

Re-engineering knowledge logistics

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The search for understanding what electronic academic and professional publishing using the Internet can deliver in terms of cost benefit is well illuminated by the discipline known as logistics. Logistics is the science of the movement or flow of people, materials and information. It had its origins in the military which was until recent times the most concerned with the need to accomplish such major movements in a relatively short space of time. Southworth (1993) and Worsford (1995) exemplify this focus in the context of the Gulf War and the British Army Logistics Corps respectively.

In most human activities, the need for rapid and effective response is not so critically significant and as such merited only limited scientific attention until the last quarter of this century (Kearney Lecture, 1991). With the aid of mathematical and statistical approaches linked to computing capability, organizations which expended up to 30 per cent of total cost on achieving effective distribution of their products in the marketplace then began to take the field most seriously.

As a science, it seeks to identify the least cost way of achieving a given level of availability or service to customers. Five key elements have been identified as determining the efficacy of such movements or flows: facilities, unitization, communications, inventory and transportation.

It is the analysis of the trade-offs between each in achieving the requisite availability or service that shows the way to the least cost solution within each cycle (Pohlen and LaLonde, 1994).

This straightforward framework can be well illustrated in commerce:

- Many ladies' fashions in footwear or clothing last for only a short season. Preparations for launch normally have a sufficiently long lead time to enable suppliers to source the items from across the world at the lowest cost. Least cost transportation can be accomplished by sea container. Inventory can be set conservatively in case the fashion does not take off. However, if the fashion catches hold, the supplier needs to know as rapidly as possible both to procure and to deliver more items to retail stores. The additional inventory required can seldom come by least cost transportation or it will arrive too late, nor can it be made far away by a

least cost source unless a higher cost transportation mode is used – such as air freight. The speed with which the supplier gets feedback from the information system on sales uptake, enabling him to forecast his need for additional inventory, determines his ability to meet demand. This has seen rocketing growth in marketing/point-of-sale intelligence systems which is apparent any time we shop today with barcode scanners capturing intelligence the moment we buy linked to our customer loyalty card demographics and replenishment cycles (Hagon, 1994).

- Industrial components, whether at manufacture/assembly stage or in the replacement after market, are required in the right place at the right time. However, to achieve that without massive inventory holdings across the marketplace would be impossible without instant access to the information on where a component might be and a willingness to use high cost transportation methods to deliver it. With straightforward statistical analysis of inventory demand, it is normally suitable to hold far less inventory, thereby reducing the risks of obsolescence, loss and damage into the bargain.

The managerial challenge in commerce has been to ensure the consideration of the “total” logistics concept, i.e. view the output of a logistics system as being the result of the trade-off between all five significant elements over an appropriate cycle time (Wenkels, 1995). Their discrete management normally leads to net loss to the enterprise. Simply to minimize transport costs or communications expense will normally give rise to much higher inventory expenditures to achieve a given level of service.

What level of logistics service is requisite?

The notion of a scientific approach seeking to achieve a least cost solution to deliver a requisite level of service or availability begs the question: what level of service is requisite? Not surprisingly, much analysis has addressed this question (Lambert, 1992) – which has an exact equivalent in the currently popular query as to what “quality” a product ought to embody.

The paramount response is, in almost every circumstance, that “reliability/consistency of the level of service offered is more important than speed”. If a promise is made, it needs to be 100 per cent certain that it will be kept. The customer for the service can plan accordingly. The precise pattern can be tailored to the customers’ needs (Fuller *et al.*, 1993).

The second response, not unnaturally, is that the speed required depends on the context in which the need has arisen. The item designations of A, B and C have been used in inventory control for many years. An A item must be there at all times – oxygen in a hospital or an aeroplane, or engines at the right assembly point in the manufacture of a car. Other items, such as a light bulb in the home, can be regarded as a B or C items. You can borrow one from another room.

Third, the potential substitutability of a given item with an identical/satisfactory competitive alternative will give saliency to the need for a high

level of service, indeed preferably 100 per cent availability. It is unlikely that most customers will change their choice of a car, or aeroplane manufacturers their choice of engine because availability is not immediate. However, a chocolate bar or beverage will often be substituted, as will a passenger seat from one airline brand to another.

