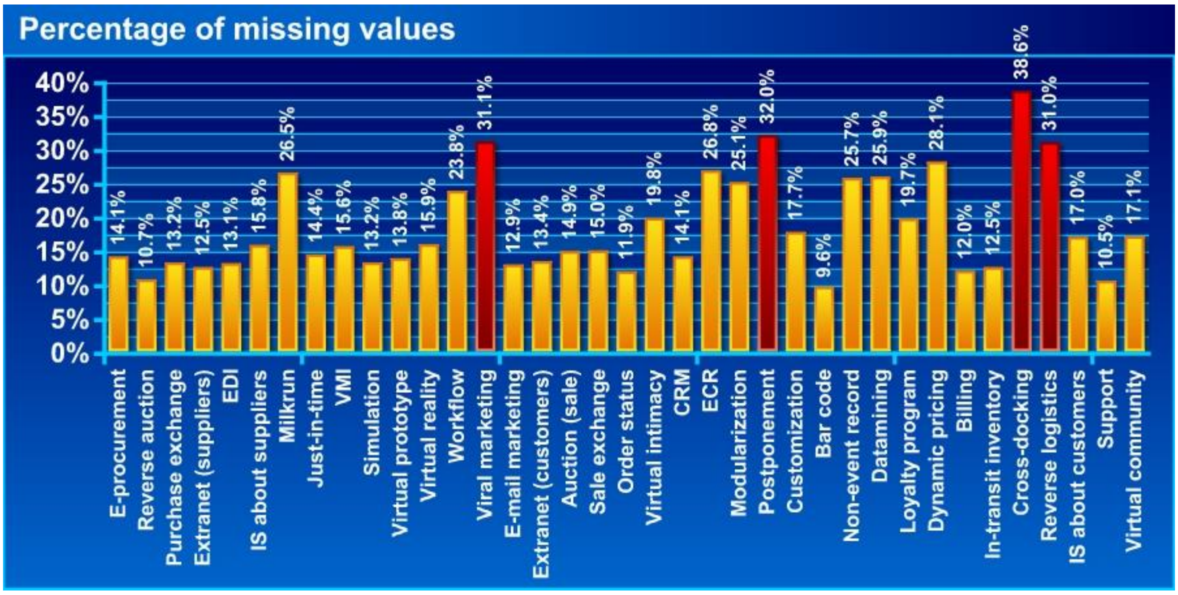

Figure 1 Percentage of missing values for each of the questions in the survey

Nota: Nem todas as variáveis que aparecem na figura (e que são objeto deste estudo) foram apresentadas formalmente na rápida revisão da literatura apresentada na seção anterior. Outros trabalhos dos autores, que não são aqui citados para preservar o processo de *blind review*, tratam em detalhe cada uma delas, justificando a sua menção.

b) elimination of participants who didn’t answer more than 30% of the proposed questions

A second criterion for the preparation of the data for the factor analysis was the elimination of any questionnaire that had more than 30% of blank answers, i.e., not more than 10 empty fields (of the

37 that were proposed) were tolerated. The decision to eliminate the answers for which the missing values' rate was high was to avoid the inclusion of data provided by participants who were either not committed to the survey or were not well informed to provide answers. The authors believe that, by doing so, they improved the quality of the information that was used in the analysis and, therefore, the quality of the results that were obtained from it. As a result of this criterion, 97 questionnaires were excluded from the analysis, which then concentrated on the remaining 536 records.

c) filling in of *missing values* with value "0"

After that, blank cells were filled in with a "0" (zero), the same value that was assigned to the answer "does not apply". The authors are aware of possible distortions that might result from such decision, but they considered that they were less biasing than eliminating the contribution of many participants, just because they left a few questions without an answer.

d) calculation of the eigen-values for the factor analysis

The next step was to calculate the eigen-values for the factor analysis, involving the 33 remaining variables (in orange, in **Figure 1**). Nine eigen-values presented a value that was higher than 1 (see **Figure 2**), which would suggest the use of 9 factors in the analysis, following a rule of thumb.

