RC22884 (W0308-107) August 28, 2003
Other

IBM Research Report

Logistics Everywhere: Can One Help in Most Managerial Problems by Using a Logistical Approach?

Charles Tresser
IBM Research Division
Thomas J. Watson Research Center
P.O. Box 218
Yorktown Heights, NY 10598

Gilles Paché
Centre de Recherche sur le Transport et la Logistique
Université de la Méditerranée--Aix-Marseille II
France

Research Division
Almaden - Austin - Beijing - Haifa - India - T. J. Watson - Tokyo - Zurich

Logistics everywhere: can one help in most managerial problems by using a logistical approach?

Charles Tresser
Mathematical Sciences Department
IBM Thomas J. Watson Research Center, USA
tresser@us.ibm.com

Gilles Paché
Centre de Recherche sur le Transport et la Logistique
Université de la Méditerranée–Aix-Marseille II, France
pache@iut.univ-aix.fr

It is now an accepted fact that logistics management aims at providing service quality, cost reduction and efficient after-sales support through an effective monitoring of supply chain operations. To reach these goals, the logisticians have learned to clearly formulate the problems they have to solve in terms of product flows optimization and to implement methods to solve these problems, that are both rigorous and rational. This paper proposes that it should be possible to apply and generalize the logistical approach to other fields, including such unlikely ones as advertising and knowledge management.

Since it began to be used by some large US manufacturing firms after World War II, logistics has been more and more effective. After some initial attempts with various degrees of success, both the definition and applications of logistics management now seem to be quite stabilized: "*Logistics refers to the systematic management of the various activities required to move benefits from their point of production to the customer… The concepts of benefits is multifaceted one that goes beyond the product or service itself to include issues regarding timing, quantity, supporting services, location, and cost. So a basic definition of logistics is the continuous process of meeting customer needs by ensuring the availability of the right benefits for the right customer, in the quantity and condition desired by that customer, at the time and place the customer wants them*" (Gourdin, 2001:2). We shall thus not try to question the traditional approach of logistics management, but will rather begin here to defend the thesis that it is possible to significantly enlarge its scope to include other fields which comprises some (and probably many) issues that are important for management sciences at large.

More precisely, we claim that there are several examples of disciplines of which each could be reformulated –at least in part– and should be reexamined as problems in logistics management. In this first paper we will devote our attention to expound this thesis, we focus mostly on two aspects of management sciences that we have essentially chosen at random, advertising and knowledge management. These disciplines, or domains of activity, are usually considered as quite distant from logistics as well as quite distant from each other. Yet, we claim that the basic problems in these disciplines can be recast as instances of a quite basic and general formulation of logistics management, were one focuses even more than usual on the basic concepts of optimization and flows. Defending such a thesis requires two components: one analytic and the other synthetic. For the whole approach to make sense, the analysis needs to reduce logistics management to its very core, and the core needs to be expressed in a way that is universal enough for it to be detected it as an essential part of the skeleton of other disciplines. The synthetic part is reduced, at this early stage of our thinking, to the case study of the two examples that have been previously mentioned.

This paper examines the foundations of logistics management, starting with the original goals, up to the most recent approaches and strategies (including supply chain process integration). More that just reviewing the subject, we defend the point of view that, despite its obvious evolution and beyond the progress that have been made, logistics management has not changed in a fundamental way, and has not undergone any significant rupture since it began to be part of management sciences. A typical MBA course on logistics management would claim "to increase the firm profitability, thus responding to the expectations of the shareholders" but the motivations hide the core mental processes. In other words, logistics (supply chain) management –that is still today limited to a support function to help better produce and better sell– is, in the depth of its problematic hard core, organized around the concepts of optimization and flows. Attacking disciplines where the methods of logistics (supply chain) management have not yet been put to work, one identifies what are the entities that need to flow, to where they have to flow –and to what benefit, what are the objectives to be optimized, and under which constraints such optimization must be performed (or approximated). We insist on the fact that the choice that we have made of the two disciplines to be taken as examples has been random: we just wanted one far fetch example to discuss briefly, and one example that would be provocative, and that could be discussed in some more details at this early stage of our research. As this paper is interdisciplinary, we have made an effort to spell out all technical acronyms, even those that are most standard in logistics management[1].

An "orthodox" view of logistics

Logistics management, which is the result of a slow maturation process in the USA and then also in Europe, has its deep roots in military sciences, the transition happening when soldiers that had worked on developing it as a modern science came back to civilian business after World War II. Until quite recently, it was founded on product flows optimization, a point of view that has been challenged by the new trends toward supply chain process integration that have been pushed forward by some researchers. We rather consider that this challenge is not motivated by any serious discontinuity in the reality of logistics management as the evolution over recent years has confirmed the presence of one major objective: to optimize inbound and outbound logistical operations to increase the firm profitability and thus respond to shareholders' expectations. In fact the commonalties of the problem solving methods of logistics are so broad that not only do they apply to both the most recent trends as to what was in favor before, but also they apply to fields quite remote from product flow optimization.