The traditional logistics model for academic and professional knowledge

In Figure 1, the total logistics flow cycle in traditional publishing is modelled across 12 months.

Academic and professional knowledge first arises in the minds of scholars and practitioners. It is mainly distributed in print or by word of mouth as at conferences, professional workshops or discussions with colleagues. These methods of distribution allow for greater or lesser levels of interaction/proactivity. In a discussion, one can readily proact and evolve a line of analysis and thought; with a book, TV programme or an article, the knowledge is not so readily negotiable. It takes much longer to take up a question and get a response from an author or TV programme contributor than it does to raise a point at a conference or discussion.

Facilities

The retail facilities used to store knowledge are most typically a library or bookstore – although journals will often go directly through the post to readers most particularly in the professions. Publishers use warehouses extensively in the distribution channel and library agents frequently offer consolidation services.

Conference workshop and discussion facilities typically are provided either by hoteliers or by enterprises themselves in countless seminar/meeting rooms around the globe.

Many individuals also create their own libraries, often more an archival stack of previously read or browsed material, in their own homes or offices.

Each of these facilities has its own aura, its own charisma. A library and a bookstore share a quietude not always to be found or even sought at a conference or a workshop, because they are not offering an interactive knowledge consumption process.

Unitization

The unit of knowledge ranges from the well maligned “sound byte” to the impressive tome. In other words, we may seek to acquire access either by simply hearing or seeing a few short sentences, or by necessarily acquiring a book. To gain access via a library, there may be a membership fee and even a fine for taking too long to read/return a particular book.

Journals and professional magazines are frequently sold by annual subscription or at least by the issue. Most conferences expect you to attend the whole at a comprehensive fee or to purchase the printed proceedings afterwards for a far lower fee.

