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# Changes in The Role of Production and Operations Management in the New Economy

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*ABSTRACT:* The paper analyses how the area of production and operations management (POM) in Brazil should change/adapt in order to remain relevant in the so called "new economy". Drawing from insights coming from both the relevant literature and a survey, a preliminary research and teaching agenda is proposed.

*KEY WORDS:* Production and operations management, research agenda, teaching, new economy, future

## INTRODUCTION

The forces behind the development of the so-called "new economy" are substantially changing the ways in which the economy in general and the business world in particular operate. The early XXIst Century literature reflects this notion and Hayes (2002), Teece (1998), McGee and Bonnici (2002), Walters and Buchanan (2001) and Walters (2004) are but a few good and representative examples. But what are the implications of this new economy for the way in which we should manage production and operations? Unfortunately, in this regard, the literature is not as plentiful as it is in announcing the changes. In an attempt to fill this gap, this research more specifically tries to answer the following questions:

- What are the main changes brought about by the new economy to the corporate world in general and to production and operations management (POM) in particular?
- Which sub-topics, within the general field of POM have been (and in the future are likely to be) most affected by the changes brought about by the new economy?
- What would be a research and teaching agenda for the next years so that we, POM researchers and teachers can increase the probability that our activities remain relevant and really contribute to the betterment of businesses and institutions performances in the new economy?

## BRIEF RESEARCH METHOD CONSIDERATIONS

Given the novelty of the research subject, this study is exploratory in nature and, given the dynamics of the current business environment, to a certain extent speculative – and so is the research methods used. First, an extensive and exploratory (given the scarcity of literature references dealing with the issues involved in the research questions) literature review was done. Content analysis and affinity diagrams were used here to try and come to grips with what would the new economy be in more researchable terms. Then, a semi-structured internet-based survey was performed involving Brazilian senior POM researchers and professors aiming at identifying their perceptions with regard to which would be the POM sub-topics that would require further research vis-à-vis the changes brought about by the new economy. A Brazilian-only sample of professors was used because at the outset we wanted the study results to be particularly useful for Brazilian professors and researchers in designing or re-designing their research agendas and teaching content. Conclusions are then drawn from both sources: literature review and sur-

vey outcomes resulting in an initial contribution to the effort of establishing research and teaching agendas for the field of POM in Brazil vis-à-vis the growing importance of the so-called new economy. It is needless to say that this study does not intend to be exhaustive or definitive. Rather it intends to add to the continuous debate on how we POM professionals should go about continuously redefining our field so that it remains relevant now and in the future.

## LITERATURE REVIEW

### New economy

Businesses, markets and above all technologies in accelerated and constant evolution for many decades have come to create an environment of which dynamics, challenges and opportunities are unprecedented in history. According to the literature (although each reference in the literature is usually biased toward its own focus of study) the general notion of "new economy" generally includes:

- Great emphasis in networks of relationships and their effects (Van den Ende and Wijnberg 2001; Fjeldstad and Haanes 2001; Srinvasan, Lilien and Rangaswamy 2004). This does not mean that the old economy did not have network-based businesses and corresponding effects (consider companies such as Avon Cosmetics and Tupperware, who historically built mighty corporations based on the so-called network marketing or the traditional Japanese "keiretsus", which are the tightly woven networks of suppliers that work in unison with large focal companies such as Toyota Motor Co. for instance). What changes in the new economy is the extent to which these "network" effects appear and are used to generate competitive advantage in the launch, production and delivery of both physical products and services (a high profile example is eBay.com, the largest internet-based auction company whose business model is exclusively based on linking millions of sellers and millions of buyers – in other words, on facilitating and managing gigantic networks of buyer-seller relationships. Another wonderful example is Wikipedia (www.wikipedia.org) an open source encyclopedia based exclusively on a network of hundreds of thousands of independent contributors that work to create and maintain what is today the largest encyclopedia in the world);
- Great emphasis on information and telecommunication technology in the development and management of both products and processes (Farrell 2003; Sahlman 1999). What was said above is also valid here: the old economy has a long history of companies whose businesses rely heavily on these technologies (the traditional telecom companies such as AT&T and IT companies such as IBM, for instance are the obvious examples, but other traditional companies like Sears & Roebuck, for instance also built business empires long ago, in the beginning of the XXth Century, based on catalog sales, which relied heavily on telecommunication technologies). However, what changes in the new economy is the extent to which these technologies are being increasingly made available and used in attaining competitive advantage by both traditional players and new players and across the board of industrial sectors – this has in many situations changed the rules of the business game. The internet, for instance, made it possible that completely new business models were created. An example is Skype (www.skype.com), a company founded by an individual with very little capital investment a little more than a decade ago which in a couple of years became a formidable competitor in an industry traditionally dominated by giant telecom companies and their huge capital assets – their physical networks for instance – which are not anymore the entry barriers that once kept their markets relatively protected. Examples of traditional companies that have reinvented their operations with the intensive use of the new technologies are also numerous – such as the airlines who use technology to bypass a traditionally important tier in their distribution channels – the travel agencies – to sell tickets directly to end users.
- Great knowledge content in the companies' assets, services and physical products (Hayes 2002; Sahlman 1999; Farrell 2003). Once again, this does not mean that in the old economy we did not have companies that based their competitiveness on knowledge intensive assets and products (nearly centenary consulting firms such as Booz-Allen & Hamilton, for instance have had this characteristic ever since they were founded). What changes with the new economy is the extent to which not only new companies but also traditional companies are adding knowledge to the traditional value package that they offer their customers. In order to achieve that, they have to

value much more the knowledge factor in their own assets. Here the traditional elevator manufacturers, such as Schindler, can provide a good example. They have added for instance remote monitoring and decision making software – in other words, "knowledge" – to their products so that preemptive action can be taken sometimes even before breakages occurs, taking maintenance efficiency and product availability to levels never though possible before – in order to achieve that, Schindler and other elevator companies had to enhance substantially their knowledge base in terms of for e.g. the operation and use of their products by their customers. Fertilizer manufacturers like Bunge in Brazil, provide another good example. They keep on selling "old economy" fertilizer to farmers, but they also can provide "new economy" detailed information and knowledge about what, and how much to apply of fertilizer directly to the farmer's applying tractor, based on global positioning system technologies that identify the position of the tractor and then, based on the Bunge knowledge base, the characteristics of that particular soil that needs correction. Knowledge became possibly the most valuable part of the value package and of the asset pool of this company.

It seems undeniable that, despite the importance of the other reasons and characteristics behind the development of the new economy, the weight that the new technologies has is disproportional as a change engine. However, what frequently happens is that the discussion about the new technologies revolves exclusively around the *internet-based* technologies whereas the scope of the discussion should be much more comprehensive. It should include the development of increasingly sophisticated, customized and powerful *software* and *hardware*, with capacities being measured in *tera-bytes* and *giga-hertz*, and telecommunication technology making it possible that information be transmitted with richness, frequency, speed and inter-activity never seen before. This allows for new ways to develop, produce and distribute products, for instance in the multi-billion entertainment industry, where music, games and video are *developed* by groups of developer teams whose members are scattered around the globe communicating via teleconferences, e-mails, video-conferences and other e-means, *copied* electronically and almost instantly (instead of traditionally *manufactured* in factories) and *downloaded* by customers instead of physically *transported* on hard media.