Product flows optimization

Supplying cities with food coming from remote countries to avoid famine is a problem with a clear "logistical" nature which arose in Europe as fact back at least as the Middle-Ages, as shown in recent historians work (see for instance Abad [2002]). Should one identify there the first enlightenment to a logistical approach? Certainly not as one cannot identify any real global thinking toward bettering the means of provisions distribution: men were then most often enslaved to random factors, such as climatic conditions, on which they had no grip. So

[1] *After a first version of the paper has been circulated, we got very encouraging comments from Alan Hoffman and an anonymous referee of* Supply Chain Forum: An International Journal. *We also got useful information from Naoki Abe, John Forrest, Bill Grey and John Tomlin about various uses of the methods of logistics in aspects of advertising operations. What these colleagues, now all from IBM's Research, have taught us is that several authors have used optimization techniques to better choose, for instance, the distribution of some advertisements, in classical settings and more recently on the World Wide Web. However, it seems that the point of view developed here which, in the case of advertising, aims as reformulating that discipline in a holistic way into a problem of logistics management is new. On the other hand these references given to us on applications of optimization methods to advertising let us expect that the approach developed here should bear fruits at some stage, and not remain just a philosophical perspective.*

to speak, while logistics problems for sure existed, and to some extend were routinely solved locally by necessity, the very idea of "logistics management" was still to be born. It appears much later, and its origin is undoubtedly military. Any randomly picked encyclopedia would teach us that logistics primarily refers to the combination of transportation, provisioning, and inhabitation means to ensure the success of the troops in combat. If big enough, the encyclopedia will probably add that the father of military logistics is the Napoleonian general Antoine-Henri Jomini, the author of the famous *Précis de l'art de la guerre ou nouveau tableau analytique des principales combinaisons de la stratégie, de la grande tactique et de la politique militaire*, published in 1838, and where he presents logistics as being one of the six parts of the art of war.

All along the twentieth century, military logistics has undergone spectacular developments, that culminate with Operation Overlord, the landing of the Allied troops on June 6, 1944 on the occupied European Continent. The French coastline was fortified and defended by particularly well equipped German troops so that it was essential to think in a very rigorous way to the different steps of the invasion so as to avoid renewing of the cruel failure of Operation Jubilee which was attempted on the beaches of Dieppe in March, 1942. To this effect the Anglo-American Head-Quarter put together organization and logistical means able to anticipate and overcome the terrain constraints. Closer from us during Operation Desert Storm in 1991 the media have often mentioned the importance of logistics in the success of military operation, in fact a necessary complement to the fire power of the Allied armies, and the quality of logistics still improved dramatically during the 2003 Iraq war. In a recent study for the Institute of Comparative Strategy, Richardot (2002) also pointed out the crucial importance played today by the Combat Logistics Force (CLEF) in the organization and efficiency of the US Navy. The link between logistics and the success of military operations thus remains particularly strong; even if one knows today that logistics is also (and mainly?) part of management. We must remember however that the application of logistics in manufacturing firms, just after World War II, directly follows from what had been learned from Operation Overlord and the overall process that represented winning the war. The distances to cover to free Europe obliged the formalization of re-supply and transport processes, which were recognized as applicable to American firms as they needed to supply customers located at hundreds or thousands of miles from the factories.

This explains that logistics management was first perceived by the American Marketing Association (1948) as the planning of the operations linked to the dispatch of goods from the factories to the consumers (transport, handling and warehousing). The goal was to adapt and apply the tools from Operations Research, tools that had been initially conceptualized in a military context. We refrain from getting more into the history of logistics management (see for instance Lambert et al. [1998]), but we want to stress that its military origins have strongly influenced its evolution till the 1970s. During that time span, the main questions continued to revolve around implementation of constrained optimization methods to help in the dispatching of goods from the origination points to their destinations. One of the best known example of such a problem is the design of the delivery round that minimizes the total distance covered as a function of the stores to be served in a given geographical area (an example of the Traveling Salesman Problem, simple to formulate but quickly too hard for any computer when the quantity of stores increases!). Logistics management thus limited itself to the "one best way" in terms of product flows monitoring. This focus was legitimate as the markets that were beforehand local and national became progressively global for the multinational corporations, which accentuated the problem of dispatching goods with at low cost and high service quality.

For well informed observers of logistics management, Magee (1968) made a significant step forward by introducing the concept of logistical process and its three systems: (1) the procurement system; (2) the operating system; and (3) the physical distribution system. However, we think that there is a continuity between the approaches of the American

Marketing Association (1948) and of Magee (1968) as the analysis remained based upon product flows optimization. Fundamentally, the quite important contribution of Magee (1968) is simply not to reduce anymore logistics management to physical distribution system. Contradicting the former reductionist views, he argued that the manufacturing firm must also optimize the product flows inside the production cycle (work in progress [WIP] management) and, downstream to the operating system, inside the physical supply cycle (materials management), if it want the total logistics system –or pipeline– to function correctly. But can one speak of "rupture" when, for Magee (1968), the issue remains to best plan the logistical operations using tools that are more and more sophisticated such as the program evaluation and review techniques (PERT) and the material requirement planning (MRP)? By the time his book appeared, the world had grown more complex, the markets where goods are consumed had become larger and further, creating the need to coordinate even better than ever before the transport, production and warehousing activities. More than ever before, logistics management fell an urgent need for managerial procedures that would use mathematical algorithms to bring the best solution at the right moment.