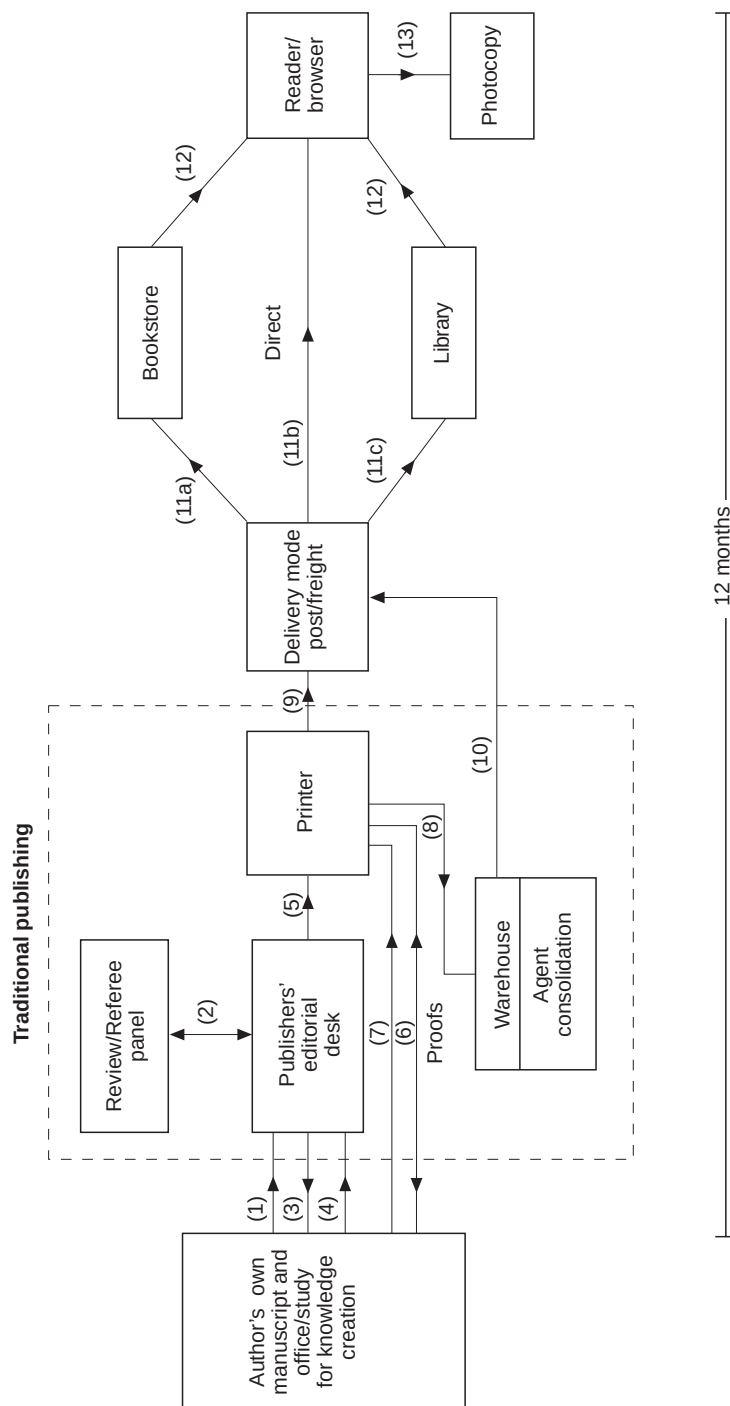


Figure 1.
The logistics of
knowledge flows in
traditional publishing

So, while the unit of knowledge is the “byte”, its sale and availability are normally in multiple bytes, as a printed volume, an annual subscription to several instalments or an entire conference. A scholarly meeting, to be truly effective, normally requires all its main contributors to be in one place at the same time.

Communications

In logistics this word is used essentially to describe the awareness available to all potential users of what units of knowledge exist and are available in what facilities or, if they are *en route*, precisely where they are at any given moment. To do this in commerce, large and extremely costly intelligence systems have been developed. Each one of us can ascertain from a bank's autoteller machine what our balances are, and a manufacturer can similarly pinpoint stock locations and levels and where they have reached in transit (Sheombar, 1992).

For knowledge today, we can ascertain the existence of a book-in-print if we know its title/author, of a journal if we know its title, and of an article if we know who wrote it and in what journal. But as to the precise location where we will find it once it has left its publisher, whether it is out on loan or out of stock, and if so how long before we can gain access – such intelligence is not normally readily available.

Inventory

The great majority of libraries will be able to identify whether a book or journal has been acquired and whether it is currently out on loan. So too will many bookshops, albeit on a more reactive basis. Some will know the rate of usage of the knowledge and the average waiting period experienced by customers for availability when it is temporarily out of stock. Knowledge of inventory held elsewhere other than in the particular location will be scant unless a regional information exchange has been established.

The inventory of conferences and workshops on offer is far less well documented. There is no global equivalent of books or journals in print with allocated ISBNs and ISSNs. The inventory is almost totally fragmented and most academics and professionals rely on personal networks and mailed information to access them. They are, however, frequently translated into book/journal format later and then become more accessible.

Finally, the inventory of authors unfinished and/or unsubmitted articles is virtually inaccessible except by word of mouth.

Transportation

The physical transportation of knowledge is usually accomplished ultimately by the reader going to the library or bookshop to collect or by delivery via the post or fax. In the case of conferences and workshops, the transportation is by participants transferring themselves to a faraway, albeit sometimes exotic place. The considerably higher expense involved in the latter mode is regularly justified by the trade-off with access to:

- the most recent knowledge not yet available in books or journals;
- the opportunity to interact and proact and thereby heighten the value of the knowledge transfer; and
- the opportunity to build networks that can of themselves become very efficient media for future learning and knowledge flows.

Requisite service at least cost

The literature of librarianship has frequently reported the application of service levels to the availability of books and journal articles, e.g. by carrying multiple copies or by offering fax or postal delivery services at differential prices. No studies have been located that attempt the total logistics systems analysis with trade-offs costed, mainly because the cost/benefit of academic and professional information and knowledge is grossly underdeveloped. Whereas a commercial product not available can normally lead to substitution of another, this will not usually be the case for knowledge. It is likely to be possible for textbooks but most unlikely for state-of-the-art articles. And the potential value of the missing knowledge must be assessed before any conclusion can be reached as to whether it should in future be provided because it justifies the cost involved.