It is important however to establish a caveat here. Maybe the terms "new economy" and "old economy" are not totally adequate and maybe they can not fully capture the essence of the ongoing changes. It is not true that what is happening is a *substitution* of the new economy by the old economy. The old economy and its assumptions remain present and some of them, totally valid and current. Steel or flour will continue having to be manufactured – as well as other products which are less affected by the phenomena described here – for them, much of the traditional operations management body of knowledge developed and perfected along the last more than two centuries (Corrêa 2003) remain valid and useful. However, as the changes amass and as the markets affected by them become increasingly important for most developed and developing countries economies, it is essential that the field of POM prepare and develop complementary approaches which can then, together with the more well established POM tools and techniques, be able to effectively deal with the old and the new economies. This is actually the main argument of this paper.

**Sub-topics within the POM body of knowledge**

With the objective to analyze the possible impacts of the new economy in the field of POM, first of all we will establish the "confines" of the mainstream POM current body of knowledge, by reviewing a number of leading POM text books authored by experienced authorities in the field. Here the assumption is that current or recent editions of these text books adequately reflect the POM approaches and techniques that are being taught in good business and production engineering schools, if not in depth, at least in scope, at the undergraduate and graduate degree-granting and, executive levels. As text books new editions nowadays are launched frequently (in some cases, yearly), we also consider that the applicable recent research results will also be present in the most recent leading books. We analyzed 12 text books, including the Brazilian (Corrêa and Corrêa 2006), European (Slack et al. 2007) and American (Heizer and Render 2008; Stevenson 2005, Chase; Jacobs; Aquilano 2006) top sellers together with 7 other also relevant text books.

In total, we analyzed [1] Chase; Jacobs; Aquilano 2006; [2] Stevenson 2005; [3] Slack et al. 2007; [4] Reid and Sanders 2002; [5] Gaithier and Frazier 2002; [6] Melnyk and Denzler 1996; [7] Dilworth 2000; [8] Heizer and Render 2008; [9] Starr 2004; [10] Russel

and Taylor 2000; [11] Corrêa and Corrêa 2006; and, [12] Wild 1995, trying to find out which POM sub-topics are more frequently found in their content. A detailed content analysis was performed by using affinity diagrams (because not always the same sub-topics are called the same way across the different text books) which resulted in Table 1.

**Table 1- Frequencies of POM Sub-Topics Found in the Analyzed Text-Books**

| | Reference | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **POM Sub-Topic** | **[11]** | **[8]** | **[2]** | **[5]** | **[1]** | **[4]** | **[10]** | **[7]** | **[3]** | **[9]** | **[6]** | **[12]** | **Total** |
| *Capacity management* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **12** |
| *Forecasting* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **12** |
| *Production scheduling* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **12** |
| *Inventory management* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **12** |
| *Quality management and Six sigma* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **12** |
| *Just-in-time and Lean production* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **12** |
| *Project management* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | **11** |
| *Plant layout* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | **11** |
| *Supply chain management* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | **11** |
| *MRP and ERP* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | **11** |
| *Aggregate production planning* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | **10** |
| *Theory of constraints* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | **10** |
| *The future of POM* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | **10** |
| *Product development and process selection* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | | **9** |
| *Process analysis and re-design* | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | **9** |
| *Work organization and reward systems* | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | | **9** |
| *Location* | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | **9** |
| *Simulation and decision making models* | 1 | 1 | | 1 | 1 | 1 | 1 | | 1 | | 1 | | **8** |
| *Operations strategy and competitiveness* | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | **8** |
| *Performance evaluation and Productivity* | 1 | 1 | 1 | 1 | | | 1 | 1 | | 1 | | | **7** |
| *Technology in operations* | 1 | 1 | 1 | | | 1 | | | 1 | 1 | | 1 | **7** |
| *Ethics and the environment* | 1 | 1 | 1 | 1 | 1 | | | 1 | | 1 | | | **7** |
| *Maintenance and reliability* | 1 | 1 | 1 | | | 1 | | 1 | 1 | | | | **6** |
| **Total** | **23** | **23** | **21** | **20** | **20** | **20** | **19** | **19** | **18** | **18** | **13** | **11** | |