In fact, even a few year later, and despite its revolutionary contributions, the way Heskett (1977) envisions logistics management remains captive of the same "product flows optimization" paradigm. The economical landscape has changed since the beginning of the recession in the Occidental countries, and in the particularly difficult context of price competition, firms must adjust their logistics (in the physical distribution system, the operating system and the procurement system) to stick as closely as possible to the downstream demand in order to reduce costs. Much before such reasoning became in fashion, Heskett (1977) indirectly introduced the idea that efficiency depended on a double paradigm: lean production and agility. From a concrete point of view it is the actual sales, and no longer sales forecast, that must trigger the operations of supply of raw materials, production, transport, etc. Thus, Heskett (1977) implicitly conceptualized the just-in-time (JIT) strategy, at the very same time when the first applications were operated in Japan by Toyota! But if that vision was with not contest an innovative one, it remained centered on manufacturing firm, whose survival depended on the optimization of their own logistics system. A good JIT strategy will first induce a reduction of the stock level of goods and materials, while it may be the case that the stock level abruptly increases at the retailer or wholesaler locations.

Supply chain process integration

Do the recent trends in logistical thinking challenge the orthodox vision in terms of flows optimization? It is possible to answer "yes" and "no" at once. Of course, for the majority of authors (see for instance Underhill [1996], and Mentzer et al. [2000]), all the firms involved in vertical exchange relationships insist on the new integrative dimension of the logistical processes: to bring the right product at the right time and at the right place to the consumer, it is necessary to coordinate all of the logistical operations along the supply chain. An effective logistics management thus becomes the means to generate a close and durable collaboration between suppliers, manufacturers, retailers, and third party logistics (TPL) service providers, so that they create together value for the customer (Grey et al., 2003). But we must also admit that the objectives of a supply chain process integration remain to create value for the shareholders, which in turns requires enforcing product flows optimization.

As a first rough estimate, even if this vision is sometimes disputed, a supply chain corresponds to a set of operations supporting: (1) logistical activities of procurement of materials in a network of first-tier and second-tier suppliers; (2) transformation of materials into semi-finished or finished goods; and (3) physical distribution of semi-finished or finished goods to customers. The basic idea is that these activities and operations must be perfectly synchronized within the framework of supply chain management (SCM), so that customers can benefit from the best possible service quality at the lowest cost. Stevens (1989) suggested the existence of four steps leading to the emergence of genuine SCM:

- *Step 1* is distinguished by complete functional independence in so far as each function operates quite separately from all others, protected by "bricks" (stocks) allowing differences between their operating rhythms;
- In *step 2,* manufacturing firms recognize the urgent need for a minimum coordination between related functions, *e.g.,* marketing and physical distribution, so as to eliminate a number of malfunctions;
- S*tep 3* is there next to increase the coordination effort by implementing the comprehensive planning of internal flows from downstream to upstream; leading to
- *Step 4* when supply chain members finally become aware that they are merely part of a whole.

The virtues of this evolutionary approach are to highlight the fact that SCM refers to a succession of tradeoffs (Lambert et al., 1998). Tradeoffs occur within a firm (*e.g.,* between purchasing and materials management, materials management and production, etc.), but also between firms belonging to the same supply chain (*e.g.,* between purchasing and first-tier suppliers, marketing & sales and customers, etc.). The objective is to find overall solutions which, through an intra and inter-organizational collaboration, will avoid a waste of resources and increase the profitability of supply chain members. An interesting case is that of convenience goods manufacturers, where large retailers and TPL service providers work together to create the packaging of a new product to reduce logistical costs, from factories to store shelves. One could also invoke the case of an automotive manufacturer and its main suppliers deciding to implement a common "milk round delivery system": a collection of vehicles that visit suppliers in a predetermined and negotiated order, at pre-agreed times during the night, from which follows a reduction of the congestion at the assembly plant (Lamming, 1993).

With some hindsight, and with all due respect, the progresses of logistics management over the fifteen years or so till now in 2003, it appears clearly that the SCM approach does not introduce a major rupture. Of course, SCM stresses the indispensable collaboration between supply chain members in an extended enterprise (Naccarato et al., 2000), but the object of analysis still remains the product –and information– flows. On the other hand, thanks to technological progresses, and notably computer technologies (from core hardware to software and algorithms, and more recently pervasive computing that enhances considerably reach and communication), it is much easier to optimize under constraint now, than say fifteen years ago, and this is where the essential change resides. For instance, a small and medium-sized enterprise (SME) could now treat in real time some optimization problems that would have been too complex for most large companies in the 1980s. Thanks to these new technologies, the supply chain members can adapt faster to all sorts of environment changes, and execute effective time-based strategies, where the game involves conceiving new products faster than the competition, and then produce them and deliver them to the customer faster and with no mistake. Since over a half century, logistics management has thus proven its capacity to better the performance of the firm, and more globally, of networks of firms by relying on a logistical approach with a universalistic ambition. From this point of view, could not logistics management become the means to help treat managerial problems that go largely beyond product flows optimization?

The central thesis and a first example

Clearly, the goal we have set to ourselves is quite ambitious and risky, but the rewards could be tremendous for most of management sciences. This began with a strong intuition that logistics was extremely prevalent, with instances possibly across most of exact sciences, from the Principle of Least Action that governs most of physics, to the way a cell work in biology. We will refrain from formulating our thesis to such generality, and concentrate in the first paragraph on a formulation that focuses on management sciences. The formulation we

provide is still quite brief but we expect that many will join us in the adventure that we see ahead, and will develop with us the fundamentals as well as the applications of the ambitious program implicitly defined by our thesis. We have picked at random one discipline in or close to management that would be as improbable a good choice as possible. It is advertising that was thus chose and that will be treated as a very first example in the second paragraph, still quite superficially at this stage, but the reader may already see there some possible benefit of our approach, such as generating, around logistics a language and a formulation of the goals that would permeate all divisions of the firm, and provide qualitative frameworks. We are among those who believe that qualitative analysis is important when it is not simple hand waving; after all, aren't qualitative improvements often far superior to quantitative ones?[2]