It is not infrequent to wait for a book from a publisher for a month or more; and to await an article by interlibrary lending for 14-48 days. In such circumstances, it is not surprising that much of the lag time in completing or even preparing a serious draft paper is occasioned by delays in gaining access to particular known items.

This of itself begs the question as to how the potential beneficiary is made aware of its existence, or has a cost-effective way of searching to find all that might be deemed cost beneficial (cp. Vinze, 1991).

It must generally be concluded that users of knowledge are conditioned to accepting that it takes a long time to find something, that the lag time will be inconsistent and that, if it cannot be substituted, the overall output will have to be delayed.

Supply side logistics

I have left until last discussion of the ways in which articles or manuscripts are traditionally procured – whether for books or journals or as conference papers. First, it must be observed that it is an especially lengthy process, rationalized as ensuring high quality but more often than not mainly reflecting inefficiencies. An article or book is normally expected to take 12 months but can take as long as 18 to appear in print. During that time, the actual working time is perhaps four weeks; the remainder is delay or misconnections in the channel of supply.

The author's work in early draft format will be circulated for comments. When finalized, it will go to a reviewer/refereeing panel whose comments will be fed back for incorporation in the manuscript – or, if a rejection, to recommence the sequence again. Once accepted for publication, the article or book will go through a production process often requiring consolidation into an

issue with eight/ten other articles, or await a seasonal catalogue or launch event. These stages, together with repeated proof checking and graphic design contributions, are what take up the 12 months.

The supply side, least cost approach delivering these service levels is, of course, not consistent, not speedy and alas not readily open to substitution of another medium of production. But there is much good news to be heard...

The purpose of this paper is to share just how great the opportunity is to re-engineer both the supply and the demand side of knowledge flows, of knowledge logistics (Ayers, 1995; Badarecco, 1991). In particular, "time to market" as a key contemporary logistics issue is addressed.

Re-engineering supply side knowledge logistics

As has been suggested, supply side flows begin when an author seeks to present research or philosophical outcomes to appropriate academics or professionals. To achieve that task to the necessary quality level inevitably will be an iterative process of formulation, feedback commentary and refinement. It will normally also include a vitally important prior necessity which is to be aware of and in command of what other knowledge exists on the issue concerned – of which more later when we discuss demand side knowledge logistics.

If, however, we commence with the draft article, or preprint, we can explore (see Figure 2) the transformations available from emerging electronic publishing approaches:

- Step 1: The author's preprint is created on a PC which can connect to the Internet.
- Step 2: The author submits to a "virtual academy" of like-minded academics/professionals for constructive critique and feedback.
- Step 3: Comments are digested and the final version prepared.
- Step 4: The author re-submits for final review and acceptance in a housestyle/template that conforms to the publisher's specification for Internet publication.
- Step 5: The editor alerts the refereeing panel by e-mail to the article's presence on the journal-protected database and asks for "credit scores" plus comments.
- Step 6: The scores and final comments are fed back to the author for incorporation.
- Step 7: The refereed finalized article or book is published on the Internet.
- Step 8: All interested parties are notified by e-mail of the event and invited to view and/or download.

Clearly links to the earlier critique of traditional knowledge logistics. Accordingly it is not surprising to find such a sequence, known as Project PeerNet, currently under development with MCB University Press for all its