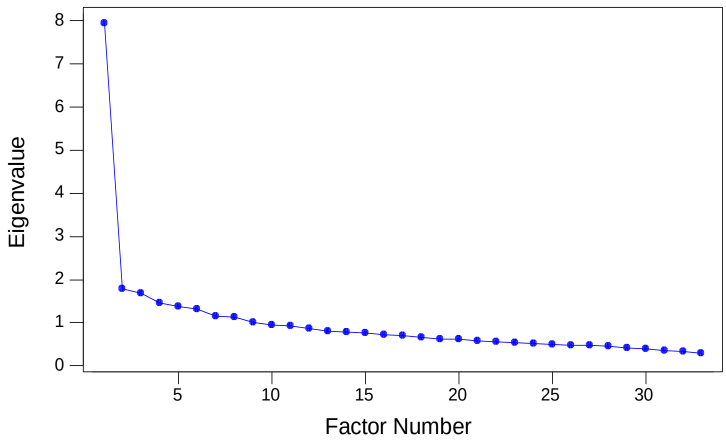

Figure 2 Eigen-values for the factor analysis

e) Definition of the number of values to be used

After having carried out a few simulations with a different number of factors, the authors consciously disregarded the rule of thumb that suggested the use of 9 factors, in this case, and chose to use only 6 factors in the model being created. The reason for that was that those 6 factors could be more easily related to possible uses of the Internet, and other synergistic practices, by the organizations. The calculations are shown below.

Calculation of the Factor Analysis

For the calculation of the factor analysis the authors used Minitab®, which is a statistics' software that provides computational tools for multivariate analysis. Minitab's output for 6 factors, using Equimax rotation was as follows:

Rotated Factor Loadings and Communalities
Equamax Rotation

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Communality
E-procurement	0,305	0,163	0,121	-0,171	-0,21	-0,349	0,33
ReverseAuction	-0,044	0,208	0,015	0,029	-0,122	**-0,699**	0,55
PurchaseExchange	0,092	0,207	0,075	-0,042	-0,036	**-0,62**	0,445
SupplierExtranet	0,171	**0,54**	0,143	0,1	-0,116	-0,222	0,414
EDI	0,058	**0,561**	0,092	-0,041	-0,159	-0,232	0,407
SuppliersInfoSys	0,093	**0,438**	0,115	0,075	-0,313	-0,135	0,336
Milkrun	-0,032	0,062	0,074	0,062	**-0,55**	-0,256	0,382
JIT	0,199	**0,411**	0,188	0,054	**-0,449**	-0,048	0,451
VMI	0,074	**0,552**	0,116	0,195	-0,273	-0,131	0,452
Simmulation	0,129	0,139	**0,753**	-0,061	-0,163	-0,079	0,639
VirtualPrototype	0,1	0,13	**0,84**	0,084	0,027	-0,076	0,747
VirtualReality	0,03	0,051	**0,738**	0,223	-0,068	-0,127	0,618
Workflow	0,069	0,173	**0,449**	0,337	-0,281	-0,135	0,447
EmailMarketing	**0,462**	-0,001	0,312	0,07	0,05	-0,209	0,361
CustomerExtranet	0,167	**0,588**	0,331	0,186	0,075	-0,036	0,525
SaleAuction	-0,031	-0,06	0,121	0,183	-0,091	**-0,67**	0,511
SaleExchange	0,345	-0,093	0,116	0,267	0,061	**-0,545**	0,513
OrderStatus	0,292	**0,524**	0,162	0,27	0,102	-0,039	0,472
VirtualIntimacy	**0,682**	0,167	0,121	0,19	0,074	-0,141	0,569
CRM	**0,706**	0,238	0,069	0,181	-0,162	-0,034	0,621
ECR	**0,652**	0,23	-0,017	0,168	-0,275	-0,086	0,589
Modularity	**0,535**	0,074	0,169	0,167	-0,335	-0,001	0,46
Customization	**0,429**	0,057	0,252	-0,066	**-0,519**	-0,049	0,527
BarCode	0,031	0,358	-0,048	0,154	-0,374	-0,06	0,298
Non-events	0,173	-0,002	0,044	0,276	**-0,602**	-0,085	0,478
Datamining	0,117	0,22	0,202	0,398	-0,33	-0,085	0,378
Loyalty	0,201	0,065	0,138	**0,541**	-0,39	-0,027	0,509
DynamicPricing	**0,418**	-0,022	0,19	0,262	-0,338	-0,002	0,395
Billing	0,072	0,359	0,071	0,391	0,115	-0,016	0,306
InventoryOnWheel	-0,016	0,343	0,122	**0,439**	-0,24	-0,215	0,429
CustomersInfoSys	0,05	0,155	0,068	**0,559**	-0,261	-0,113	0,425
Maintenance	0,297	0	0,226	**0,492**	-0,093	-0,139	0,409
VirtualComunity	0,256	0,08	0,098	**0,684**	-0,018	-0,061	0,554
Variance	2,9499	2,6946	2,6943	2,602	2,431	2,1729	15,5448
% Var	0,089	0,082	0,082	0,079	0,074	0,066	0,471