Logistics everywhere: analysis and the thesis in a nutshell

Having taken a weakly reductionist approach, which loosely speaking abstracts logistics to optimization of some flows, we had to make an adjustment when passing from pre-SCM to SCM: considering SCM forced us to speak of "product –and information– flows" rather than just of "product flows" as what needs to be analyzed and then optimized. This is where the "yes" and "no" answers to the question on whether SCM has brought a rupture in logistics management come together. If one believes that the fact that the flows referred to product in pre-logistics management are were essential, one has to consider SCM as a revolution. Otherwise, it becomes more of a quantitative progress, where one optimizes over as many parameters as technologies permit and as far as the efforts provide returns that benefit the shareholders.

This is the point of view we have adopted and pushed to its limits as the basis of our thesis, that, "*in some sense, the logistics management approach can be omnipresent in the way one tackles all sort of problems, from exact sciences to management*." In particular, and we will restrict ourselves to those aspects in the present paper, most if not all the issues that relate to decision support, organization, processes, etc., if fact all that concerns the life of the firm, as a separate entity and as part of a web of networks of all sorts can benefit from the logistics management language and methods. This mean in particular that we believe that the transition to SCM was mostly due to the emergence of technologies that allowed to treat bigger and bigger optimization problem and to collect more and more information that could be taken advantage of in the optimization process. But we propose to go much further and in what we think is a natural next conceptual step, we propose in fact to treat most other problems in management as problems in logistics management.

Once other aspects of the life of the firm, or of some networks of firms, will have so been treated, we expect that some large scale integration of the scope of logistics management will take place, but we will refrain to make any attempt at that here: the bricks must be shaped before a wall can be built. In fact, for the time being, we will content ourselves by providing two examples that we hope will illustrate the soundness of the ambitious program that we offer here to the broad community of people interested in all aspect of management. What we aim at for now is formulating classical problems as instances of logistics: a broad sampling of expertise may be needed to describe how to manage these logistical problems by themselves, even before the grand unification across the board takes place. It may be the

[2] *This is the idea defended notably by Williams (1986, 1990), where he indicates that when confronted with combinatorial problems that are too big, mathematical optimization fails because the computiong power that would be needed is out of reach, sometimes forever (the computation would last many times the life of the universe with the fastest machine that could ever be built). Mathematical optimization must then leave the place to some form of heuristics (that may then possibly use mathematics). Williams illustrates this point in the context of the «*Traveling Salesman Problem*» that we have already mentioned. We are indepted to John Tomlin for pointing us to the work of H.P Williams after this paper was first circulated, and to H.P.Williams for helping us in getting fast access to his work. Some of Williams' theses look indeed rather close to ours, but he defends «optimization evrywhere», a point of view that now has many supporters, rather than our «logistics management everywhere» which might assume a smaller «everywhere» but seems to not have been explicitly advocated before.*

case that the logistical approach only brings qualitative changes to some problems. We believe that this may still be quite valuable, and we will begin with the advertising field which may be one of the toughest challenges to our thesis: there we expect to convince some of the validity of our proposal by exhibiting the mere possibility of a discussion of advertising as an instance of logistics.

Before we get to the first example, we want to express our opinion is that it would be unfair to condemn our approach just because after being reinterpreted as a form of logistics, a discipline only admit a qualitative discourse, and for instance, only qualitative optimization. In fact, even in the most traditional application of logistics management, reducing its impact to optimization in the most mathematical and formal senses would be an important mistake. Thinking about using empty trucks for new services on the way home, or imagining new shapes of parts to improve packaging by allowing much better bigger ratios weight-to-volume are just some samples of how qualitative inputs, that are facilitated by formulating the right problems, can have dramatic impacts. The strategy we thus propose to have quick benefits from our thesis in new disciplines is to map logistics management as completely as one can to the new discipline (or map the other way round), and try in particular to identify early on the quantities that need to be optimized and the constraints.

Advertising as an instance of logistics

In order to recast advertising as a logistics problem, think of: (1) the message as the good to be transported; (2) the minds of the people one seeks as customers as the points of delivery (in first approximation, *e.g.,* for some products for which one desires a recognition beyond the strict customers crowd), and (3) the advertising supports as vehicles of transportation. Of course, it may be more adequate to distinguish the signified message and the significant message. This is good news! In fact, we interpret this example of discovering a natural distinction to be made among messages as an instance of a phenomenon that we expect to manifest itself quite often.

Conjecture: *A first degree interpretation of a problem as a logistical issue should often invite to refine the definition of the mapping from logistics management to the discipline to which the problem belongs, and such refinement of the mapping would improve the benefits of the approach.*

In the case at hand, thanks to such refinement, the signified message becomes the good to be delivered, while the slogans, trademarks, etc., become the package, which may have some implications on the relative importance of the elements which participate to the discussion and the way to deal with them. Remember then that in complicated logistical problems, those which are not just amenable to a linear optimization problem, sometimes one has to make a substantial detour in the approach before one can proceed to any form of systematic optimization. For instance, building a very expensive new road may give the key to the best solution in some typical logistical problems. We leave listing novel implications on advertising, if any, to experts, but existing practices such as advertising during the Super Bowl or the World Series might be considered as the counterpart in advertising of that sort of expensive road building. We will spend a few more lines on examining whether one can get constraints and objective functions which would allow to more efficiently cast advertising in the logistics framework. So far, we essentially showed the mapping to exist, but with little commercial or even conceptual advantage: a little more thought then reveals that we may need metrics to even start casting advertising in the optimization grinder.

