THE IPTS REPORT

Produced by IPTS and issued in Cooperation with the European S & T Observatories Network

FEBRUARY 1996

EUROPEAN COMMISSION
Joint Research Centre

This Report addresses itself to the decision-makers involved in 'managing change', seeking distilled, selective presentation of technoeconomic intelligence and prospective alert on underdiscussed facets of a topic, rather than a deluge of data and encyclopaedic reviews.

This Report stands as the most visible indication of the commitment of the IPTS to Technology Watch, its main priority and mandate (see inside back cover). In this context, the Report aims to focus on issues of projected pertinence for the decision-makers, exploring *prospectively* the socioeconomic impact of S/T developments. On the one hand, such exploration implies signalling on issues which are not yet clearly on the policy-makers' agenda, but can be projected to draw attention sooner or later. On the other hand, it implies alerting actors about underexplored aspects of an issue on the agenda, aspects which, though under-appreciated today may have substantial consequences tomorrow.

The Report benefits from a validation process, underwritten by networks of renowned experts and Commission services, making this Report a product of not only the IPTS, but also of its collaborating networks of Commission and external experts. The process of interactive consultation guarantees the validity of the points highlighted, the relevance of the topics chosen, and the timeliness of their examination.

There are many publications excelling within their discipline. The Report takes the extra step, prospectively exploring interdisciplinary repercussions, often drawing quite surprising connections. Moreover, sharing the Commission's priorities, the Report is still the product of a research institute, and can be a neutral platform for dialogue on issues of relevance and a nexus for debate facilitation.

The present issue is the second installment in a seven-issue introductory series that will last until September 1996. Throughout this period, and with the feedback and comments of its readers, the Report will be shaped and fine-tuned. In this issue some of these comments have been adopted. For instance, the too academic looking abstracts have been replaced by a more original introduction. Short notes, which aim to inform and not analyse, and longer analytical pieces attempt to cover in a balanced way issues spanning a vast spectrum. Instead of lamenting having inexorably to deal with disparate topics, we make a virtue out of multidisciplinary necessity, we cherish escaping restrictive tags, and valorise the very wide spectrum of expertise in our network of European S/T Observatories (ESTO).

Looking for a common thread through such a diverse set of articles is only slightly less hopeless than looking for a black cat in a dark room. In the present issue however, the common thread is provided by network synergy (a common thread pointed out by members of our network). This undercurrent is exemplified most clearly in articles such as the one on logistics, emphasising the importance of collaborative networks and information technologies in improving both the efficiency of logistics, as well as its environmental impact. Similarly for mobile communications, the key to the success of the proposed third generation systems is the unification of the present diverse networks into a seamless service-rich network. Furthermore networks may help reduce monopoly profits for intermediaries and allow content providers to reap higher rewards.

The article on biocomputing recapitulates the message at an ultra micro-level as well as at a macro-level (at ontogenetic and phylogenetic levels, if you will forgive the pun). It is the massive parallelism of DNA working together in synergy that renders biocomputing such an attractive vision, on the other hand (net)working together for biology and informatics can produce quantum leaps in S/T - vindicating multidisciplinarity.

At another level, the feasibility of bioenergy requires an integrated approach to bioenergy networks/systems, reflecting technical, economic and environmental considerations, as well as the heterogeneity of bioenergy sources, uses and techniques. For plastics recycling, synergy between R&D and environmental policy will facilitate meeting the targets of EU directives, by exploiting recently demonstrated technologies (e.g. feedstock recycling). Even the article on Japanese R&D strategy can be seen to highlight the synergy in the Japanese R&D system wherein the government is emphasising basic research, while firms reorient their R&D strategies in other directions.

In closing, networking synergy is particularly close to the heart of the IPTS. Not only is the work of IPTS crucially related to its ESTO network, it is also pervaded by an approach emphasising synergy and bridge-building. It is not surprising therefore, that the latter pervade this issue.

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The Joint Research Centre is the corporate research laboratory of the European Union. It is a multidisciplinary research organisation playing the role of a pivotal node in the European Research and Technological Development (RTD) system, belonging as an autonomous Directorate General to the European Commission. The work of the JRC is couched on the realisation of the unequivocally crucial role of science and technology (S/T) for the socioeconomic context which shapes and is shaped by S/T, in general, and for specific issues including European competitiveness, employment, and sustainability. Indeed one of the institutes of the JRC, namely the Institute of Prospective Technological Studies (IPTS) at Seville, is dedicated to the assessment of the emergence and implications of S/T. Moreover such concerns do not escape the other Institutes, i.e. Reference Materials & Measurements(Geel), Transuranium Elements (Karlsruhe), Advanced Materials (Petten & Ispra), Systems, Informatics and Safety (Ispra), Remote Sensing Applications (Ispra), besides their specialisation which is indicated by their denomination.

The JRC promotes and carries out customer-driven research of the highest quality and integrity in support of Community policies. First, it provides scientific and technical support to the services of the Commission responsible for the implementation of the various EU policies. This support can take several forms: i) laboratory work or theoretical studies drawing on the scientific competence or experimental facilities of the JRC; ii) S/T work for implementing EC legislation or S/T assistance with drafting of new legislation; iii) scientific assistance in the management of projects or contracts.

Second, it acts through its research as an instrument for the coordination of the national R&D activities and to achieve cohesion within member states' S/T systems. Subsidiarity is a key guide for the effective and efficient deployment of the JRC's resources. The emphasis is on work which has to be done at European level, or for which critical new dimensions emerge beyond the national level. Examples include the provision of reference materials and measurement techniques, decentralised European data management systems, experimental installations for structural mechanics research, and safety research, environmental observations, the running of the network of European S/T Observatories (ESTO) etc. In other words, areas in which the sum is greater than its parts, areas in which it is highly helpful that neutral bodies at the EU level bring together for cross-fertilisation intelligence from across the EU.

In terms of mode of operation the JRC carries out institutional activities, fully-funded by the EU framework programme (e.g. directly assisting specific DGs); competitive activities under the framework programme (e.g. participation in shared-cost action programmes in association with partners from member states; competitive activities outside the framework programmes such as participation in Community programmes like PHARE or TACIS, and work for third parties (contract research) from industry or national bodies; and exploratory research, aimed at ensuring scientific vitality, and at expanding technological competence.

In closing, it is precisely the inherent impartiality of the JRC, its tradition of multidisciplinary research, its cooperative mode of operation, its sharing of the EU's goals and concerns, and its coordinating ability which affords it a central role in the EU S/T system.

Lessons To Be Learnt From Japan's Changing R&D Strategy

Maurice Bourene and Patrice Laget

Issue: Japan has built its competitiveness and rapid economic growth on technology. The recent changes in industrial research activities are therefore likely to have significant economic consequences, particularly as companies, which account for 70% of R&D expenditures, are changing their research priorities. Japanese firms are slowing down their effort in basic research (thus reversing a trend which began in the early 80s) and focusing more on short term applied development.

Relevance: Recent initiatives from various Japanese ministries are targeting the training of scientists and stimulation of innovation, and are providing increasing financial support to R&D, including basic research. Although no net increase in overall R&D funding has resulted from this change of public-private emphases, the shift of sources of funding from private to public may allow for more openness among firms as well as, internationally, more collaborative projects and spillover effects across companies and industries. A new form of cooperation between the public and private sectors is replacing the old-fashioned approach of the previous decades. The often criticized and admired Japan Inc., may soon become a scientific superpower, by adding to its well known capacity of exploiting research results, a new talent for creating these results.

During the last fifty years, Japan has suffered several economic crises and has always reacted by increasing the competitiveness of its export led industry. Strong technological development and improved management played a key role in this process. The current recession, triggered by the end of the financial bubble in the early 90s, is no exception to this rule. While the Japanese firms are adapting to a new situation, the government has launched a series of major initiatives to foster the country scientific base and to pave the way for future economic growth. Japan is going to remain a strong competitor for Europe. Its new R&D strategy calls for careful analyses from which lessons can be drawn for Europe's own S&T policy.