## SURVEY RESERACH WITH POM PROFESSORS: DEVELOPMENT

### Sub-topics that have been obsolesced by the new economy according to the survey

Taking into account the list of the most frequently found sub-topics of the POM body of knowledge identified in the analysis of the text books described above, an internet-based survey was performed involving 219 POM (and POM-related areas) professors (all doctors) of Brazilian teaching and research institutions. They are the group of professors who usually help as blind referees for the articles submitted to SIMPOI (the International Symposium of Production and Operations Management, yearly hosted by Fundação Getulio Vargas Business School, in Brazil). A questionnaire was sent in 2005 to the professors where we initially defined what we would consider as the new economy in this research and presented the identified list of POM sub-topics to them. We then asked the participants to elect the three sub-topics that they considered as the ones whose current POM techniques and approaches were most obsolesced (or that are most prone to become obsolete) by the new economy. For the three elected sub-topics, we then asked the respondents to list 1 to 3 specific issues (within each sub-topic) that would require inclusion / change / development so that they could better meet the needs of the new economy.

We received 36 usable responses (16.4%). The results probably cannot be considered statistically representative (given that the usable resulting sample is not random) of the 219 professors who received our survey invitation and they are even less likely to be representative of the universe of Brazilian POM professors. However, the analysis of the responses gave us a number of valuable insights and, most of all, the specific topics that the professors suggested that should be developed can help in the development of an agenda of broad directions for POM research and teaching for the POM area in Brazil (for a detailed account of the survey research findings please refer to Corrêa 2006).

The sub-topics that were most and least frequently present in the professor's responses as obsolete when considering the new demands brought about by the new economy are shown in Figure 1.

**Figure 1 – Most and Least Frequent Topics in the Professors' Lists**

| **Sub-topics which were most frequently mentioned by the respondent professors as having obsolete current techniques and approaches when considering the demands of the new economy** | |
|---|---|
| *Performance evaluation and Productivity* | 26% |
| *Product development and process selection* | 23% |
| *Work organization and reward systems* | 23% |
| *Production scheduling* | 20% |
| *Operations strategy and competitiveness* | 20% |
| *Inventory management* | 17% |
| *Location* | 17% |
| *Ethics and the environment* | 17% |

| **Sub-topics which were least frequently mentioned by the respondent professors as having obsolete current techniques and approaches when considering the demands of the new economy** | |
|---|---|
| *Just-in-time and Lean production* | 6% |
| *Theory of constraints* | 6% |
| *Maintenance and reliability* | 6% |
| *Project management* | 6% |

### Specific topics requiring development according to the survey

Below are some illustrative examples of the specific topics suggested by the respondents as deserving development / further development so that the obsolesced sub-topics of the POM body of knowledge can better serve the needs of organizations that operate in the new economy:

*Performance evaluation and Productivity*

- Indicators for service operations
- Data envelopment analysis to measure and analyze network 'nodes' performance
- Methods to evaluate effectiveness in new economy service operations
- More balanced methods between profit and human values to evaluate performance

*Product development and process selection*

- Early involvement of suppliers and co-design techniques
- Technology/knowledge-based product development techniques
- Outsourcing in product development

*Work organization and reward systems*

- Work organization studies based more on individual specialization than on links with institutions
- Virtual service operations management – networks of independent experts serving specific markets
- Organizational structure in modular system supply networks
- Organization and knowledge management in new economy operations management
- Work organization of virtual work groups working remotely
- Performance analysis and reward for innovation

*Production scheduling*

- Planning and scheduling methods using actual data, with immediate feedback
- Production planning in modular production systems

*Operations strategy and competitiveness*

- Company competitiveness principles extended to the competitiveness of networks
- Strategic alignment between markets and operations in new economy services
- Methods for evaluating the strategic impact of actions in new economy operations
- New taxonomy for operations, more appropriate to the new economy
- Flexibility and reliability in new economy operations management