Getting to such metrics may be the hardest task each time one wants to seriously apply logistics management methods to a new discipline. If performances of the whole system are the only metrics easy to grasp, possibly empirical trials are the way to go to get some traction

from the logistical/optimization approach. For instance, the methods of experimental economics could be used, and many observable measured, the correlation of which to accepted signs of success could then in turn be evaluated. However, there might be cases, and advertising might be one of them, when one should not be too ambitious to begin with, and be content with the logistical vision helping teach and otherwise communicate about some fields of human thought or activity (but see Remark 1 below that is much more optimistic). Maybe also in some cases where instinct is how things mostly get done as of now, but sometimes some hard decision have to be made at times, the logistics language will allow to better formulate the questions the experts and practitioners have to face, and it seems reasonable to expect that unifying the language will help communication in the firm as well as between firms.

Remark 1: *As mentioned previously, we have learned of work using optimization techniques to improve the distribution of advertisements on the World Wide Web (see for instance Langheinrich et al. [1999], and Tomlin [2000]). John Forrest told us that he was involved in trying to use optimization to distribute advertising in the UK as early as 1967: magazines were the support of the advertisements then, but the results were unsatisfactory, probably because of the limited power of the computers available at that time. These works did not start from a full reformulation of the advertising problem in terms of logistics management, but they certainly help support the idea that the approach that we propose has most probably very direct commercial value besides its philosophical implications and the way it may facilitate communication inside the firm and between firms.*

From knowledge management to logistics

Knowledge management (or KM), as it is known, at least in the circles of information technology (IT) where everything that counts gets referred to using an acronym, is quite interesting a field. Think about it: managing knowledge, to make it more available when one needs it, for the good of the firm or to benefit to human kind, or even beyond that, to help generate the knowledge needed to solve problems that were not solvable before knowledge began being managed, all that sounds like a dream. Who would not like management of knowledge to work better? Probably, as a fashionable element of the tool kit for trendy executives, KM died with the year 2001, after tremendous popularity following the publication in 1995 of two books whose titles marked the initial hopes in the promises of the new field: *The knowledge-creating company* (Nonaka and Takeuchi, 1995), and *Wellsprings of knowledge* (Leonard, 1995).

A snapshot of how the field evolved is provided by the reprint collection of some major management articles on KM (Harvard Business Review, 1998), that start with an early article of Drucker (1988), where the author writes that twenty years from then, the typical (large) business will be knowledge-based. From the same time as that review, let us also mention the monograph *Working knowledge* (Davenport and Prusak, 1998). Most contributors to the KM literature were also the people benefiting most directly from KM, *e.g.*, by conferences, consulting, or teaching. This may explain why during its few years of intense success, KM depended, not only on culture (this was often said and written), but also on the models for national politics, the country economics, the attitudes of Wall Street, whether long term success is expected from the firm, if the strategy of the firms that paid most for KM consulting looked or not beyond the end-of-quarter bottom line, the morality in corporate board rooms, and more factors of this kind, which were mostly occulted.

We will in deed see below that at least another element, some successful and authentic artificial intelligence (AI) that would serve for some aspects of KM, has been ignored. As we will see, this explains more than anything else its falling out of grace as a field (while less

ambitious sub-disciplines such as unstructured data analysis begin to flourish). A logistical approach leads us to rethink what should be the fundamental concepts of KM. Then we re-examine at the light of what consider as fundamental concepts, the usual building bricks of the KM discourse: data, information, and knowledge. This occupies the second paragraph. The logistics approach is then explicitly invoked in the third paragraph, although we consider that some of the benefit of the approach are already obtained just by the way the logistics vision conditions the whole problem (see in particular Remark 5 below).

Fundamental concepts

KM needs first to define its basic objects, whose list can be extended, but has to contain the following three elements, to which we will restrict ourselves: *data, information,* and *knowledge.* Indeed, several authors also recognize that some nomenclature of these basic three elements of the field is a necessary prerequisite to any serious discussion. Our approach is to consider that these three elements are not fundamentals, but refer to some real –but maybe also some virtual or imaginary– universe, and also depend on who attempts to describe, understand, exploit, make better, or more generally transform such universe, and for which goals. The rationale between the difference is probably that we are not interested only in business, but indeed in interdisciplinary issues (even if we do not discuss here physical and natural sciences). Data, information, and knowledge are not only valuable in the business world, and we want to make sense of them beyond that. Here are the elements we think need to come into play to define the basic concepts that need to be managed by KM:

- *The world elements*. They comprise objects (including living entities and people), or at least the object aspect of them which all that one may access or need in some cases, but also entities that allow a space description: (1) histories, that need space-time descriptions, with non-negligible time span, (2) events or histories, essentially instantaneous, and (3) mixed collections of the above, as may be needed to capture a personality for instance.
- *The people and groups*. Groups have concurrent interests, but people in groups may have also diverging interests, some in support of the group goals, some quite independent of that. There may be neutral entities, and groups or individual whose position is well established, but unknown to some or all other parties. Groups usually come with explicit and sometimes also different hidden structures, partly hierarchical or completely.
- *The cultural models*. They directly condition the ways of thinking and the ways of action of both the emitting and receiving parties. This comprises political trends, opinions, public or secret agendas, etc.
- *The emitted and received messages.* It is the communication between parties that allow them to cast in such or such direction. Messages should be distinguished also according to their formal contents, intended contents and perceived contents.
- *The scales*. This refers to scales, precision levels, and/or granularity at which one expects to know and/or understand a problem.