Reorientation of R&D efforts

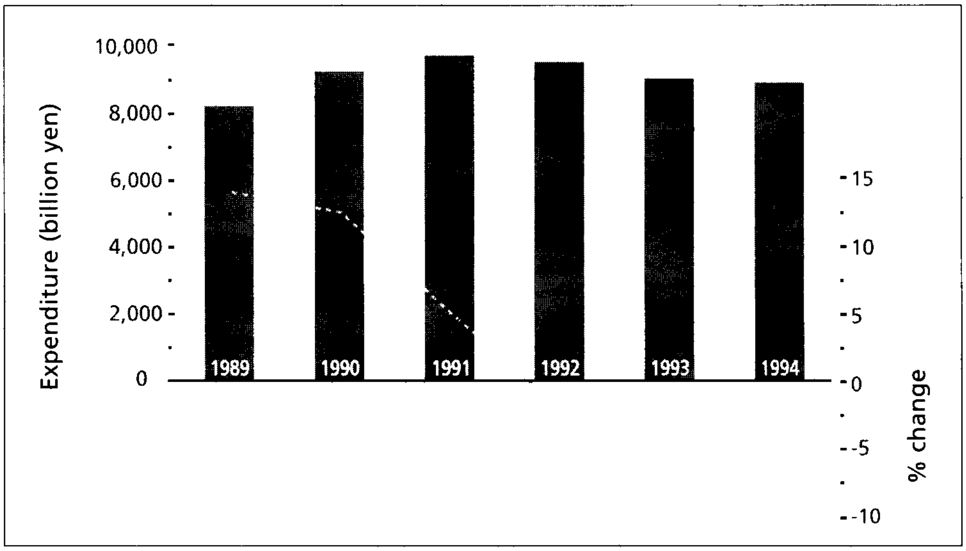
It is not surprising, under the present economic situation, that Japanese companies have decreased their overall R&D expenditures (see fig.1) and have stopped the regular increase of their budget for basic research, thus reversing a

Japanese firms reorient their priorities in order to react better to the market pressure

trend which started in the early 80s. However, this does not mean that they are reducing their efforts in this strategic area but rather that **Japanese firms are reorienting their priorities in order to react better to the market pressure**. The research intensity, as measured by the ratio of R&D expenditures to sales, has, indeed, remained stable and the number of scientists and engineers still continues to increase. Moreover, 1994 may have been the end of the decline in private R&D expenditures (see fig.1).

The crisis has not affected all sectors evenly. R&D expenditures remained steady for chemical products or general machinery, while they fell from 1991 to 1993 for electrical machinery (-11%) or transportation equipment (-13%), two of the most strongly export-led sectors.

Fig 1: Recent Evolution in Industrial R&D



Source: General Affairs Agency, Office of Statistics, "Results of the Inquiry on Research in S&T," (Nov 1995)

For firms basic research is projected to decrease at least until 1997 in manufacturing, and what will remain will be targeted fully toward the core business of the firm

In the 80s, strong investments in R&D by big companies were, to some extent, part of their efforts to build a high profile image. This was also true for basic research activities which were often supported without clear corporate strategies and driven more by image competition than by real need. This situation has changed and the new trends observed in the early 90s will continue for a while. According to a recent report released by the Science and Technology Agency (1994), the importance of basic research will decrease, at least until 1997, in all manufacturing industries, while priority will be given to applied research. However, contacts with R&D executives from several large groups indicates that the ratio of basic research will stay around 7% of total research expenditure (personal communication with local companies, 1995). Companies still need in-house activities in this domain in order to create high added value products, especially for electronics and pharmaceuticals. Nevertheless, **basic research will be fully targeted toward the core business of the firms**.

The results of a survey of 1,800 firms released in April 1995 by STA also show that 76%, as compared to 39% in 1987, will **rely on their own R&D activities for the design of new products in the future**. Half of the respondents will implement this strategy within 2 or 3 years, and 81% consider that priority should be given to the development of products which respond to the needs of the clients.

Scientists and engineers will, therefore, become a strategic resource for Japanese companies. Their number will continue to grow at an accelerated pace and a 30% increase is forecast from now to 1998. However, the supply of innovative researchers by the Japanese education system is a major bottleneck for the implementation of the firms' strategy. They have therefore adopted three parallel measures to tackle this problem. Firstly, firms are working closely with Monbusho (the Ministry responsible for Higher Education) for the training of their staff at university laboratories. Secondly, they are attracting young scientists from abroad with their own fellowship programmes, and lastly, they are setting up research centres in technologically advanced foreign countries.

The government creates a new environment for innovation

Well aware of the needs of the industrial sector, the Japanese government has launched, in recent years, a series of initiatives to promote basic research, higher education and innovation. This is clearly shown by **the increase, in absolute terms, of the government R&D budget** (table 1), even if real expenditures, which may be different from the budget figures, slightly dropped in 1994 after a boost of nearly 11% in 1993.

Of course, government commitment to R&D has led to higher expenditures and growth of the number of scientists and engineers in university and research centre laboratories. A large share of them in private research institutions are "external non-regular researchers". They are seconded by their companies and represent an important mechanism of technology transfer.

The trend should continue since the first priority of the "Economic Measures toward Steady Economic Recovery" published last September is the "development of science and technology, provision of facilities for education and welfare" (Government directive, 1995). The message is clearly to accelerate structural reform of the economy through the promotion of innovative research at the frontiers of knowledge. A specific budget of 300 billion yen is allocated to this task.

The change of attitude can also be seen in the qualitative aspects of the new programme. The Ministry for International Trade and Industry (MITI) is a good example of this. In the 80s one of its flagship projects (JISEDAI) targeted the development of "basic technologies for future

. for instance firms will rely in the future on their own R&D for the design of their new products

Scientists and engineers will become even more of a strategic resource for Japanese companies

Table 1: Recent Evolution in Government Support for R&D

	90	91	92	93	94	95
Budget	1,921	2,022	2,135	2,267	2,359	2,490
% change	5.8	5.3	5.5	6.2	4.1	5.6
% inflation	3.1	3.3	1.6	1.3	0.7	NA

Source General Affairs Agency, Office of Statistics, "Results of the Inquiry on Research in S&T, (Nov. 1995)

industries". Today, priority is given to the "leading research" programmes and to the "centres of excellence" focusing on basic research open to international cooperation. It is also significant that part of the universities' funding, while still marginal, is now being channeled through MITI, who, until recently were not involved in this process. Opening up the universities to research funding from ministries other than the Monbusho constitutes an important structural change in the Japanese R&D system.

In a global effort to establish a "science and technology oriented state", various ministries are

In the 80s MITI focused on basic technologies for future industries, but now stressses leading research programmes and centres of excellence, open to international cooperation

preparing a new action plan under the generic term of "New Scheme for Strategic Basic Research Promotion". Within this plan, new framework programmes have been set up which allocate the largest share of the budget to non-targeted R&D (see Box 1). This qualitative change in the way funds are allocated is much more significant than the actual increase of funds available for basic research. In addition, all the programmes are open to foreign scientists.

Box 1: Framework Programmes for Basic Research

- STA: The JRDC Strategic Basic Research Promotion System, 1995 budget - 5,1GY, 1996 requested budget - 15GY.
- Monbusho: JSPS Programme for the Promotion of Scientific Research with a view to Creating Intellectual Resources, 1996 requested budget - 11GY.
- MITI/AIST: Innovative Industrial Technology R&D Promotion Programme, managed by the NEDO; 1996 requested budget - 2,7GY.
- Agriculture Ministry: Basic Research Programmes for the Creation of New Agro-Related Techniques and Industries, managed by the "Bio-oriented Technology Research Advancement Institution". 1996 requested budget - 2GY.
- MPT: System for Basic Research in the field of Info-Communications, organised by TAO, (Telecommunications Advancement Organization) of Japan. 1996 requested budget - 0,5GY.

The synergy between public and private sectors

The classical scheme of positive interactions between the government and Japanese companies is functioning again with a brand new approach, at least by Japanese standards, based on cooperation rather than *dirigisme*. In the 60s and the 70s, various ministries, and especially MITI, were the driving forces behind the rapid growth of the industrial sector. Research was not an independent activity, aimed simply at creating new knowledge, but rather was fully integrated into the production system with a view to collecting and processing scientific and technical information.

The economic crisis has accelerated changes which were needed anyway

Paradoxically, the economic boom of the 80s put the national research centres and, to some extent, the university laboratories in a difficult situation. They were not needed anymore by the companies which had developed a full range of in-house R&D activities and had access, through different means, to the results of international research. Both of these activities reached their limit in the 90s (although the Japanese system continues to be very good at undertaking technology watch and collecting economic intelligence). In a sense, **the economic crisis has accelerated changes which were needed anyway**. The government has anticipated them and taken a series of initiatives which aim to provide industry with a sound national base for technological development. The companies have, in turn, reoriented their R&D activities to fully exploit the contribution of the public sector.

Even if government S&T policy focuses on topics which may pay off for the industry in the future, the crucial point is that this policy is not driven by immediate market needs. The new priorities are to reform the education system and to promote first class open science.

If Japan succeeds in this bold venture it will add to its well known capacity of exploiting research results, a new talent for creating scientific knowledge and it may soon become a scientific power in its own right. **Europe has yet to learn how to exploit its own research potential** and to transfer quickly bright ideas from the laboratory to the users, without losing its advantage in basic research. The recent evolution in Japanese R&D activities creates **new opportunities for better S&T cooperation between Europe and Japan**, including within the private sector, which could be further explored.

Europe can exploit the new openness of the Japanese R&D programmes, and hopefully improve its record in translating ideas from the laboratory to the market

Keywords

S&T policy, R&D strategy, Japan, Industry, Government.

References

- NISTEP Report 37, January 1995, *Science and Technology Indicators 1994*
- STA Report, March 1994, *Enquiry on Research Activity in Industry*
- General Affairs Agency, Office of Statistics, November 1995, *Results of the Enquiry on Research in S&T*

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Content vs. Distribution:

The medium loses to the message

Dimitris Kyriakou

Issue: Continuing technological innovation and liberalisation drives have caused a reduction in telecommunications distributors' expected profit margins and, increasingly, improving prospects for content providers and packagers.