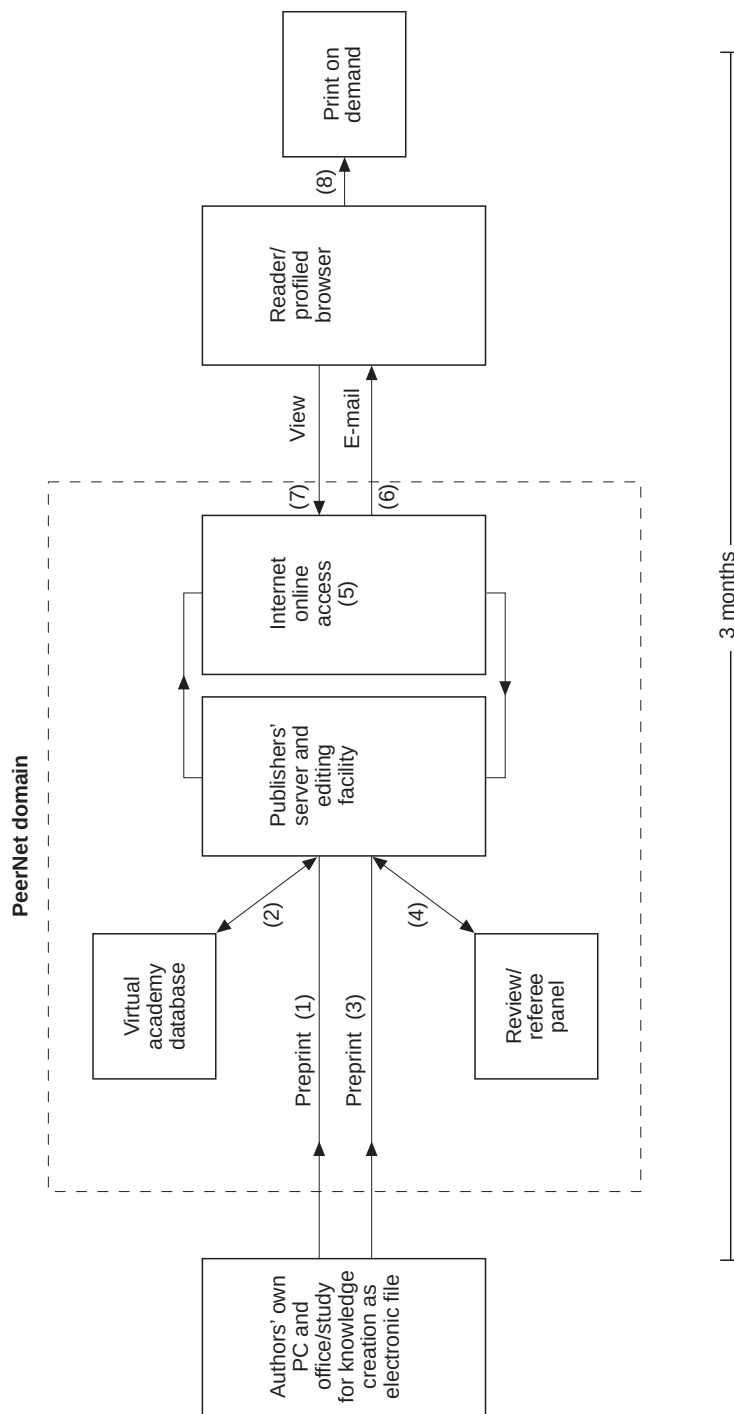


Figure 2.
The logistics of
knowledge flows in
electronic publishing

journals. It goes further, however, than reducing up to 75 per cent of the lag time in getting articles or books into print. These are some of the major improvements to the very publishing process itself:

- The virtual academy allows a much wider audience to see and comment on a preprint. MCB University Press' Literati Club of 15,000+ authors across the world is keyworded to achieve this broader canvass.
- The preprints in process are assembled in an electronically available "citation/list/register" – thereby enabling others to be aware sooner of what is on the way and at the same time to protect the author against plagiarism.
- The online credit scoring in the refereeing process can be expected to produce more consistent and reliable results.
- There is no need to wait for a full issue or a seasonal catalogue to be assembled. Each article can be published as it is accepted.
- The article's abstract can be added immediately to the global abstracting and citation sources rather than awaiting consolidation.
- The author and publisher can proact with interested readers rather than await a visit to a library, a bookshop, a conference or the post to arrive – by e-mail notification to all concerned about publication.
- The interested reader can proact with the author to follow up on a line of argument or analysis.
- The references to the works of others cited in any article or book can be traced and accessed speedily using the newly arriving PII references which are unique indicators for each article.

Verdict

This process will be more consistent in the service levels and the quality judgements experienced. It will be faster. It will be very much cheaper to accomplish once all parties have access to the required technologies. It will, however, almost certainly increase the substitutability of one journal or publisher for another. It will be easier for an author to "shop around" and less time-consuming and expensive for that process too.