*Inventory management*

- Inventory management models reviewed for new economy supply chains

*Ethics and the environment*

- Ethical impacts of the use of technologies (e.g. privacy issues)
- Work ethics in hyper-competitive environments
- Incorporation of ethical values in new economy operations management

*Supply chain management*

- Impacts of RFID technology in supply chain management and inventory management
- Collaborative planning in new economy supply chains
- Implication of the extension from the 'chain' to the 'network' concept in new economy supply management
- Partnerships as leverage factors in cultural change between nodes in supply networks
- Techniques to determine total (rather than local) costs in new economy supply networks
- Models for global logistics
- Better models for the make-or-buy decision in the new economy
- Reliability and risk in global and virtual supply chains
- Organizational clustering and value chains
- New economy service supply chain management
- The role of new actors (e.g. 3PL) in supply network management

*Process analysis and re-design*

- Process mapping for less structured productive processes
- Process management with telework

*Forecast*

- Demand forecast for highly innovative products
- Sales forecast with information sharing among supply network partners

It is interesting to notice that however *Supply chain management* has not had an expressive number of votes as an obsolesced sub-topic (present in only 11% of the respondent's lists), it was by far the one with the largest number of specific topics to be developed in the view of the researched professors (28% of the total number of specific suggestions related to *Supply chain management).* This probably means that although the professors do not consider the sub-topic obsolete, they urge it to mature, since *Supply chain management* is still a relatively young and develop-

ing area. Other sub-topics with large numbers of specific suggestions are *Work organization and reward*, *Ethics and the environment* and, *Performance measurement and Productivity*.

## ANALYSIS AND RESULTS

We now analyze the impact of the changes brought about by the new economy on the POM body of knowledge, based on the two main sources of this study: analysis of the relevant literature and survey research with Brazilian POM professors. For each of the main sub-topics, we then propose some basic research questions/ observations that can represent possible directions for research and teaching POMS in Brazil so that we provide our students and practitioners with tools that will allow them to better face the challenges presented by the new economy.

### *Work organization, and reward systems / Performance measurement and Productivity*

The new economy substantially changes the organizations' assets and products making them much more information and knowledge-intensive. This, together with the new levels of connectivity made possible by technology advancements, substantially altered the relationship between individuals and organizations. It is possible today, for instance, that an academic institution assemble their courses to be taught remotely by individual professors with expert knowledge, without necessarily developing institutional links with them. The same way, a professor can be part of the pool of instructors of several educational institutions without having traditional formal links with any of them. What type of work organization an operation like this requires? What type of motivational techniques can be used to get the best out of this pool of professionals sometimes scattered around the globe who are not anymore part of a group of co-workers who gather around the water fountain? How to coordinate them so that they convey the consistent messages that will differentiate each of the various teaching institutions? The same is valid for other types of companies who sometimes use the expertise of independent engineers and analysts with whom very thin institutional links are developed. How to retain the talents involved in these virtual pools? How to make sure that sensitive information is kept inaccessible to competitors with such weak links? These are questions that we should try to help answer. Other interesting questions in this sub-topic: how to manage knowledge in operations that are increasingly knowledge intensive? Knowledge is an asset that is different in nature of other assets: the more you use, the more you have it and not the opposite. Another important aspect of knowledge that affects operations management is the knowledge value. How different methods of knowledge and intellectual capital valuation affect decisions in POM? In an analysis of capital investment, for instance, how do the different levels of learning associated with different capital investment alternatives should be taken into account in decision making? The possibility of telework increasingly possible and adopted with the new economy also poses interesting questions regarding work organization and performance measurement. Possibly, models for performance evaluation that are much more based on results than on physical presence will be necessary to be further developed and this certainly represents a big departure from traditional models. It is also clear that the new economy brings with it much larger flow of innovation. In operations in which the main assets are knowledge and information, the capacity to innovate becomes a fundamental characteristic. How to organize and motivate teams for innovation? What motivates the product and process innovators? How to attract them and retain them?