Remark 2: *The reader will probably detect already some effects of logistical thinking in the above list of basic concepts, some desire so to speak, to cast the problem in a form more amenable to be mapped to logistics*.

Revisiting data, information and knowledge

At this early and basic stage of our logistics approach to KM, we feel that from the above list, the world elements and scales are the crucial dimensions on which to anchor the analysis, which explain why we insist so much on the pair WeS (World element, Scale). A strong factor of the feeling that dictated this choice is the fact that this allowed us, we think, to arrive

independently and rapidly, at some core ideas of KM, while bringing to light ideas that may transcend what was done before.

The data set attached to a WeS is the collection of all that needs to participate to a full description of the world element in question at that scale being used. A data element, data point, piece of data, or sometimes just a data, is an atom of description. For instance, a stock name, a time and a price –say $102.23 of the Alpha stock at that time– forms some data set, in fact of a special kind as it fully defines a WeS. In this example, the price ($102.23) is a data point. However, the digit zero is not a data, while the collection (0, third digit in decimal notation) is data, of limited value, which is contained in the price.

A more ordinary data set, as it is different form the WeS, is attached to a bottle of milk at macroscopic scale. This data set comprises a bottle shape, the volume it contains, the volume it is supposed to contain, if it is in good condition or dirty, or the closing device has been tampered with, the date, the expiry date. One could add to that any description of the product (*e.g.,* is it regular or low fat?), the quantities of nutrients, the nutrients listed on the bottle, the region where live the cows from which milk has been collected for this patch of milk, the veterinary assessment of these cows, the history of the trust one may have in that veterinary, the assessment of the competence of this veterinary and of who provide this assessment, etc., and the list is probably far from complete!

Remark 3: *Probably, no one will need, nor ever be able to determine the data set of any WeS except for simple ones as in the first example we gave.*

Information has several meanings that should be clearly distinguished. First it is possible to analyze it as a collection of data intended (by who select and/or communicate it) to provide some usually partial, but sometimes full, knowledge of a WeS; there is some strong cultural dependence there. One can also see it as a collection of data that are thought (by who receive and/or use it) to provide some (usually partial but sometime full) knowledge of a WeS; there is some strong cultural dependence there as well. But information presents itself also and mainly in the form of a message, or more generally, means to store or communicate what it is all about in one of the previous senses.

Remark 4: *Receiving any information changes the state of knowledge of some WeS, possibly up to revealing the previously unsuspected existence of that Wes, or even the unsuspected existence of a WeS of that sort all together. Information can also change comprehension, and further high functions of the brain, but will stay as far as possible from a discussion of such matters.*

Remark 5: *According to Davenport and Prusak (1998:2), the remark that "information is data endowed with relevance and purpose" goes back at least to the paper by Drucker (Harvard Business Review, 1998) that we have mentioned previously. We fully agree with Drucker's statement (1988). However we feel we got it as a Lemma, instead of simply a definition, as we think it follows from the definitions of data and information we have provided.*

Finally, when it becomes knowledge, information comes in two types, passive knowledge (PK) and active knowledge (AK), a splitting which does not prevent further or concomitant dichotomies as we will soon discuss:

- PK of an individual or of a group is the set of data and information that can be used by this individual or group. Some part of it can be external to any human, as long as it existence is known and as long as it can be retrieved.
- Implicit PK is the knowledge that could be generated from a given data and information set, some by just locating it, others after some possibly very hard analysis.

- AK is knowledge that can help decide, act, or generate new knowledge.

The three concepts of data, information, and knowledge as developed so far are not orthodox to the KM way of discussing them. Notice however that we have seen that we obtain the statement of Drucker (1988) as a Lemma, instead of a definition, which is a strong argument in favor of our approach. The following dichotomy of knowledge between tacit and explicit knowledge is, to the contrary, pretty much central to the development of KM in the 1990s. The notions of *tacit knowledge* versus *explicit knowledge* were introduced by Polanyi (1983) in the 1950s, and used by Nonaka (1991) and Nonaka and Takeuchi (1994, 1995) to formulate a theory of organizational learning around the theme of conversion of knowledge between these two forms. They appear to us as both more obscure and essentially parallel to AK and PK, except possibly for those have worked with them for a long time as some KM experts.

Calling logistics to the rescue

We want to demonstrate that the logistics vision helps gives KM some structure, and that this point of view indicates easily to why KM failed (or at least failed so far). What we really hope is help give KM some more life (under this name or not), as we believe (and everyone witness) that management of knowledge will be essential in years to come, be it only because so many firms accumulate massive quantities of data and information at least, but also often massive quantities of knowledge; it is clear that those which will be more able to use parts of it will have decisive advantages. So we need first to play the basic game of "what is what?" to map standard logistics to KM. Such mapping game should be the basic exercise in any new conquest of logistics as it invades the intellectual world, and often an exercise which needs to be repeated, sometimes frequently, when trying to deepen the logistical approach. We may also need to understand what the logistical game is all about in KM, the field that we are now contemplating, as will also be needed in each new field. Here some elements of the mapping:

- *The goods:* the data, the information, and more generally any form of knowledge elements (some have expiration dates, others long-shelve life);
- *Some shelves:* the heads of personnel, at various level of hierarchy in the organization;
- *Other shelves (for long shelve-life goods):* the support for knowledge, *i.e.*, artifacts that encapsulate it;
- *The packages:* the form in which the data, the information, and the knowledge will be stored, retrieved, and shared or used in some form or another;
- *The transport vectors:* the various means to transport or transfer knowledge, from lectures to video tapes and coaching, etc.