The prize accordingly goes to the publisher with the most helpful and supportive supply side process, the best virtual academy resource and the best accreditation of the publication by branding of the collection or list within which it appears. Finally, the best publisher will have the maximum outreach to the author's intended listeners (cp. Brown and Watts, 1992). This gives a whole new meaning to the concept of database marketing and marketing intelligence/loyalty systems. In electronic terms, the more intended listeners one can alert by e-mail to the publication of the article, the stronger the desire of authors to commit their knowledge to that particular publisher.

Re-engineering demand side knowledge logistics

The author is, of course, just one example of a user of knowledge. The great majority of users are not involved with knowledge in order to benchmark their own nascent contribution. They are there either:

- to take it on board for an educational or professional purpose – a course to follow with an examination to pass or a known professional need to learn or implement a strategy; or
- to browse to stay abreast with no specific goal or expectation, which can be satisfied both by finding nothing exceptional and by serendipitously learning, e.g. database mining approaches (*Computing*, 1992; Grupe and Owrang, 1995).

The ultimate requirements of the author, of the tasked student or professional and of the serendipitous learner will be the full text of the article or book concerned, but all will find it more than helpful to be able to scan/search all the literature available in a designated field speedily and appropriately. The premium here accordingly is on the design of user-friendly, user-conscious search engines of the burgeoning archive of knowledge.

With the benefit of standard general mark-up language (SGML) tagging of electronic text, searching by keywords can readily be accomplished, together with textual mentions. This requires sympathetic thesaurus development within subject fields. Further search criteria can differentiate the recent from the less so, take one to all the contributions of a given author, select by country of origin or reference to industry or corporation, theoretical vs. practical case study as opposed to literature review, and most recently and boldly to the allocation of quality criteria within several key categories.

One can readily see the advantage to being able to select the most recent literature review in a chosen field from a total of 2,000 or more articles on offer. However, even more so, one can readily see the advantage for any professional or educator presenting to an audience to be absolutely up to date with the field concerned so speedily. Before electronic publishing, such a realization was simply impracticable.

The revolution dawning is even greater for the process of updating course materials as in distance learning institutions. On average, the materials they despatch were last updated two-and-a-half years ago. Using automated electronic searching links they can be supplemented with the latest literature as it appears. All that is required is to allocate keywords to each course module and make hyperlinks to the database concerned. This approach is now in operation on a prototype basis. It is no dream; it is a reality and its contribution is awesome.

Similar keyworded or behaviour derived/ modelled (Tafti and Nikbakht, 1993) profiling of individual managers can be automated wholly to deliver current awareness. By linking agreed personal key areas of interest to the knowledge database, e-mail alert routines with full text retrieval on demand are being delivered. Complaints that this is tomorrow's junk mail are as well founded, but no more so, than the complaint against postal messages in the

mailbox today. We are always at liberty to ignore such messages or to have a separate file structure/ pending tray for them that does not interfere with the routine of important messaging – just as we may have an ex-directory phone line or a PA/secretary to intercept calls and messages on our behalf.

Knowledge logistics is clearly poised on the threshold of artificial intelligence/expert systems/neural networks for academics and professionals. The leveraging of the contribution of knowledge workers (Lewis, 1992; Li, 1994; Mockler, 1990; Mykstyn *et al.*, 1994; Osyk and Vijayaraman, 1995; Quinn, 1992, 1993; Ryman-Tubb, 1993; Venugopal and Boets, 1995) has been examined extensively elsewhere in services, manufacturing industry and the professions but not directly for the field of electronic publishing.

Verdict

This process will be both more comprehensive in its ability to trace and retrieve knowledge and will do so almost instantaneously. The data overload which will inevitably arise can be attended to by use of search engines for keywords and abstracts which do not militate against serendipitous browsing or searching but do not necessarily require it.

The benefits of the outreach in distribution first by alerting interested parties in profiled areas but also by immediate availability in the global databases will be of great value to authors both to publicize their work and to elicit interaction.

How key elements in knowledge logistics flows are changing

In Figures 1 and 2, the two logistics flows are modelled. Thirteen discrete phases have been replaced by eight. That presages a major cycle time transformation, but it becomes clear just how wide the re-engineering required truly is when we examine the five key elements of logistics (Persson, 1995).