The service organization networks which are territorially dispersed, made possible by the new economy developments, also require new approaches for productivity measurement. How to compare the productivity of small design offices scattered around the world, each under different contour conditions? More sophisticated productivity measurement and management techniques such as data envelopment analysis need to be developed and incorporated into the tool box of the POM professional. Broadly speaking, substantially new approaches for performance measurement should be developed so that operations in the new economy can be more effectively managed.

### *Operations strategy and competitiveness*

Possibly one of the most affected sub-topics of POM with the upcoming of the new economy is Operations strategy and competitiveness. This is a relatively young sub-topic (the seminal articles, on "manufacturing strategy", by Professor Wickham Skinner, from Harvard University, date from the 60's and 70's – Skinner 1969; 1974). However probably because of its very origin, its development still revolves around

manufacturing operations in well defined manufacturing units. The techniques and approaches of Operations strategy need to be developed so that they incorporate the strategy design and management of networks of productive operations that not necessarily generate only physical products but a package that also includes services. To the traditional basically "top-down" approach (present in most of the current operations strategy frameworks), also a "bottom-up" approach should be added in which emerging and resource based strategies should help consider the more knowledge-intensive assets of new economy operations. Traditional Operations strategy approaches also either adopt the "trade-off" approach to performance attributes (Skinner 1969) – in which one assumes that an operation cannot improve simultaneously in all performance attributes or adopt the "best practice" approach (that sometimes make believe that there is no such thing as "trade offs" in operations). When facing the new economy conditions however the learning aspect of the strategic process gains importance and less static concepts that incorporate the learning aspect such as the concept of dynamic capabilities (Teece and Pisano 1997) can be helpful but still needs further development for practical use. Traditional operations strategy frameworks also normally ignore the possibility of cooperation with competitors (sometimes called "coopetition"). With the highly dynamic environment in which the new economy operates, with windows of opportunity opening and closing quickly, the agility of virtual multi-company organizations that might include competitors in coalitions to seize temporary opportunities should be seen as a real possibility for the operations strategic processes. Another issue that certainly deserves further investigation is the use of information intensive assets to explore the possibility of achieving superior levels of agility, security and reliability brought about by the possibility of acquiring, monitoring and tracking 100% of transaction information in operations networks in real time, continuously and at affordable costs. However, we now have to learn how do deal with universes of data rather than with samples of data. In many situations it is not substantially more costly to acquire all information about a process than it is to acquire samples of information. This is wonderful, but we need slightly different statistics and different tools to help managers digest the gargantuan volumes of data that are now available.

*Product development and process selection*

Here, the traditional methods of product development (that emphasize the development of physical products) should be complemented by methods that are able to deal with "value packages" (Corrêa et al. 2007) that include physical goods and also information / knowledge / service components that the new economy technology allows and the new economy markets require. This substantially affects the very way products are developed. Concepts such as "design for manufacturability" should be expanded to include "design for effective use" and "design for reuse/recycling" because some times the products in the new economy incorporate information/ software/ knowledge to facilitate its use (as in the case of the Bunge example in a previous section of this paper). Simultaneous engineering in two dimensions – product and process development and in three dimensions, including the simultaneous development of product, process and supply chain (Fine 1998) should now consider a 4$^{th}$ dimension for development: the customer experience/ relationship dimension. In product development processes of the new economy the "timing" of the product introduction and the so called "time to market" are essential aspects. Some times arriving earlier in the market is more relevant than arriving with quality perfection or lowest price but late in the market. In order to be successful given these conditions, maybe new approaches are needed. On top of it, consider the need to deal with complex networks of cooperating organizations (that many times include competitors – for e.g. competing pharmaceutical companies frequently join efforts in the expensive activity of new drug development). These new approaches must be studied, researched and taught to managers going to the market in the era of the new economy.