Remark 6: *Some firms (*e.g., *technology companies) create knowledge as value* per se*, others create knowledge mostly as a means, to better produce what the company manufactures or more generally sells (*e.g., *know-how, work methods, controls, workflows, etc.).*

Next, we look at where is the optimization problem(s) that one may formulate with the elements that are images of traditional logistical entities under the mapping. Then, if not before, we must contemplate what are the goals of the parties, what is the nature of the parties, what is the economical system one wants to deal with, etc. Some questions naturally arise just because we need to know what are the objectives –as in any logistical problem– such as:

- Is the firm only working for the shareholders; is it family business built to last a few generations or something in between?
- Are there some grand goals, or any non-financial/non-economical agenda that also need to be part of the objective function design?

- Is it in an environment of harsh naked capitalism, or in a more socially oriented environment?
- Is the firm only interested in the end-of-quarter bottom line, if not what are the other horizons that the firm is really interested in?
- Are the longest horizons to be considered only for credibility and defend short time stock price, or is there really a long term strategy?[3]

Depending on a combination of choices and constraints, the natural quantity to be optimized could be something like the profit, the efficiency, or the long term averaged profit of the corporation, something of that sort. But thoroughly considering the large scale components of the objectives is not enough to help, or to save KM: the personal objective functions of people in the firm have to also be taken into account. In fact, not everyone may want all knowledge to circulate freely, especially if freely also means for free (*i.e.*, free from benefits to the sources of knowledge). Indeed, here is one fact that has to enter into the equations: everyone is happy to be a knowledge sink, if not obliged to prove that knowledge was acquired, but being a source for free may be dangerous, beside painful and not gratifying. Figuring out the right metrics, retribution, and related incentives and deterrence systems will be essential for things to evolve properly[4]. So we do believe that just thinking "logistics management" would help design KM strategies much better.

What KM seems to have most grossly missed is the full understanding that some forms of knowledge, especially of the tacit or active kinds, may be anywhere from hard to beyond present time capabilities to move around, or transfer, either from brain to brain, or from brain to machine (to brain), and if possible, possibly too costly (and cost becomes a more obvious game to play when one explicitly deals with optimization issues). Too much of the KM literature has advocated very strongly that there is much more to knowledge that just data, information, and passive and/or explicit knowledge. In doing so, the KM gurus have set expectations which could not be fulfilled because one would like to transmit genius, and would settle for transmitting high brightness, but we still cannot do it. This issue, which stands in the way of the success of KM, interacts of course with the previously mentioned issue that constitutes the lack of explicit description of the objectives[5].

We think that there is no serious progress to be made in the most nontrivial aspects of KM before significant progresses is made in AI: this seems in fact almost tautological as it is knowledge handling, thus something rather close to intelligence that we are talking about. Before AI makes real progress, advances in KM can be made however by lowering the expectations, and this is happening right now (often using weak forms of AI such as automated text analysis as well as it can be one now). For instance, many tools have been developed that allow the employee to find useful information about their own firm and about the world (mostly using the Internet). Most of this progress on effective management of knowledge in not done under cover of KM.

Packaging of the information has indeed began to happen using technologies such as the extended markup language (XML), and we expect that the combination of XML and modern search engines, that combine basic search, categorization, prioritization, and more and more substitutes to semantics would allow now an efficient mapping to logistics management of the management of superficial-but-essential knowledge (*e.g.,* who hold some account? How are damages on cars rented for business covered? Who in the company can speak about

---

[3] One expects affordability to be a necessary, but not a sufficient condition for the firm to seriously consider long term investments.

[4] This has certainly been understood by some, although it is often very well hidden, for the least, in the KM literature.

[5] For instance, the more the firm cares only about shareholders, the more it considers the employees as commodities, and of course the more it is anxious to extract tacit knowledge from these employees, and the greater the difficulty in managing this aspect of knowledge increases.

such or such aspect of the strategy?, etc.). The basic nomenclature on knowledge that we have proposed and the concept of WeS in particular will help. As times passes, more and more of AI or substitutes for it get developed which allows, for instance, better handling of unstructured information[6]. These progresses enable getting more and more complex mappings from logistics management to KM. It also becomes more and more clear that the issues in information handling have already become so complex that optimization of this handling has begun to help, and in fact is now vital. As we discuss our point of view, it has for sure begun to be used implicitly; the recent progress in military logistics could not be explained otherwise, which brings us back to were it all started from.

Conclusion

For about twenty years, logistics management has undergone important developments both in manufacturing and retailing firms. At the same time, it has benefited from an unquestionable academic recognition, as corroborated by the multiplication of international conferences and specialized journals. Europe has eventually partially caught up with the USA, in particular by developing organizational innovations in terms of products and information flows management. Today, the winning logistical strategies seem to be universalistic and some authors are not afraid to assert that there is undoubtedly "one best way" to develop a sustainable competitive advantage. In a somewhat provocative manner, this paper is aimed at showing that logistics management is even broader in its application than most, if not all, have dared to propose so far. It offers a way of thinking that will allow us to appeal on logistics language, vision, and methods, to comprehend and help solve managerial problems that can extend quite far from the traditional field of logistics management.