Relevance: The repercussions of the dual prognosis above for policy are substantial: content is, at present still a small part of the telecommunications market, but it may well reap the lion's share in the future. On the other hand distributors (many of them public telephony operators) will need to adjust to leaner times - though not necessarily as desperately lean as some scenarios present them.

Introduction

Technology and liberalisation are reducing the power of intermediaries, undermining the 'natural monopoly rationale' for telecommunication services provision, and favoring the 'message' over the 'medium'. The content provided is becoming increasingly crucial in the consumer's decision to opt for one among several rival distributors, i.e. intermediaries providing access to the carried content. The room for growth of the content part of telecoms is tremendous since, according to the Boston Consulting group, the larger part of the telecoms market is still data transport-based with only a small part content-based. The prognosis need not be bleak for all distributors however. First through alliances, which are an interesting development though not the central topic of this article, they can hope to diversify their business; second, the key to survival and success will be product differentiation - and technological innovation provides opportunities for such differentiation; and third, an eventual consolidation in the marketplace should ameliorate prospects for the survivors.

The all-encompassing multimedia information society

The multimedia information society (MIS) is an all-encompassing concept that attempts to capture an all-encompassing transformation. The MIS is hence a concept reflecting the result of a series of developments on both the demand and the supply sides, centered around the increasing facility, speed and affordability - due to technological as well as (de)regulatory reasons - in manipulating data in various forms in increasingly efficient ways. The concept encompasses the increasingly interactive services and the applications riding on them and providing the added value that justifies the launching of such conduits/processors; it encompasses the work of the builders of this infrastructure and of the interacting users, producing and consuming information. The Information Society entails the ubiquitous impact on the socio-economic sphere of these pervasive technoeconomic developments, that not only change form continually, they also reshape the social context which gives rise to them.

The MIS network of networks, the late 20th century's Holy Grail, can be sketched out as a multi-layered structure that will be based on infrastructure providing access and connections (optic fibre, coaxial, copper, satellite, radio, microwave, etc). This grid is the backbone of the MIS. Service providers (public or private) will have access to the grid, and will use it to provide services (e-mail, teleshopping, tele-education, telebanking, etc.) to their customers who will be receiving information through the grid. Application developers will be fashioning new application packages for the network which they will sell to consumers through the service providers.

As mentioned above this breakdown serves analytical purposes; in practice firms are not limited to one part of the chain. We will, for simplicity, collapse the first two categories into a large 'content' category, the last two into one 'end usage' category, and will not explore deeply the otherwise crucial function of the gatekeepers which may develop into the most strategic and attractive area of activity - unless ease of entry undermines its profitability.

In order to assist us with the eventual evaluation of prospects for various players in this supernetwork, one can project, for analytical purposes, the following production chain:

a) Content originators (artists, writers, movie studios, etc);
b) Content packagers (TV stations, cable channels, On-line service providers);
c) Gate-keepers of gateways to the network (nanigation software, encryption specialists);
d) Distribution providers owning the conduits to consumers (cable companies, telecom operators);
e) Access devices (TVs, PCs, etc);
f) End users

Intermediaries vs content providers

One of the clearest statements about the MIS that is dawning, and its value/production chain presented above, is that content will be vindicated, in the sense that for a long time ideas, creators, as well as the businesses that marketed the products of human creativity, were often at the mercy of intermediaries/distributors, who controlled the means of access to the public, in textual, audio, video, computer file, etc formats. The distributor of the package created by the content provider could often dictate his terms on the latter, because it was technically, legally or financially impossible for the content provider to bypass the distributor or assume the distribution task himself.

The transformation undermining the power of the distributors is due to two factors. Firstly, the deregulation/liberalisation drives of the last decade have undermined the privileged, and often legally-endorsed, monopoly position of distributors, and have facilitated entry of new players in the market for distribution/transportation of information. The new players' basic market penetration strategy has been to beat the incumbents on price, since in terms of infrastructure and coverage they are often, at least initially, at a disadvantage. Furthermore the captive market enjoyed by the monopolists and the intricate settlements accounting schemes for international calls/connections/transactions have led to heavy overpricing that left room for newcomers to undercut prices.

Although the distributors of information used to have the upper hand....

deregulation and technology are undermining their position

Secondly, and perhaps most important, technological developments increasingly undermine one of the basic pillars of monopoly treatment of telecoms operators, namely the natural monopoly character attributed to the telecoms industry over a very long period. The start-up fixed costs were deemed to be so high, and economies of scale so strong, that it made sense for the state to have one distributor and regulate it (often through direct control/ownership). Falling marginal costs for transmission, storage, retrieval, and processing of information are questioning the validity of such claims. The convergence of telecoms with one of the most fiercely competitive markets (information technology) has further weakened the foundations of monopolistic structures in the telecoms industry.

and enhancing the prospects for content

On the other hand, the increasing, and increasingly affordable, information carrying capacity is leading to a proliferation of intermediaries who are fundamentally in the business of selling a 'connection' to a 'pipe', a conduit (or parts of the conduit itself). In order for the users to pay, directly or indirectly, for such connections however, the content they will be receiving should be attractive. Since the number of creative producers does not seem to have kept pace with the proliferation of intermediaries, there will be more distributors chasing after more or less the same number of content providers. To put it simply, **whereas in the beginning content providers paid intermediaries in order to get their products distributed on-line, they now sell their intellectual products to intermediaries** - often dearly as the recent Microsoft deal with the NBC television network showed. To avoid confusion, note however that large firms such as Microsoft may have content-providing parts as well as intermediary functions. In setting up its own on-line network Microsoft has entered the business of selling connection, of 'intermediating' - not necessarily an optimal move as both its legal troubles as well as its most recent Internet-espousing commercial moves seem to indicate.

There is room for the projected growth in the market for content, since distribution still claims the lion's share

These developments in supply and demand explain why 'content will rule' in the MIS, in the sense that it will be at a premium, at least when compared to its relative weakness in earlier times. **And there is room for such rebalancing in the market in favour of content:** according to the Boston Consulting Group, although the telecoms market is worth more than $400 billion, only $50 billion are devoted to content, whereas transport of information claims the lion's share - $260 billion dollars (*Le Soir*, 2nd Dec.1994, p.6, Economie). These numbers reflect the hitherto enviable position of intermediaries/distributors. The attractiveness of content benefits content packagers in multiple ways, since they repackage it in various guises (e.g. movie, video, soundtrack, t-shirts, etc). Intermediaries, such as on-line services may well suffer as the much cheaper and more populous Internet becomes increasingly attractive; they may be forced into lower profit margins and into selling connection to the Internet, instead of competing with it.

Content rules

Eventually the gap between supply and demand, and the high returns enjoyed by and projected for content providers (e.g. Microsoft, US film industry) will stimulate others to join the club of content provision, which would bring down the profit margins for content *in the longer run* (at least for the less creative content-packaging part). Furthermore, whereas telecoms, and in general the more "hardware-oriented" parts of the industry, could enjoy some legal/regulatory/technical protection, the more creativity-based, "software-oriented" activities have always had the lowest barriers to entry. However, that entry does not guarantee success, especially in "creative" industries, where product attractiveness is notoriously hard to predict. In such industries, star performers receive huge rewards, attracting masses of emulators who must survive on meager rewards and grand aspirations while hoping their time will come.

The very characteristics that make commercial appeal unpredictable, *a priori*, for creative products, also shield these products against "reverse engineering" by competitors seeking to decipher the elemental "formula" for success, so that they can then apply it themselves. The flip side of intellectual products' resilience against reverse engineering is their vulnerability with respect to sheer, crude copying, to which they have fallen victim throughout the ages. This points to one factor that may taint the rosy scenario painted above for content: the importance of adequate protection of intellectual property rights for the full realisation of the potential of content provision as it is gradually being liberated from the grip of distributors. The recent emphasis on **intellectual property rights (IPR)** protection, is partly attributable to the fact that European policy-makers and entrepreneurs, as well as their US and Japanese counterparts, increasingly realise that high returns, and the comparative advantage of the industrialised countries, lie with knowledge-intensive activities, including intelligent, flexible MIS-informed manufacturing, and not with traditional mass manufacturing. In the latter, East Asian and other competitors learn extremely fast how to outsell their First World teachers.

There are a few hitches in the above scenario, though not enough to undermine the validity of the main argument. First, as mentioned already above, the culture of the content industry and the fleeting, unpinnable character of product attractiveness makes content a risky business, and this preoccupies investors. Second, from a macroeconomic perspective, since **personal disposable income edges up slowly, expenditure on content would have to be displaced from cars and houses, etc.** If, however, consumer spending on leisure increases then content should benefit. Finally, in the longer run the distributors, currently competing among themselves, and bidding up prices for content, will likely consolidate and limit content providers' power.