Figure 3 Minitab's output

ANALYSIS OF THE RESULTS

Numbers in red in **Figure 3** indicate those variables that had loads higher than 0.4, in absolute terms, for a specific factor. In those situations, the authors considered that the factor was particularly representative of that variable, due to high correlation between the factor and the variable. Analyzing the loadings, Factor 1 was nick-named *Customer Orientation*, as it is representative of variables such as *VirtualIntimacy*, *CRM*, *ECR*, *Modularity*, *Customization* and *DynamicPricing*. Factor 2 was called *Logistic Coordination*, because it represents variables such as: *SuppliersExtranet*, *EDI*, *SuppliersInfoSys*, *Just-in-time*, *VMI*, *CustomersExtranet* and *OrderStatus*. Factor 3 includes variables related to *Design Virtualization*: *Simulation*, *VirtualPrototype*, *VirtualReality* and *Workflow*. Factor 4 was called *Customers Retention*, as it represents variables such as *CustomersInfoSys*, *OnlineMaintenance*, *VirtualCommunity* and *Loyalty*. Factor 6 concentrates Internet purchase and sale variables, with a special emphasis on *Reverse Auction* possibilities over the Web. The only factor that could not be clearly related to a specific participants' concern was Factor 5, which was highly correlated to the following variables: *Milkrun, Just-in-time, Customization* and *Non-events*, which, on their turn, didn't seem to be logically related to one another.

The 6 factors together explain 47.1% of the structure of the 33 variables that were included in the analysis. The variable for which, on its own, the model provided the lowest explanation level in the study was *BarCodes* (only 29.8%). However, the model's overall explanation capacity was much higher, as one can see in column *communality* of Minitab's output (see **Figure 3**).

The authors then checked if the variables that had been excluded from the model, due to high incidence of missing values, were correlated to any of the factors. Minitab's output is presented in **Figure 4**, which shows the correlations among such variables and the 6 factors.

	F1	F2	F3	F4	F5	F6
ViralMarketing	0,281	-0,019	0,185	0,216	-0,127	-0,063
Postponement	**0,343**	0,194	0,191	0,078	**-0,351**	-0,042
Cross-docking	0,084	0,119	0,079	0,221	-0,285	-0,18
ReverseLogistics	0,17	0,111	0,135	**0,323**	-0,234	-0,079

Figure 4 Minitab's output presenting the correlation of excluded variables and factors

It was noticed that correlations are weaker (values are printed in red when higher than 0.3), as one could already expect, considering that the variables were not used in the development of the model, but they still keep some coherence with the nicknames that were given to the factors. For example, *Postponement* correlates to some extent to Fator 1 (*Customer Orientation*), which makes sense, as it is a technique that can be used to improve the fit between the company's product and the customer's specific needs. Variable *ReverseLogistics*, on its turn, presented higher correlation with Factor 4 (*Customers Retention*). And, again, *reverse logistics* surely is an issue that has to be taken care of to provide fast and reliable repair/warranty service to the customers, contributing to their loyalty.

MANAGERIAL IMPLICATIONS AND CONTRIBUTION TO THE FIELD

By means of this research project, it was possible to detect the existence of inter-relationships among several different variables concerning the adoption of the Internet in the corporate environment. That means that some initiatives or uses of the Internet normally happen in conjunction with others, complementing one another or generating synergistic benefits. Factors 1 to 4 and factor 6, resulting from the factor analysis performed according to the previous section, demonstrate the existence of some essential dimensions of possible uses of the Internet to perform or support value adding activities of the enterprises. In addition to the marketing concerns of selling the product and intensifying the contact with customers, which are typical of any business, it became clear that manufacturing companies believe that the Internet can bring other benefits to their operations, with special emphasis to logistics coordination, virtualization of design activities and the possibility of purchasing materials through the web, particularly by means of reverse auctions.