The position developed here might have been operationally useless until a few years ago, before the computer revolution, but it is hard to believe that it will not bear fruits in a world where information treatment has so much evolved and improved. Hopefully, the rigid treelike organizations will be rearranged in more reasonable and evolving structures –or lack thereof– using modern communication methods to fulfill better the roles of communicating information, knowledge, commands, and feelings. In some sense, logistics may help redesign the very organization of the firm, according as an instance of our thesis put to work. Of course, you do not need to believe that "logistics is everywhere" to hope that to happen (see for instance Evans and Wurster [2000]), but we do believe that this point of view will help practitioners by allowing them to consider with a fresh vision the challenges they face today, and will face in the future. We cannot terminate without mentioning that the *Integrated Supply Chain Management* (ISCM) that IBM has adopted, earnings of $5 billion it in the first year of implementation, goes a long way beyond SCM, even if it still falls short of the ultra-global vision of "logistics everywhere" that we advocate here. The new view on logistics that represents ISCM, which assumes in short that logistics is almost everywhere and anyway much more important than ever before, is now well digested: after sharing its experience with its major customers, IBM is already proposing to SME's a properly scaled version of ISCM under the name of *Integrated Supply Chain Solution*.

References

Abad, R. (2002), Le grand marché: l'approvisionnement de Paris sous l'Ancien Régime, Paris: Fayard.

[6] *Some observers argue that anything that resembles AI is AI, so that, for instance, speech recognition is AI. Although we have taken the opposite point of view merely for definiteness, we will not enter in this dispute, whose issue is irrelevant to our purpose.*

Davenport, T. and Prusak, L. (1998), Working knowledge: how organizations manage what they know, Boston (MA): Harvard Business School Press.

Evans, P. and Wurster, T. (2000), Blown to bits: how the new economics of information transforms strategy, Boston (MA): Harvard Business School Press.

Gourdin, K. (2001), Global logistics management: a competitive advantage for the new millenium, Oxford: Blackwell Publishers.

Grey, W., Katircioglu, K., Bagchi, S., Gallego, G., Adelhelm, M., Seybold, D., Stefanis, S. and Shi, D. (2003), Beyond ROI: mastering the art of supply chain value, Supply Chain Management Review, Vol. 7, No. 2, pp. 20-27.

Harvard Business Review (1998), Harvard Business Review on knowledge management, Boston (MA): Harvard Business School Press.

Heskett, J. (1977), Logistics–Essential to strategy, Harvard Business Review, Vol. 55, No. 6, pp. 85-96.

Lambert, D., Stock, J. and Ellram, L. (1998), Fundamentals of logistics management, Burr Ridge (IL): Irwin–McGraw-Hill.

Lamming, R. (1993), Beyond partnership: strategies for innovation and lean supply, London: Prentice Hall.

Langheinrich, M., Nakamura, A., Abe, N., Kamba, T. and Koseki, Y. (1999), Unintrusive customization techniques for Web advertising, Proceedings of the Eight International World Wide Web Conference (WWW8), Toronto, available on http://www8.org.

Leonard, D. (1995), Wellsprings of knowledge: building and sustaining the sources of innovation, Boston (MA): Harvard Business School Press.

Magee, J. (1968), Industrial logistics: analysis and management of physical supply and distribution systems, New York (NY): McGraw-Hill.

Mentzer, J., ed. (2000), Supply chain management, Thousand Oaks (CA): Sage Publications.

Naccarato, B., Yao, D., Lin, G., Kim, K., Koenig, L., Ettl, M., Allan, R., Buckley, S. and Bagchi, S. (2000), Extended enterprise supply chain management at IBM personal systems group and other divisions, Interfaces, Vol. 30, No. 1, pp. 7-25.

Nonaka, I. (1991), The knowledge-creating company, Harvard Business Review, Vol. 69, No. 6, pp. 96-104.

Nonaka, I. and Takeuchi, H. (1994), A dynamic theory of organizational knowledge creation, Organization Science, Vol. 5, No. 1, pp. 14-37.

Nonaka, I. and Takeuchi, H. (1995), The knowledge-creating company: how japanese companies create the dynamics of innovation, Oxford: Oxford University Press.

Polanyi, M. (1983), The tacit dimension, Magnolia (MA): Peter Smith Publishers.

Richardot, P. (2002), Les Etats-Unis, hyperpuissance militaire, Paris: Economica & Institut de Stratégie Comparée.

Stevens, G. (1989), Integrating the supply chain, Logistics Today, Vol. 8, No. 4, pp. 19-22.

Tomlin, J. (2000), An entropy approach to unintrusive targeted advertising on the Web, Proceedings of the Ninth International World Wide Web Conference (WWW9), Amsterdam, available on http://www9.org.

Underhill, T. (1996), Strategic alliances: managing the supply chain, Tulsa (OK): PennWell Publishing.

Williams, P. (1986), Optimization is best, Inaugural Lecture as Professor of Operational Research, University of Southampton, Faculty of Mathematical Studies, November.

Williams, P. (1990), Optimisation and operational research, Institute of Mathematics and its Applications Bulletin, Vol. 26, No. 4, pp. 76-85.