Facilities

At a minimum, the printing house, the warehouse and the library/bookstore (Schneider, 1994) are either substantially or totally eliminated or metamorphosed as the move grows apace for electronic publishing. However, no progress can be accomplished until:

- publishers establish the host server for the incoming preprints and their proactive discussion with the virtual academy and referee panel; and
- authors and readers have PC and printer facilities at their disposal for the beginning and end of the process.

It is a classic chicken and egg argument of course. Who moves first? The expense for a publishing house in creating a host server that most of the readers currently do not know how/are not inclined/are unable to use is daunting. But the prizes are paradigmatic if the patient investment can be made. The threatened facilities are slow to respond because they are largely sunk costs and accordingly seem to have only a marginal incremental cost in comparison with a total investment/payback model for the incoming publishing investments.

Furthermore, extant budgetary procedures in libraries, for instance, give the funding to the facility and inventory manager not to the reader/browser – to whom knowledge often seems to be a free good – if only you can find it and wait until it arrives. The electronic publishing paradigm requires the reader/browser to have the discretion to buy (within a budget) as appropriate. Institutional inertia and power structures will certainly delay not alleviate change in such circumstances (Smith and Saint-Onge, 1996; Woodside, 1996).

Unitization

The unit of knowledge for the commencement of searching and retrieval in electronic publishing is the keyword not the journal issue or book title. Keywords lead to abstracts and abstracts to full text, with paper wastage eliminated at each stage (Wu and Dunn, 1995). Ultimately, only the articles that cannot be digested on screen will be printed, and only the areas profiled will be drawn to anyone's attention in the first instance if the service offered is proactive.

The need to publish batches of articles for effective traditional publishing and distribution is gone. So is the constraint on how many articles can be published or acquired in any given time period. The remaining challenge which is to quality assure the knowledge offered is not accomplished by a journal *per se* but the quality procedures its editors employ.

Communications

Perhaps the most significant change in the communications element of logistics is the immediate, categorized access to the total body of knowledge for searching and retrieval. This does, of course, include quality guarantees of the knowledge offered. These latter aspects will surely see a transformation from one being driven solely by the editorial review/refereeing procedures to one driven also by the keyword/abstracting services. Many readers or browsers will be unaware of the status of many suppliers of knowledge. The strength of the “retailer branding” via the abstract providers will readily overcome that dilemma (cp. ANBAR Management Intelligence).

The major challenge still to be overcome, albeit with PII's emerging as the equivalent of barcodes, is how to have a universal referencing system for all units of knowledge for retrieval and within the search engine a uniform thesaurus. These are not unfamiliar problems in the world of knowledge and have been resolved for books (ISBN) and journals/serials (ISSN). As the appropriate unitization changes, however, the new order has to be addressed. There are, in a range of disciplines such as management/human studies, referencing systems that have been pioneered by the major abstracting services for paper-driven retrieval systems. But these will need to give way to a universally accepted article referencing system and keywording thesaurus.

Once these are in place, the residual role for document supply services, such as are to be found in the British Library and other major archival centres, will surely disappear. Only the archival role will continue to provide for historical research and to act as a backup for lost electronic knowledge. Some electronic

publishers are now simply depositing a “golden copy” with these national archives to this end.

This new scenario compares with a helpful librarian who assists a reader/browser to undertake a search beginning with the knowledge in stock in the library concerned, or the bookstore, and then moving to bibliographies and abstracting services one by one – either paper or CD-ROM-based... and then awaiting paper delivery from afar after a time lapse of greater or lesser proportions.

Inventory

The only physical inventory remaining in the electronic publishing paradigm is the printout on demand created by the professed interested party; and the “golden copy” in the national archive and backup for electronic memory.

The startling conclusion for all concerned is that all the warehousing and retailing inventory necessitated by the printed form will eventually be eliminated.

In this context, CD-ROM clearly can be seen as a transitory form of distributed electronic storage/supply because the transportation and connectivities of the total system are not yet in balance. In comparison with only calling on what you need as opposed to the whole inventory on a CD-ROM and a price to match it, it is clear that the future belongs to online access provided that the reader/browser facilities are well able to access it which is closely intertwined with the fifth and final key element in logistics.