Intermediaries' fortunes

This leads us directly to the second clear proposition that is often heard regarding the MIS value chain presented earlier. As already explained above, **distribution is generally projected to suffer from falling profit margins, due to technological breakthroughs and deregulatory drives, that will virtually turn it into a commodity business.** Is the future indeed that dire for distributors? Not necessarily: the need for continuous technological updating and the technological requirements of high quality multimedia applications imply that not all distributors will be offering the same services. Product differentiation is the best antidote to becoming commodities, and at least some distributors may afford it (e.g. offering not mere telephony but packages of services with special, even custom-made features). The problem, of course, is that if a large number of them may afford it competition among them in a globalised market will be fierce, and the dire prognosis presented above applies in equal strength. It is quite likely, however, that eventually consolidation will improve prospects for the remaining distributors. Nevertheless, the high profit margins of days passed would be hard to realise, because excessive price mark-ups will trigger market entry by new rivals (since set-up costs are falling) as well as competition by cellular and satellite operators etc.

Finally, in dealing with such challenges, distributors are both forming alliances and sharpening their knives. They form inter-industry alliances (e.g. with content providers) to diversify their activities, and to gain a friend while they still have something to offer - market power, access, assets, etc. before competition erodes their attractiveness as partners. They also form intra-industry alliances in order to benefit from concentration, and to be able to promise global end-to-end, problem-free, seamless telecommunications, which can be a lucrative market, especially with respect to business customers. They also aim, through forming alliances, to spread risk better; to enhance their tactical advantage in light

Though entry in the content industry has always been easy, success has not

Creative content products can not be reverse-engineered

. but they are vulnerable to crude copying

The prospects for distributors can be mitigated through product differentiation, inter-industry alliances and eventual consolidation

of crucial negotiations (e.g. worldwide satellite distribution); to share costs of possible investments; and even, through advertising blitzes, to intimidate rivals, or, defensively, to balance similar posturing by rivals. It should be noted, however, that more than 60% of such alliances fail within a year.

In summary, technology and liberalisation are reducing the power of intermediaries, undermining the 'natural monopoly rationale' for telecommunication services provision, and favoring the 'message' over the 'medium'. The content provided is becoming increasingly crucial in the consumer's decision to opt for one among several rival distributors, i.e. intermediaries providing access to the carried content. The room for growth of the content part of telecoms is tremendous, since, according to the Boston Consulting Group, the larger part of the telecoms market is still data transport-based, and only a small part is content-based. The prognosis need not be bleak for all distributors however. First through alliances, which are an interesting development though not the central topic of this article, they can hope to diversify their business; second, the key to survival and success will be product differentiation - and technological innovation provides opportunities for such differentiation; and third, an eventual consolidation in the marketplace should ameliorate prospects for the survivors.

Keywords

content providers, distributors, product differentiation, market entry, IPR, reverse engineering, natural monopoly, falling marginal costs

References

- Conferences on Telecoms, multimedia, information society and converging technologies held in Brussels (June 1995) and San Francisco (November 1995)
- *Telecommunications Survey*, The Economist, Sept. 30, 1995, p.75 ff.
- *Multimedia Information Society*, D. Kyriakou & I. Maghiros, IPTS Technical Report, 1995

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Achieving a New Generation of Personal Communications

Alois Frotschnig

Issue: At present personal communication services are provided by a range of first and second generation networks and technologies. It is envisaged that the next generation will bring together all the attributes of existing personal communications into a single unified system. However, in order to see how this can be achieved it is necessary to consider a number of technical, economic, regulatory and market place issues.

Relevance: What is at stake is a vision of the world where terrestrial and satellite based mobile communications systems will allow people to make and receive calls from any point on earth using the same multi-purpose handset whether at home, in the offices, or outside. The progressive migration from second to third generation systems, which is expected to start at the turn of the century in a way that is relatively seamless, attractive and natural for the user, is going to have dramatic implications both in market and social terms.

The Universal Mobile Telecommunication Systems (UMTS) and Future Public Land Mobile Telecommunications Systems (FPLMTS/IMT2000) are third generation mobile telecommunications systems which aim to unify the present diverse systems into a seamless radio infrastructure, capable of offering a wide range of services around the year 2000 (see Box 1) for a brief review of second generation standards).

Using terrestrial and satellite based mobile communications systems could allow people to make and receive calls from any point on earth using the same multi-purpose handset whether at home, in the offices, or outside. The first signs of the shift to ubiquitous personal communications are evident in the success during last year (1995) in Japan of the "Personal Handy Phone" (PHS), an inexpensive, light weight handset that operates as a cordless telephone in the home, and as a cellular phone elsewhere. Thirty-five companies have grouped around the Japanese PHS standard, to promote it on a worldwide basis. These include Fujitsu, Hitachi, Matsushita, NEC, NTT, Sanyo, Sharp and Sony as well as multinationals with interests in the technology or market such as AT&T, C&W, Ericsson, Motorola and Nortel (Northern Telecom). Apart from deployment in Japan, nearby Asian countries, such as Singapore, Hong Kong, Malaysia and even China are being targeted for PHS products, while NTT has already launched a trial in Indonesia in cooperation with the national operator.

Third generation systems aim to unify present diverse systems into a seamless radio infrastructure

Digital Cellular Standards

A cellular network comprises a series of low power station sites, each providing a relatively small area of coverage (cell) which combines to form continuous coverage throughout a given area. The first analogue cellular mobile communications network was launched in Europe in 1981, and the first digital cellular network, based on GSM, was launched in 1992, 11 years later. Although analogue networks are not dead, the future lies in digital systems such as GSM, D-AMPS, PDC or CDMA.

Global System for Mobile communications (GSM): GSM is a pan-European standard and offers operators the additional added-value benefit of international roaming. GSM networks have now been deployed throughout Western Europe and are rapidly gaining ground in Eastern Europe and the former Soviet Union. They have also been installed in Australia, Hong Kong and India, and are being evaluated or adopted in most countries in the Asia Pacific region. In China, GSM is emerging as the preferred digital cellular technology. Already some 8 million subscribers in 86 countries use digital mobile phones based on the GSM standard, which is 90% of all customers using digital cellular systems.

Digital Advanced Mobile Phone Service (D-AMPS): This US digital cellular standard (also known as Time Division Multiple Access - TDMA) has been developed from the analogue AMPS cellular technology. It has been installed in Canada, South America, the Asia Pacific region and the former Soviet Union. AT&T has chosen TDMA technology, while Pacific Bell Mobile Services has gone for GMS.

Personal Digital Cellular (PDC): Japan has developed its own digital system, which has not been taken up outside. The PDC system offers a variety of services in addition to high quality speed (high speed facsimile, modem transmission at speeds up to 9.6 kbps) and it supports the supplementary service categories that are defined by the International Telecommunications Union.

Code Division Multiple Access (CDMA): This transmission technology promises to be the state-of-the-art digital cellular system. It enables improved quality voice communications and even greater capacity than existing digital standards. The technology is still immature and has yet to be proven in a commercial network, and so far South Korea is the only country to adopt it as its chosen digital cellular standard. CDMA's higher capacity makes it a more likely option for carrying large amounts of previously fixed traffic from the home to work. CDMA has been adopted as the preferred technology of a number of US consortia planning to offer personal communication services in the US, including Sprint Telecommunications Venture, GTE Mobilnet, and PCS Primeco (including Nynex, Bell Atlantic, US West and AirTouch Communications).

State-of-the-art technology

As a first step, digital cellular systems have recently been introduced in many countries because of the advantages they provide in terms of capacity and adaptability for new services. The principal goals for digital or second generation technologies were to achieve more capability from the spectrum available, and to prepare for new (non-voice) features and facilities. In analogue cellular transmission the voice signal is transmitted in a continuous wave, whereas in digital cellular communications it is transmitted in short, timed bursts. During the pauses in one conversation the bursts of another can be accommodated. This means digital cellular technology has much greater capacity than its analogue counterparts. It offers faster set-up times and greater voice clarity and uses encryption techniques to provide more secure communications.

The demand for change has been partly technological and partly supply-side driven. The principal drivers of digital cellular technology are very similar across the world, however, the maturity of the market will influence the impact of these drivers. Factors affecting market maturity include pent-up demand for mobility due to changes in societies and working practices; expedient deployment of cellular technologies reducing "fixed" PSTN (Public Switched Telephone Network) waiting lists; competition; price reduction to the customer in handsets and tariffs; improved coverage and quality in cellular; broader distribution channels; and new and value added features like roaming (moving from one geographic area to another without losing the communications link), mobile information displays or messaging. By seeking to liberalise mobile communications, governments and regulators are encouraging demand for these new and value added features in telecommunications.

Interoperability requires standards

Standards are the key to mass acceptance of new technologies. The four principal families of digital cellular standards we see today include the Global System for Mobile communications (GSM), Digital Advanced Mobile Phone Service (D-AMPS), Personal Digital Cellular (PDC) and Code Division Multiple Access (CDMA) (see Box 1). Such standards have been developed in order to realise interoperability between countries. However, they are not completely integrated with fixed networks, and European networks are not compatible with standards developed in Japan and the US. For further development of personal communications the issue of the combining both terrestrial and satellite-based technologies, such as the Digital European Cordless Telephone (DECT) and the GSM needs to be considered. With respect to second generation systems for office communication we observe an evolution to integration of voice and data. Through wireless, digital technologies such as DECT multi-line mobile services can be offered. However, for data transport through wireless Local Area Networks (LAN), much more bandwidth and transmission capacity is needed. Next generation systems will be able to deal sufficiently with these problems, facilitating broadband mobile applications such as wireless video.