*Supply chain management*

This sub-topic is subjected to the influence of many of the new conditions of the new economy. It is now necessary for instance that the activity of production process selection ceases to be performed in an isolated stand alone fashion, inside a productive unit to be performed in coordination with the process selection of other production units in the network. The network of operations should now be the unit of analysis and it is the production process selection of the network that should be aligned with the market needs. For instance, if one unit of the network chooses an efficient but not-so-flexible pro-

cess and the subsequent one selects a flexible but not-so-efficient process, these misaligned decisions will certainly come at a cost for the supply network performance. The POM body of knowledge has mature and well established models to help with process selection - e.g. Hayes and Wheelwright's (1984) product-process matrix – for the strategic selection of a production unit process. Not much however has been developed in terms of frameworks to help select processes for the operations networks of which the new economy is made (there are exceptions though that confirm the rule such as Fisher 1997). Another decision that deserves more research attention in the new economy is the "make or buy decision" – in other words, what part of the overall process will be performed by the company in analysis and what part will be delegated – or "outsourced" – to partners. What are the variables that should be taken into account when making this decision so that each of the network partners gives the network performance its maximum contribution? This decision increasingly requires that a more strategic approach is adopted than simply deciding based on marginal costs of making in versus sourcing.

*Quality management and, Simulation and decision making models*

In terms of productive process quality "improvement", the easy, cheap and fast (many times, in real time) access to the universe of information related to the networks of operations and their flows can substantially contribute to fast identification of alterations/ imperfections in the flows of materials, products, customers and information, allowing for much shorter control and correction cycles. With shorter control cycles and the corresponding accelerated learning, the improvement processes can also be accelerated and intensified. All this is desirable, no doubt, but how to really get the most value out of the data universes now available without suffering from "data asphyxia" is something that still requires development in the field of operations management. Another area that deserves further attention is quality management. In the old economy, the total quality paradigm preached that, if one day before the launch of a product, a defect or flaw was identified, the product should not be launched, the aim was to have a "perfect" launched product. What prevails today in some markets however is the attitude that the aim is to obtain a product with minimum levels of quality "acceptability" by the market, because pressures to shorten the "time to market" together with the high level of complexity of some products make it impossible to wait until perfection is attained and then launch the product. If the product was developed considering that it should be easy to gradually update, correct/ improve, and with easy download of new releases/ patches, it is even possible to count on the contributions of millions of users as "quality inspectors" providing valuable information about product correction and improvement.

Consider for instance the launch of a new operational system by Microsoft. Differently from the old economy, it is quite plausible that Microsoft prefers to launch a new operational system without having tested it to get rid of 100% of the flaws, because it is so crucial that they get to the market in the right window of opportunity. They then use the ease of connectivity to continuously collect data on flaws from their huge pool of users and also continuously update and correct their system remotely sometimes without the user knowing it. We are certainly not advocating one or another approach to quality (wait until the product is flawless and then launch or launch a somewhat flawed product and then gradually correct it). We are just trying to make the point that the new economy brings countless substantial changes that at least challenge some of the traditional paradigms of POM. Researchers and professors should acknowledge this fact and help develop and incorporate new approaches into the body of knowledge of POM so that our students do not get surprised when they get to the job market because in some instances of the new economy some traditional approaches and techniques are used very differently or ignored altogether.