Transportation

The use of air and surface postal services to deliver knowledge, increasingly supplemented in the past 30 years first by photocopiers and then by faxes, is destined to be transformed further by server to PC interchange either using the telephone providers or cable networks. Cable provision, linked with television programming, is gaining rapidly on telephone services most especially where telephoning is an expensive access mode. Those centres such as Singapore and Hong Kong with no or almost no charges for local phone calls have shown just how the absence of the cost hurdle can accelerate adoption.

In every scenario presented, the expense of interconnection between PCs and publishers' services using data compression techniques will be well below that of current post or fax services. In many circumstances, dedicated telephone lines and fixed annual access fees are already sufficient to stabilize the transformation cost of knowledge to make it manageable.

The “total” systems challenge

The rapidity with which the re-engineering of the total logistics system of knowledge takes place will be determined by push and pull factors.

Authors will push for more rapid publication with guaranteed quality assurance. Readers and browsers will pull because of the efficiencies and

effectiveness of the new approaches, although requiring involvement on their part and competence with the various connectivities.

However, there will be a combination, as has been shown, of socio-economic and psycho-technological blockages to the re-engineering process. Where a single unifying entity is able to redesign a substantial part of the total system, using a balanced approach across all fields, progress will be greatest (Kaplan and Norton, 1992; 1996). Any new age logistics system that can build critical mass for the PeerNet construct identified in Figure 2 is in a very strong position to exploit the trade-offs (Wills, 1995; Wills and Wiles, 1996; Wills and Wills, 1996). A number of extant publishers with very strong links both with supply side authors and demand side library and reader markets are now attempting this.

Their six key strategies are to:

- (1) put in place the interactive server routines for author preprint manuscript review that attract the best quality knowledge in the first instance;
- (2) develop Internet sites that have a critical mass to attract readers and browsers;
- (3) build virtual academies-cum-professions as well-classified, benefit-oriented databases – that have their own life in Conferencing, ListServers and NewsGroups;
- (4) drive hard for e-mail/Internet connectivities with their end-users via awareness and assistance – cybercafes online and on-site;
- (5) create search engines of the highest quality with customer-user-focused search criteria backed by full text delivery online;
- (6) empower customers/users to exploit the benefits of the knowledge at their disposal via educational and self-development guidance and support.

A total systems perspective such as this, encompassing strategy (6) above, questions the dividing line between knowledge logistics for publishing and knowledge for education and learning. The new age total knowledge logistics model must expect to see the backward integration of the librarian into knowledge distillation and capture rather than warehousing and stock control – a higher order, higher value-added cognitive task in any event. And it must expect to see the publisher reaching forwards into alliances and joint ventures with educational institutions offering the constant updating of knowledge against given curricula. This can be most clearly achieved in the realm of distance learning where the infrastructure inertia will be least. The high value-added role of the tutor of the future will be to design the curriculum and to facilitate the learning processes in an interpersonal, interactive way. The delivery of mass lectures to students, along with vain attempts to provide adequate levels of tutorial support, will be replaced with tutoring as a caring profession. Staff will be freed up from myriad domestic tasks by the electronic publishing phenomenon.

Those educational enquiries taking place around the globe to see how education and learning can be cost-effectively achieved for the future, as more

and more people have higher and higher expectations and needs, have an agenda item they can now address and can take the bold leap forward. They can disaggregate the budget for acquiring information from its central focus and share it among the customers and users at their PCs. They can follow that through by transforming library buildings into tutorial centres. And, finally, they can agree on limited hard copy national archiving strategies, i.e. get rid of the obsolete stockholdings or inventory in educational institutions in favour of downloading on demand. To make progress, however, requires high level managerial skills (Barclay *et al.*, 1994).

The other breakthrough opportunity can be expected among those who have not yet invested in the massive infrastructure of the traditional logistics systems who can go directly to the new paradigms. This will certainly include all major new universities being developed in the Asian region over the next two decades as well as in Latin America and India – which together encompass nearly half the world's population. And it will equally apply to Russia and its own Commonwealth partners as they begin to access the full gamut of Western knowledge.

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