The study was carried out without making any distinction among sectors or areas of activities of the hundreds of companies that were involved, within the manufacturing industry. Therefore, although major Internet adoption drivers have been depicted, it is impossible to know if they are equally important to players in different fields. Future studies could focus on assessing the relevance of each of those drivers (i.e. *customer orientation, customers' retention, logistics coordination*, *project virtualization* and *reverse auction*) to different sectors of the manufacturing industry. After that is done, companies will be able to evaluate their own performance with respect to market demands or their competitors' efforts. **Figure 5**, below, presents a hypothetical evaluation diagram, by means of which a company would realize that it needed to improve its Internet efforts towards customer orientation and logistics coordination, in order to keep up to customers' expectations, for example.

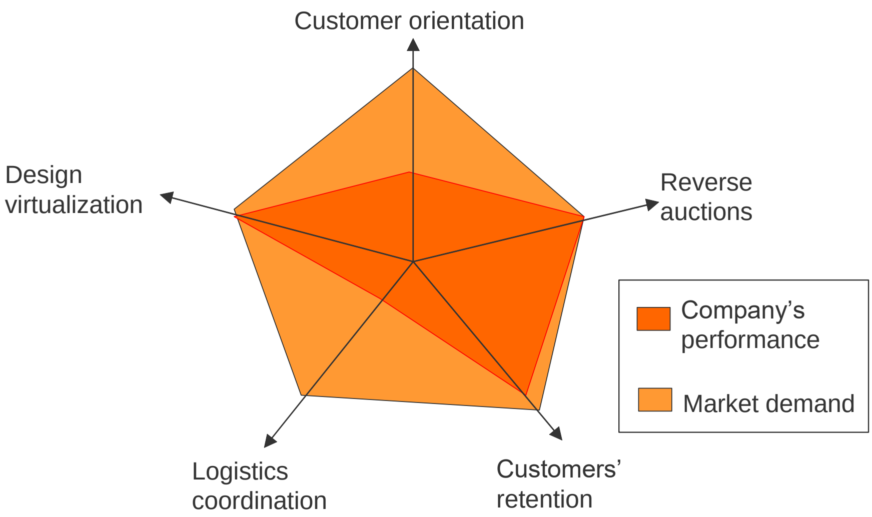

Figure 5 Potential Internet impact drivers on manufacturing organizations

Note: this diagram is only for the sake of illustration. The authors have not developed any study on the relative importance of the drivers that were presented, when compared to one another. Relevance is surely also a function of industry sector or segment, which has also not been assessed.

Design virtualization, *logistics coordination* and *reverse auctions* (to purchase raw materials) are concerns that are particularly relevant to manufacturing companies. They have to develop products and production processes, and believe that the Internet can provide the infrastructure and tools for the coordination and sharing of team design work. Manufacturing companies also face the challenge of reducing inventory levels without affecting availability to end customers. The Web can become an important weapon in their struggle to better coordinate their activities to those of their suppliers and customers, reducing the devastating effects of the lack of suitable information flow along the value chain. Manufacturers are also interested in new procurement possibilities, particularly those involving reverse auctions, which have become popular over the Web, more recently. Such concerns wouldn't probably show up, had the survey focused on retailers or other industries.

Even *customer orientation* and *customers' retention* have different meanings for manufacturers than they do for other industries. Manufacturing companies, which traditionally have little or no contact with consumers, consider the Internet a means to start interacting with consumers, providing some degree of product personalization and achieving feedback. The logic behind the new Internet-based production approach is completely different to the way manufacturers are used to work. It allows manufacturing to be pulled by the consumers, instead of being pushed through distribution channels until products finally reach the end customers. In other words, manufacturers can now work in a make-to-order – instead of a make-to-stock – fashion. That is why manufacturers are beginning to worry about developing *virtual intimacy* with customers, which means gathering information and establishing bonds to better understand and address customers' needs. In that sense, *Customer Relationship Management (CRM)* systems may play an important role. In order to provide *customization*, i.e. products that can be adjusted to specific needs, manufacturers rely on *modularity* principles, among others, so that scale benefits do not vanish while the company attempts to personalize its output.

The Internet's impact on the way manufacturers perform their routine activities or develop their strategies is just starting to become noticeable. The "revolution" that may take place in that industry due to the adoption of the Internet, other IT, techniques and practices mentioned in this paper is silent but steady. It is almost impossible to predict where this is all going to end. Much easier is it to understand its beginnings. Where we go from here is a matter that is on the manufacturers' own hands.