*Production planning and scheduling*

This sub-topic is very affected by the changes of the new economy. In practical terms, the whole field of production planning, scheduling and control, developed mainly after the II World War, focused on productive units and assumed that access to information was highly constrained. With the changes in these basic assumptions, new approaches started to be developed, mainly after the 90's. These started to take into account that logistic flows suffer from some network-related effects that are not possible to analyze if the adopted unit of analysis is the production unit in isolation. One example is the so called "bullwhip effect" (Sterman 2000). These effects happen because of the lack/ difficulty of coordination among network partners. Although the connectiv-

ity technology needed to allow for coordination is largely available nowadays, what is still missing is actually how to get the best out of the available technology. The constraint is not anymore the technology per se, but maybe the managerial aspects that surround the use of technology: are the incentives of the partners of the operations network aligned so that they agree to share information and coordinate decision making processes? Are the cultural aspects surrounding cooperation in place in the relationships along the network of operations? Is the right level of trust present in the network? How to foster and maintain trust among partners that for a long time have gotten used to conflict rather that cooperation in network relationships? These are aspects that need to be addressed if the field of POM intends to remain relevant in the new economy.

*Ethics and the environment*

The intensive use of information technologies in operations management causes interesting ethical issues to surface. It is increasingly possible to track all the steps that an individual takes during his/her day-to-day life based on the transactions he establishes with several information systems (for example by using his/her credit card) in commercial transactions, financial movements, etc. Companies are creating mega databases with detailed information about people's lives without careful discussions of the implications of it to individuals' lives and to society as a whole by our government officials and law makers. What is the limit, for instance, that companies should respect when collecting, selling and using such detailed information? To whom do an individual's data belong? This is but an illustrative example but the ethical and environmental considerations of this and other aspects of POM is something that have been insufficiently discussed in the current literature. We should not forget that POM is a wonderful discipline dedicated to the creation of value. However it is also a field that encompasses decisions that if poorly made have the potential of causing severe damage to individuals and to the environment. Consider Mattel and the largely publicized problem they had in 2007 with lead paint used by some of their Chinese suppliers to finish some of their toys and the potential health problems it could have caused to thousands of children. An apparently simple outsourcing decision turned into a public health problem. We need to prepare our students to make right decisions not only from the viewpoint of corporate costs and benefits but also from the viewpoint of social and environmental costs and benefits. This has always been true and important but, with the new economy, with the ease with which companies re-design their production network configurations and flows, the problem intensified tremendously.

*Forecasting*

The sub-topic of sales forecasting is one that is bound to be substantially altered by the new economy. Nowadays, there are companies (e.g. www.genexis.com) that specialize in collecting, consolidating and treating transaction information in specific industrial sectors, obtaining not samples but 100% of the transactions between partners in a supply network. This allows that short term forecasts, for instance, can be updated almost on-line, in real time, after every new transaction. We need that analytical models be developed and taught which are able to deal with such universes of data so that operations managers can quickly identify patterns that are relevant to the operations-related decision making processes in the middle of this ocean of data.

*Project management*

The changes of the new economy have made Project management grow in importance. An example can illustrate this point. The pharmaceutical companies can easily spend US$ 500 million in developing a new drug. Production and distribution costs of the resulting medicine (that contains the drug) in its package, therefore become relatively less relevant. Project management tends then to be relatively more relevant than process management in this particular circumstance that holds true not only for the pharmaceutical companies. The high technology sector tends to work under similar conditions: an Intel plant (which manufactures the processors that equip computers) is designed to last 4 years – after that the technology changed so much that the plan is rendered obsolete. If the project management behind the building of this new plant fails, one of the following three will certainly happen: either the costs (sometimes several hundred million dollars) go up possibly by millions, or the dead lines are not met (with possibly disastrous consequences for the "time to market" of the products) or the specifications of the plant are not met (also with potentially disastrous consequences to production levels, quality etc). The POM body of knowledge included project management, no doubt. However maybe we should rethink about the emphasis we give to it in our courses.

## FINAL COMMENT

The new economy brings very interesting challenges to the field of production and operations management. It is our (researchers, professors and practitioners) duty now to face this challenge competently so that the field of POM continues to give its valuable contribution to the continuous improvement of the efficiency and effectiveness of the value adding processes of our society. Although we started this research with the objective of finding out elements to define research and teaching agendas for the new economy POM in Brazil, we believe that the findings can be reasonably generalized to other regions too.

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