The global challenge

The shift to ubiquitous personal communications is also evident in the number of consortia competing to establish satellite-based systems for inexpensive world-wide personal communications. These include Iridium, led by Motorola, ICO Global Communications and established by Inmarsat, and Globalstar led by Loral and Odyssey headed by TRW. Generally they claim that services will be available globally. The systems will support basic services, available to all users, and supplementary services and optional offerings. But in today's world the possibilities of mobile communications are limited. There are islands of coverage that allow only limited roaming. The multitude of standards is, in some cases, leading to decreasing interoperability, and coverage inside buildings and in rural areas are still a problem.

Cellular telephones will continue to be the backbone of the wireless world, but the following options for mobile communications are, or will shortly be, available to complement the market:

- Satellite is the most cost effective solution for wide area, low population density environments. It is also an essential element in offering global roaming, due to the major regional differences in cellular standards.

Shift to ubiquitous personal communications previewed in the success of the Personal Handy Phone in Japan in 1995

Second generation aimed to achieve more capability from the available spectrum, and prepare for non-voice features

The maturity of the market will influence the impact of the drivers for change

Standards are key to mass acceptance of new technologies

Next generation systems will deal with high bandwidth and integrate services

- Cordless techniques are a cost effective solution for limited coverage in high density and indoor environments.
- Fixed networks can be enhanced towards Universal Personal Telecommunications (UPT) which will enable users to make and receive calls to a personal number at any access point.

The path towards the third generation

Third generation mobile communication systems aim to integrate all the different services and technologies mentioned above (cordless, PCS, cellular, satellite) and provide a competitive service (voice, data, video, multi-media) compatible with the technology developments taking place within the fixed telecommunications networks.

At the global level, the work carried out within ITU (International Telecommunication Union) has been instrumental in the definition of FPLMTS/IMT2000. In Europe, R&D on third generation, referred to as UMTS, is coordinated by the European Telecommunications Standards Institute (ETSI) Special Mobile Group. The UMTS work is aiming toward the ideal of ubiquitous coverage and universal access. An ideal multimode terminal would:

- have similar selling price, weight, and size as single mode terminals;
- support a unique call number whatever the host network;
- allow roaming of the terminal over different access networks;
- allow the user to have his same personal service profile anywhere;
- automatically switch to the best locally available radio access for the required services (according to the user's criteria);
- allow the user the same procedures for call, mobility, and service management, independent of access technology.

In Japan, NTT DoCoMo is going to realise the next generation system, aimed at implementing personal and multimedia mobile systems, by taking two approaches: enhancing the current Personal Digital Cellular telesystem (PDC) and developing an entirely new system (third generation, know as FPLMTS). In Japan the rate of increase of cellular communication systems in the fiscal year 1994-1995 was more than 100%, with approximately 7,48 million cellular subscribers by November 30, 1995, of which 1,730,000 had signed up in the previous four months. The surge of demand coincides with the launch of PHS services in July 1. By the end of November, there were 485,000 PHS customers in Japan, with three PHS networks in operation. These two systems evolve independently for the time being. Regarding the network technologies, the second generation systems (digital cordless PHS and digital cellular PDC) will evolve into the third generation FPLMTS systems.

The next objectives for the PDC system is to realise a much higher capacity and to provide new services. According to M. Kuramoto (NTT Mobile Communications Network Inc., Telecom 1995), for the next several years, the PDC system may be the major mobile communication system in Japan. It is estimated that the number of subscribers will be around 10 million in the year 2000. As for FPLMTS, more spectrum-efficient and more flexible radio transmission technologies are necessary in order to provide multimedia services, and to facilitate the coexistence of macro-cells and micro-cells.

In order to realise the ultimate telecommunication system described through key words such as "personalisation", "mobile multimedia" and "intelligent system", many advanced technologies are required to be developed: Ultra Compact Portable Phone with Low Power Dissipation, Multimedia Mobile Terminal, Multi-Beam Antenna, Efficient Spectrum Utilisation, Integrated Service for Voice, Video and Data, Infrastructure Transparent to Any Media (e.g. Asynchronous Transfer Mode - ATM), Intelligent Mobile Network, Artificial Intelligent Processing, etc. Technical solutions are being developed, as for example in the mobile ATM. The main problem of the ATM technique is the transportation delay in low bit rate transmission, such as speech. Therefore a new mobile ATM cell configuration is being developed that assigns the voice signals of different calls for the same destination to the same ATM cell in a statistical multiplexing manner (more about ATM can be found in the 00 issue of the IPTS-Report, Dec. 1995).

The framework of the global telecommunications infrastructure

Three trends - Globalisation, Liberalisation, and Convergence - are reshaping the performance of national telecommunications infrastructures in specific markets and across the global economy. These trends will be manifested as industry drivers at the local level that affect the cost structure and the competitiveness of particular operators. At the global level, these trends affect the relative performance and competitiveness effects on national operators and the Global Information Infrastructure.

Telecommunications and Information Technology (IT) are increasingly defined in terms of interoperability. Meeting customer expectations as they increasingly transcend time and space will become an attraction and challenge for service providers throughout the world. In both the telecommunications and IT industries, trading entities like the North Americal Free Trade Agreement (NAFTA), the EU and the Asia Pacific Economic Cooperation (APEC) foster and accelerate the reduction of barriers to entry and traffic flows. They also promote rapid standardisation and implementation of common market platforms. Nevertheless, there are three different approaches in the land mobile telecommunications industry to realise its goals: one common ETSI system for a vast multinational region in Europe; one common national system, standardised by majority industry members in Japan, including foreign countries (the Japanese PHS is now one of the ITU standard systems); and no single standard but multiple systems freely compete for ultimate domination as the de facto standard in the US.

Japan is focusing on developing a third generation system known as FPLMTS

The European initiative to develop UMTS is, therefore, seen to be part of the policy to provide an advanced, transparent, fully interoperable and integrated personal communications service across the continent. UMTS provides the wireless component of this service. Questions of system revolution, evolution or migration are not only technical problems but also issues of long-term European strategic telecommunications policy.

On a global scale, the standardisation of UMTS is linked to the development of FPLMTS, even though the latter will be influenced by diverse market conditions and economic drivers. Current developments in the USA with auctioning of the radio spectrum for PCS will lead to the rapid deployment of a variety of standards. This will inevitably lead to a delay in the introduction of new technology for FPLMTS in the USA. Japanese systems have been constructed solely for the national service operations. If considered for introduction abroad, they have to be partially modified. The ETSI achievement of multi-national and regional standardisation is a commendable solution. Advancing in the very successful digital mobile, GSM was a central learning process to European telecommunication industry and to regulatory and standardisation bodies within Europe. There is no doubt that the definition and implementation of third generation mobile systems constitutes a major challenge to the organisation of R&D programs, as to the telecommunications industry and the institutions of regulation and standardisation within the EU. The outcome of this process is of extreme importance to the European telecommunications industry.

Many new technologies are prerequisites for achieving the performance promised by third generation systems

There are three different approaches to standardisation a common standard for Europe, another specific to Japan, and multiple competing systems in the US

Keywords

Mobile Telecommunications Systems, Digital Cellular Systems, Information Technology

References

- Speakers' Papers, *Telecom 95*: ***7th World Telecommunication Forum - Technology Summit, ,*** Vol. 1,2. Organised by the ITU, October 3-11, 1995, Geneva.
- *Survey on Mobile Communications,* ***Financial Times***, Monday November 27, 1995.
- The 2nd annual ***Global Mobile & Mobile Satellite Conference 1995 - Conference Proceedings***. Organised by CMP Publications International, Corp, November 1995, Brussels.

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Using DNA for Data Processing:

Biotechnology meets informatics

Kay Beese

Issue: In a recent breakthrough an American scientist demonstrated how a series of biomolecular (DNA hybridisation) reactions could be used to solve a class of economically very important mathematical problems.

Relevance: This 'biocomputing' experiment gave a brilliant example of how revolutionary new approaches towards important technical problems can be achieved by stimulating cooperation of disciplines usually separated under current R&D programme schemes. In such areas the competitiveness of European industry depends on highly interdisciplinary cooperation and the early involvement of industrial R&D. Otherwise the potential market - like in other fields of information technology - will be lost to the US and Japanese competitors who have established such structures.

Do we need a non-semiconductor based computer technology ?

The breath-taking computer development conceals the fact that there are still many economically important mathematical problems which conventional computers can not solve within a reasonable time. A model for such 'hard problems' is the so-called "travelling salesman problem", the task of finding the shortest route between cities. As the number of cities grows, the number of possible routes grows as n!, or factorial n, where n is the number of cities. If a computer takes 5 seconds to solve a 10-city example, it would take around 100,000 years to solve one involving 20 cities (Matthews 1995). This example belongs to the important group of NP (non-deterministic polynomial time) problems which are considered as "inherently intractable", meaning that it is believed that no deterministic polynomial algorithm exists for solving them efficiently. Scheduling problems (train, aeroplane, teachers timetables) typically belong to this group and optimisation could save an enormous amount of resources. Network design, storage space minimisation and molecule design are only a few other examples (see Garey & Johnson 1979).