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REFERENCES

BAPAT, V. Explaining virtues of virtual manufacturing. InTech, v. 49, n. 11, p. 76, Nov, 2002.

BEDNARZ, A. Internet EDI: Blending old and new. Network World, v. 21, n. 8, p. 29-30, Feb 23, 2004.

COTTRILL, K. Cutting edge. Traffic World, p. 1, Jul 21, 2003.

DEVIPRASAD, T. and KESAVADAS, T. Virtual prototyping of assembly components using process modeling. Journal of Manufacturing Systems, v. 22, n. 1, p. 16-27, 2003.

DUARTE, A. L. M. and BARBERATO, E. The evolution of tools for the development of new products as a competitivity driver [in Portuguese]. In: Simpósio de Administração da Produção, Logística e Operações Industriais, 6th, São Paulo. Electronic proceedings. POI-FGV, 2003. p. 1 CD-ROM.

ECR BRASIL. What is ECR?: ECR Brazil Association [in Portuguese], no date. Available at: http://www.ecrbrasil.com.br/o_q_eh.asp. Accessed: 19/08/2004.

FISHER, A. Understanding e-procurement: Finantial Times (FT.com), 2000. Available at: http://specials.ft.com/eprocurement/FT3AC3PXKFC.html. Accessed: 25/01/2004.

GOLDIN, D. S., VENNERI, S. L. and NOOR, A. K. A new frontier in engineering: Mechanical Engineering Magazine, 1998. Available at: http://www.memagazine.org/backissues/february98/features/newfront/newfront.html. Accessed: 25/01/2004.

GRAEML, A. R. and GRAEML, K. S. Customization: key competitive factor in the new economy [in Portuguese]. In: Simpósio de Administração da Produção, Logística e Operações Industriais, 8th, São Paulo. Electronic proceedings. POI-FGV, 2005. p. 1 CD-ROM.

JONS, O. P. Preservation and restoration of historic vessels in virtual environments: Maritime Park Association, 1997. Available at: http://www.maritime.org/conf/conf-jons.htm. Accessed: 25/01/2004.

KEENAN, F., et al. A mass market of one: As custom online ordering moves into the mainstream, Web merchants learn to fine-tune their trade. Business Week, n. 3810, p. 68, Dec 2, 2002.

KIRKMAN, B. L., et al. Five challenges to virtual team success: lessons from Sabre, Inc. Academy of Management Executive, v. 16, n. 3, August, 2002.

MARQUES, E. V. and DI SERIO, L. C. ECR in Brazilian retail [in Portuguese]. In: Simpósio de Administração da Produção, Logística e Operações Industriais, 3rd., São Paulo. Electronic proceedings. POI-FGV, 2000. p. 1 CD-ROM.

MENEZES, R. A., SILVA, R. B. and LINHARES, A. Multiatribute reverse auctions: a multicriterium decision approach adding value to government procurement in Brazil [in Portuguese]. In: Encontro da Associação Nacional dos Programas de Pós-Graduação em Administração , 29th., Curitiba. Electronic proceedings. ANPAD, 2004. p. 1 CD-ROM.

OZER, M. Using the Internet in new product development (managers at work). Research - Technology Management, p. 10-16, Jan/Feb, 2003.

PIRES, P. J. and PRATES, R. C. Manufacturers' organizational strategies and production reestructuring in Brazil in the 90's [in Portuguese]. In: Encontro da Associação Nacional dos Programas de Pós-Graduação em Administração, 28th., Atibaia, São Paulo. Electronic proceedings. ANPAD, 2003. p. 1 CD-ROM.

RUDDY, M. Mass customization now closer than ever. Machine Design, v. 74, n. 12, p. 59-61, Jun 20, 2002.

SAAB, J. and CORRÊA, H. L. The Forrester effect reduction: one size fits all? In: Second World Conference on POM and 15th Annual POM Conference, Cancun, Mexico. Electronic proceedings. POMS, 2004. p. 1 CD-ROM.

SLIWA, C. EDI: alive and well after all these years. Computerworld, v. 38, n. 24, p. 1, June 14, 2004.

TREBILCOCK, B. Lean & mean. Modern Materials Handling, v. 59, n. 3, p. 43-46, March, 2004.