There still exist hard problems of economic importance for which computers are still too slow

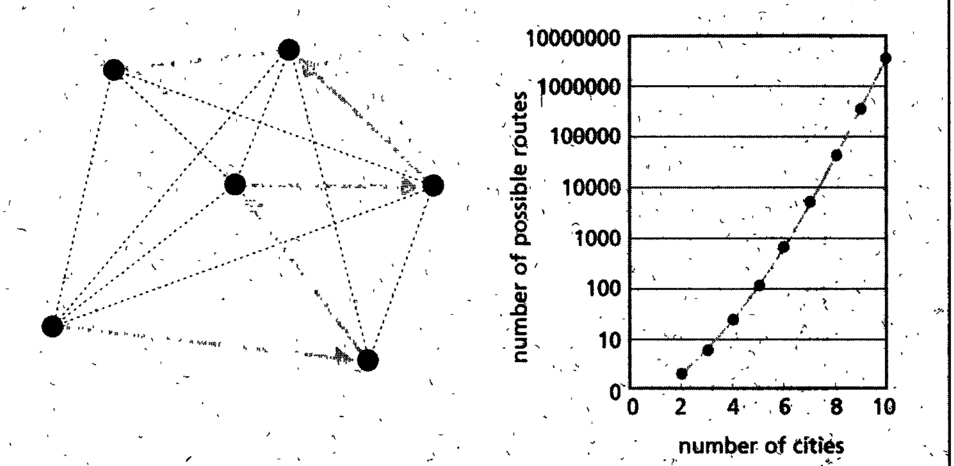
There are ideas for processing data more efficiently

In recent years several new ideas have been developed to use non-electronic natural phenomena for real, efficient computation. Several concepts to increase the degree of parallelism have been discussed theoretically, with a particular emphasis on using quantum-mechanical (Lloyd 1995) or biomolecular (Rooß & Wagner 1995, Birge 1995) mechanisms. While quantum-mechanical computing is still at a theoretical stage, calculating with DNA has become reality.

The massive parallelism featured by biocomputers can be applied to hard problems

Fig. 1: "The Travelling Salesman" Problem

The travelling salesman problem is a typical NP problem. The number of possible paths visiting all of a given number of cities once grows as n! (factorial n, n is the number of cities) if for each pair there exists a single connection.



...the number of possible paths connecting all cities... ...grows rapidly with the number of cities

Although state-of-the-art computers can easily do 100 million instructions per second, the number of processors running in parallel is small (up to a thousand). Solving NP problems, however, requires an approach asking for massive parallelism. Integrated circuit technology may be running up against its physical and technical limits. Moreover, in reducing size by half, production costs increase by a factor of five, meaning that development of classical computers will reach its economic barriers long before physical limits are reached (Birge 1995, Lloyd 1995).

Table 1: Different Computer Concepts - Their Advantages and Disadvantages

Concept	speed	parallelism	technology	stage
Silicon chip computer	rather fast 100mio MIPS	limited 1000 processors	simple	standard
DNA computer	slow	huge (10^{20})	complicated	model
Optical computer	very fast	limited	simple	reality
Quantum computer	fast	huge	complicated	theory

Silicon chip computers and optical computers are unbeaten in terms of processing speed, but new concepts allow a yet unknown degree of parallel processing.

October 1994 - The era of DNA computing begins

In October 1994 Leonard Adleman of the University of Southern California demonstrated in a very clever experiment how a series of DNA reactions could solve an instance of a problem closely related to the travelling salesman problem, namely the Hamiltonian path problem[1], which called for discovering a continuous path linking all (seven) cities (Adleman 1994, Bass 1995). The general idea was to use a large number of DNA strings as "processors" which computed in parallel (see fig. 2; for technical details see Adleman 1995 and Beaver 1995). The design of this experiment required not only understanding of the mathematical problem but also detailed knowledge of DNA structure, molecular mechanisms and techniques (DNA synthesis, hybridisation, PCR, affinity purification, graduated PCR, etc.).

Tiny test tube systems using biomolecules can, theoretically, carry out some billion billion operations at once, much more than all the computers in the world working together can accomplish. An attomole of oligonucleotides would have been sufficient for the Adleman experiment. However, the travelling salesman example can only serve as a model for economically more important problems and the brute force algorithm used would be too inefficient for a problem with many cities. Was this experiment just a curious footnote to the history of computing?

It does not seem so, even if many researchers doubt whether biocomputing will ever have a large scale application. Richard Lipton (1994) showed that Adleman had solved a NP complete problem, meaning that such a system - a DNA computer - can be adapted to solve any NP problem. Considering the enormous economic importance of such problems it appears worthwhile to check the feasibility of the approach.

Will the DNA testtube replace the silicon chip ?

Nobody suggests a purely biomolecular computer. The system developed by Adleman was designed to solve very specific - NP - problems, other calculations can be done more efficiently by conventional computers. Although many computation (even non-NP) problems can be solved by massive parallelism, hybrid machines combining DNA and semiconductor systems appear much more feasible than pure biocomputers. Even those hybrid systems could be fifty times smaller and up to a hundred times faster than current computers (Birge 1995).

Using current technology the Adleman experiment requires one week of laboratory work, this time should grow linearly with the number of cities. For each problem the DNA test strand composition has to be specifically designed. It is obvious that only automation of these processes in small desk-top machines can make biocomputing practical. Automation of the processes and miniaturisation of the devices down to chip-size is being developed for biomedical purposes but could also be adapted for biomolecular data processing. The requirements in terms of size, speed, reliability and robustness are quite the same.

What is the state-of the-art in Europe, the U.S. and Japan ?

Biomolecular data processing is far from being operational and it is too soon to tell which way molecular computers might take off. It seems that in terms of practical approaches towards biocomputing nothing has been published since Adleman presented his experiment in autumn 1994, in the U.S., Japan or Europe. However, although unnoticed by most scientists, the field seems to move fast, laboratories are trying to solve harder problems and to design a sort of

. and was successfully applied in late 1994 in the US

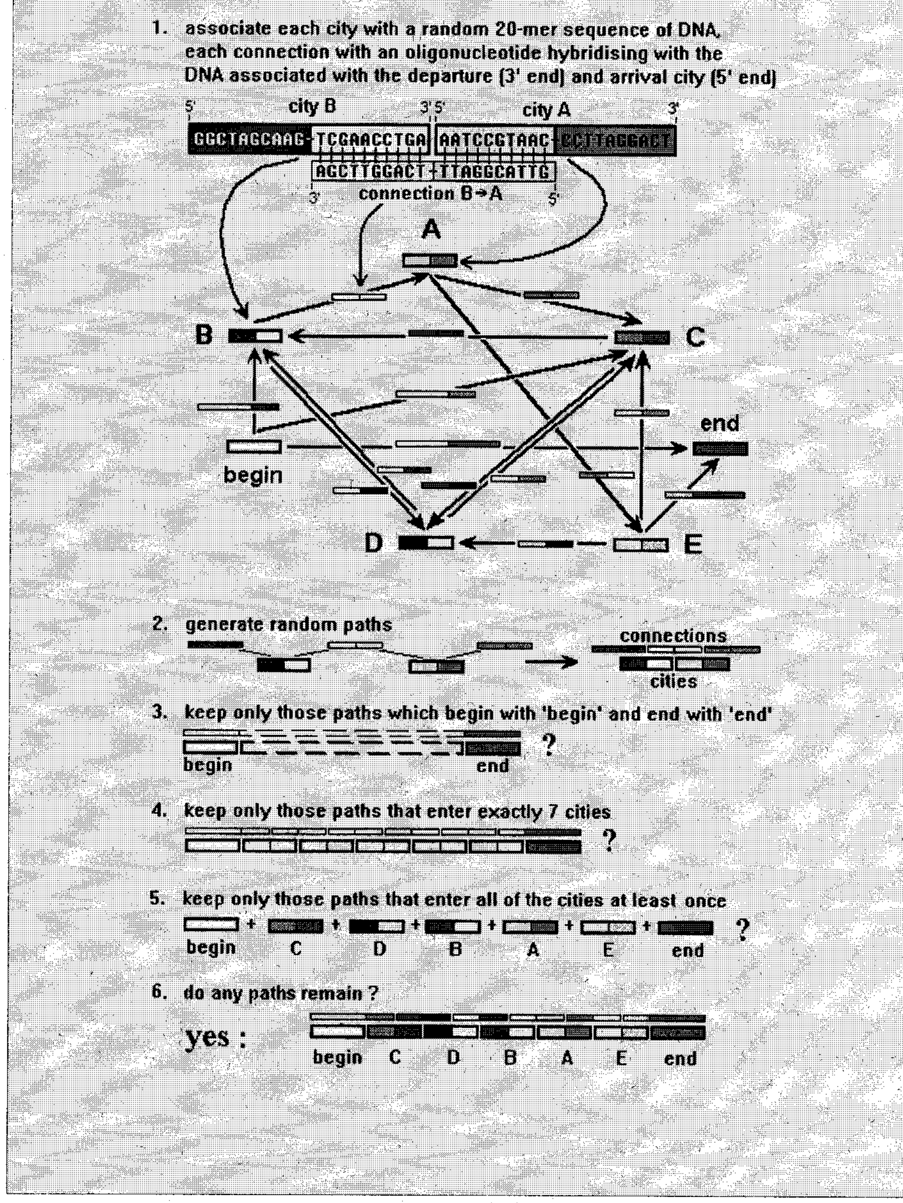
Although pure biocomputers are not projected anytime soon, hybrid machines may be feasible

with the help of automation and miniaturisation

1 The Hamiltonian path problem entails identifying a path between the designated first and last cities (nodes), visiting each city exactly once, in a directed graph where cities are represented by nodes, and where directed edges linking nodes represent the permissible one-way paths between nodes

Fig. 2 The Adleman Experiment

How to use DNA strings in finding a path connecting all of a set of seven cities ? Connections between cities and their direction, as well as the departure and arrival city, are predetermined.



universal DNA computer. Representatives of US (AT&T Bell Laboratories) and Japanese (NEC) companies have already expressed their interest in these developments (Kolata 1995).

European research is up-to-date as far as the theoretical assessment of biocomputing potentials is concerned (e.g. University of Würzburg, see Rooß & Wagner 1995) and there is widespread interest in the subject. However, due to the lack of cooperation between and molecular geneticists, the feasibility of theoretical concepts has not been proven by experiments.

Consequences for R&D funding schemes

Multidisciplinarity is a magic word for R&D managers but usually is a continuation of conventional approaches, just making them more efficient through the cooperation of different specialists. DNA computing research goes far beyond such concepts. Biology research and informatics have by necessity been quite divergent. Biology intends to understand fully formed masterpieces while computer development builds from the ground up. Only occasionally, as in the case of genetic algorithms, have computer scientists seriously raided nature's bag of tricks (Levy 1995).

Without moving towards practical experiments and technical development a potential market - like in other fields of information technology - could be lost to US and Japanese competitors. The relevant knowledge and skills are available in Europe and merging them could lead to a great leap forward. Current research programmes rarely allow funding of such projects but an adaptation in this direction would appear promising. Commercial exploitation requires an early industrial R&D involvement which could concentrate on automation of DNA synthesis and analysis.

Need to explore multidisciplinary collaboration in order to avoid being left behind

Lack of cooperation across disciplines hampers future development

Key words

interdisciplinary R&D, biocomputing, parallel data processing, NP problems

References

- Adleman, L.M., 1994, *Molecular Computation of Solutions to Combinatorial Problems*, Science, 266, pp1021-1024.
- Bass, T.A., 1995, *Gene Genie*, Unpublished manuscript.
- Beaver, D., 1995, *Computing with DNA*, Unpublished manuscript.
- Birge, R.R., 1995, *Computer aus Proteinen. Spektrum der Wissenschaft*, November 1995, pp30-36.
- Garey, M.R. & Johnson, D.S., 1979, *Computers and Intractability - A Guide to the Theory of NP-Completeness*, W.H. Freeman & Co. New York.
- Kolata, G.,1995, *A Vat of DNA May Become the Fast Computer of the Future*, N.Y. Times News Service.
- Leutwyler, K., 1995, *Calculating with DNA*, Scientific American, September 1995.
- Levy, S., 1995, *Computers Go Bio,*. Newsweek May 1, p. 48.
- Lipton, R.J., 1994, *Speeding up Computations Via Molecular Biology*, Unpublished manuscript available on the World Wide Web at **http://www.cs.princeton.edu/~rjl/**
- Lipton, R.J., 1995, *DNA Solution of Hard Computational Problems*, Science Vol. 268, 28 April 1995, pp542-545.
- Lloyd, S., 1995, *Quantum-Mechanical Computers*, Scientific American, October 1995, pp44-50.
- Matthews, R., 1995, *Hard Maths? No Problem.*
- Rooß, D. & Wagner, K.W., 1995, *On the Power of DNA-Computers*, Unpublished manuscript available on the World Wide Web at **http://haegar.informatik.uni-wuerzburg.de/pub/TRS/ro-wa95.ps.gz**

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Plastics Recycling in Europe:

Learning through innovative comparisons

L Bontoux and D. Papameletiou

Issue: Although in most European countries plastics recycling is virtually non existent, the implementation of the EU packaging directive, adopted in December 1994, imposes significant recovery and recycling targets by the year 2000. The directive calls also for the review of the achievable targets every five years and opens a long-term frame for technology development.

Relevance: Under the pressure of the packaging directive, Europe is already playing a leading role in developing innovative technologies. Japan has started only very recently to follow, and the USA appears to have no large scale action plans. In this context, better coordination between national and EU environmental and R&D policies is essential for guiding the future adoption of fast developing technologies and maintaining the European leadership. Current planning can benefit from lessons learned in the early 90's in Germany, where an ambitious national recycling plan based on traditional recycling technology was adopted. Moreover, implementation of the packaging directive could be helped by using recently demonstrated alternative technology options, such as feedstock recycling in the iron and steel industry, and in refineries, or energy recovery in several industrial applications .

There is some experience at the national level of the prevention-collection-sorting-recycling cycle of plastics packaging waste, particularly in Germany. The major lesson learnt is that traditional mechanical recycling, based on the remelting and extrusion of waste plastics, has limitations both in cost and efficiency. It can only achieve high recycling goals at extremely high cost. To solve these problems, new concepts are being developed, including the feedstock recycling and the energy recovery options, which, if adapted efficiently in national waste collection schemes, could provide an optimum between cost and environmental benefits. The challenge is now for each country to adopt the appropriate mix of management concepts, logistics and recycling technologies.

In this context, adoption of innovative technology at a European level seems promising in the long-term. Investment decisions in new feedstock technology have to take into account the fast developments and frequent changes of course in technology, that cannot be easily reviewed and evaluated with respect to cost and environmental impacts. On the other hand, the implementation deadlines of the directive seem to have been realistically chosen (up to 2005) to allow all Member States to benefit from the current development of some of the emerging techniques and to learn from experiences gained in pioneer countries.

Lessons from Germany: combining collection, sorting and recycling technologies

While most of the European countries are just starting to elaborate implementation plans for the packaging directive, Germany already has a recycling industry based on "traditional" mechanical recycling techniques due to the early establishment of specific legislation forbidding plastics incineration. It is also worth mentioning that in countries like Denmark, France, the Netherlands and Sweden, incineration with energy recovery is regarded as a strong priority. As for the collection and sorting logistics, large scale projects are being further developed in Austria, Belgium and France. Other Member States are now planning their own national recovery and recycling schemes.

The early packaging waste management concept introduced in June 1991 in Germany set extremely ambitious recovery and recycling goals for plastics waste: 64% by 1st July 1995. The design of the overall system was based on the collection, sorting and recycling technology available in the early 90's. The operating results, seen from today's point of view, reveal that the high environmental awareness of the German population has enabled high collection rates to be achieved. However, recycling technology was soon identified as a bottleneck. Mechanical recycling can only be carried out if the plastics waste material is separated into mono-material fractions of identical molecular structure (PVC, PE, PP etc.). This separation only proved to be economically feasible for the waste plastics fraction made of large parts (heavier than 10 g, for example bottles). The real challenge for achieving high recycling targets lies with the smaller and dirty parts such as yoghurt cups or small wrappers. Waste statistics show this fraction to be 70-80% of the total plastics in the municipal solid waste. Based on this knowledge, the European packaging directive and legislative provisions in other countries clearly avoided setting high recycling targets and settled for a level of 15% recycling.

Seen from the point of view of traditional techniques, high recycling targets are intrinsically expensive. Total costs up to 3000 DM per ton have been reported in Germany with about 70% of this cost being due to collection and separation. Since the processing and recycling represent only approximately 30% of this cost, cost reduction is best achieved by new combinations of logistics, and avoiding the expensive separation steps by employing novel recycling techniques that can accept mixed plastics waste fractions. Cost reductions of 30% or more are said to be achievable in Germany by using improved logistics and innovative technologies.

Linking policies with recent technology breakthroughs

In Germany, despite the difficulties in realising the original recycling plan based on traditional technologies, the high targets were not lowered. This put industry under extraordinary pressure to provide solutions, and led to new research activities which focused on avoiding the expensive separation of plastics into mono-fractions. As a result, the door to feedstock recycling was opened because it allows the handling of mixed plastics waste, and high collection and recycling targets became achievable at a more reasonable cost.

The concept of feedstock recycling regards waste plastics as hydrocarbons and injects them, following adequate pre-treatment, into crude oil refinery operations to deliver several oil fractions and waxes depending on the particular local circumstances. The system, therefore, takes advantage of large existing refinery capacities and returns the plastics waste to virgin raw materials. Large scale demonstration was provided by VEBA's 40.000 t/y (tons/year) hydrogenation plant for mixed plastics waste in Bottrop, Germany. Furthermore, important announcements from DSD (Dual System Deutschland) in Ger-

In the early 90's mechanical recycling was a bottleneck, making it unfeasible for small, light waste

Total costs of up to 3000DM/ton are reported in Germany, due largely to collection and separation

Feedstock recycling has become attractive because it allows handling of mixed plastics waste at a reasonable cost

Mixed plastics waste can be of use as a reducing agent in the iron and steel industry

many in 1994, promised to expand such capacities up to 500 000 t/y in cooperation with a number of large companies, for a gate fee of around DM 325/t. Research activity in this direction is also being carried out at the international level. A pilot project has been initiated by a consortium including BP, DSM, Elf Atochem and Enichem.

Another breakthrough was recently made public involving the possible use of mixed plastics waste in the iron and steel industry as a reducing agent for iron ore. The endothermic character of the reaction allows the classification of this technique as feedstock recycling and not as energy recovery. Large scale industrial project results are reported from Klöckner, Germany. The demonstration project started in 1992 and the latest continuous one year experiment (50 tons of plastics per day) was recently concluded, apparently with success. This technology appears to be the cheapest plastics recycling alternative available today, even compared to mechanical recycling. Promising experiences are also reported on the co-combustion of plastics waste in an increasing number of cement plants in Europe.

In Japan there is a clear preference for plastics liquefaction, and for energy recovery

Competition expected from Japan

Outside Europe, the only recent event is that policy makers in Japan have decided to follow the European path by introducing a framework law, similar to the EU packaging directive, expected to enter into force in early 1996. The most striking feature of the Japanese developments is the clear preference for "plastics liquefaction", the Japanese version of feedstock recycling, and for energy recovery. Recent announcements from MITI (Ministry of International Trade and Industry) reveal that full operability of large scale industrial systems is expected to be reached within five years thanks to dedicated R&D projects.

Interesting areas of research include logistics, standardised ecobalancing methods, as well as co-combustion of plastics waste in the cement industry

Need for a targeted R&D strategy

With the exception of some publicly funded projects carried out in Germany, research on novel technologies capable of treating mixed plastics waste has until now been carried out exclusively by industries at their own cost. In order to sustain the achieved European lead, it is now crucial to adopt a long-term strategy. First of all, existing R&D goals supporting developments of the "traditional" systems need to be reconsidered in the context of the desirability of developing the new technology options further. Existing R&D projects for developing automatic separation and sorting techniques have not yet delivered sufficient results to solve the bulk of the problem. Energy recovery, fuels and feedstock recycling may be included in the priority options. The investigation of the feasibility of plastics waste recycling in the iron and steel industry, and of energy recovery through co-combustion of plastics waste with other fuels in the cement industry are particularly attractive. More emphasis needs to be placed on research for improved logistics that will allow optimisation of combinations between prevention of waste generation, collection and final treatment of plastics waste. Further research could deal with the development of standardised eco-balancing methods for national administrations to harmonise the selection of management and technology options. Long-term research options include topics such as design for recycling and dematerialisation of production/consumption in society.

Plastics waste recycling implementation options

For most EU Member States building a plastics recycling industry nearly from scratch in the near future, poses several questions. Firstly, the setting of collection and recycling targets calls for an integrated evaluation of logistics and performance capabilities of the final treatment technologies. Where high recovery levels are enforced, such as 64% in Germany, the technology mix needs to include feedstock recycling and energy recovery in addition to traditional mechanical recycling. The optimum combination of the various technological options can be established through eco-balance studies, and depends on local conditions and market forces.

Lower recycling targets, in line with the requirements from the EU packaging directive, can be achieved by adopting either mechanical recycling or novel technologies.

In conclusion, it appears that nation-wide schemes can achieve high recycling or energy recovery targets while minimising both collection/separation and recovery/recycling costs, and they could be developed further in the near future. To move in this direction, countries without traditional mechanical recycling industry now have the opportunity to opt for the use of modern technologies.

Integrated evaluations of final treatment technologies would help set realistic collection and recycling targets

Keywords

plastics waste, recycling, packaging directive, eco-balances, technology options, mechanical recycling, feedstock recycling, energy recovery

References

- J. Brandrup (Ed.), 1995, *Die Wiederververwendung von Kunststoffen*, Carl Hanser Verlag München, Wien.
- L. Bontoux & D. Papameletiou (Ed.), 1996, *Proceedings of an International Workshop on Technology Options for Plastics Waste Recycling*, held at IPTS, Seville, Spain, 20-21 November, 1995.

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Bioenergy:

Technology development and the dilemma of its future

Pietro Moncada Paternò Castello

Issue: Bioenergy technology development has not driven bioenergy to large commercial achievements and has not made bioenergy ready to exploit some advantageous market situations. Future uncertainties linked to bioenergy need to be considered and analysed in a market- and technology-oriented approach.

Relevance: In the debate on "sustainable development", bioenergy is seen as one of the important instruments due to its possible positive socio-economic, environmental, and energy supply potential. However, bioenergy systems have to be proven technologically and economically, and in many cases shown to be environmentally implementable/sustainable, if their large-scale diffusion in future scenarios is to be considered. The success of bioenergy development depends on this assessment, and also on appropriate system management, and concerned policy strategy. Without necessarily requiring more public funding, there are ways to predict, verify and, if appropriate, improve bioenergy schemes.

Although not a major energy source in most EU countries, biomass receives attention due to its long-touted potential

At present, biomass represents about 2% of the total European (EU-12) primary energy supply, if only commercial sources are considered. The use of biomass for home heating (e.g. fireplaces) and, especially, for in-house consumption by industry (e.g. paper mills) are relatively important but do not appear in the statistics. The new EU countries present a higher rate of primary energy supplied by biomass than the EU-12 figure: Austria 13%, Finland about 18%, and Sweden about 16%. Despite its present energy contribution, which in some EU countries is rather modest, bioenergy receives considerable attention because of its potential and of its possible socio-economic benefits. Although, the development of bioenergy systems has been fairly slow, and bioenergy can now be portrayed as a set of resource-technology couples, some of which are in full development while many others are in a regression or still in a non-commercial phase.

Bioenergy & technology development

Bioenergy conversion technologies can be distinguished into two main groups: technologies for power generation (heat, electricity and cogeneration), and technologies producing transportation fuels. Both annual and perennial crops, as well as agricultural or forestry wastes/residues, can be converted into heat, electricity, or biofuels. The choice to use one or another technology and biomass raw-material depends upon many factors which include environmental, economic and social considerations.

The *power generation technology* most often used in bioenergy schemes - namely *combustion*, benefits from R&D investments for coal-based power technologies. Northern European countries have developed and are extensively using (mostly for heat generation) combustion technology. This technology also reaches attractive overall efficiencies on a small scale (28-30% in considering electricity generation; up to 85% in cogeneration of electricity and heat), and today represents a good tradeoff between investment cost and efficiency for small plant capacity.

Technologies that burn *landfill* or *sewage gas* are again an example of the use of technology originally developed for burning conventional fuels. In fact, landfill/sewage gas is used in traditional internal combustion engines ranging from hundreds of kW to several MW capacity with little adaptation being needed. Less usually, in the case of larger sites it can also be used in gas turbines. Depending on the fuel gas quality, these plants present relatively high conversion efficiencies (of over 30% in electricity generation).

Concerning *gasification* technology coupled with turbines, both simple cycle (STIG) and combined cycle turbines (IGCC) are commercially available (i.e. STIG) or employed at a demonstration scale (i.e. IGCC), and present high efficiencies (from 30 to over 40%, depending on the plant capacity). In Europe, IGCC demonstration plants are demonstrating the use of biomass as a fuel. The experience gained from these IGCC plants allows the EU to be the world leader in this bioenergy technology. Gasification can also be coupled with Stirling combustion or steam engines. Stirling engines offer high secondary conversion efficiency but at small scale. However, it is estimated that biomass-fuelled Stirling systems can become commercial during the next 20-25 years. Important advances have been introduced to innovate steam engines, and their success depends on the high production volume of such engines which can reduce the present high capital cost.

Biomass *pyrolysis* technology, involving the burning of bio-fuel oil in existing power plants or in large diesel engines (e.g. marine engines), is still at a research stage. Both gasification and pyrolysis technologies were initially developed to convert fossil fuels into secondary energy products.

Biofuels for *transportation* are considered as an interesting but difficult option for the future in Europe, and related technologies have not benefitted greatly from technology developments in other fields. Consequently, biofuels (ethanol, methanol, vegetal oils, methylesters, etc.) are today far from being competitive, and/or need large public subsidies, due to high costs, weaknesses in production and application technologies, need for car-engine modifications, etc.

There are many biomass technologies depending on the input, the conversion mechanism and the ultimate energy use

Ethanol and *methanol* can be produced from acid or enzymatic hydrolysis. Advances in biotechnology have been made in reducing the cost of ethanol production via enzymatically catalysed options, but more advances need to be made in future to further reduce costs. Acid hydrolysis presents economic inconveniences to produce ethanol from biomass. Currently, it is preferred to produce methanol by gasifying biomass, the resulting gas being catalytically reacted to form methanol.

Esthers are typically derivatives of alcohol and are used as additives to supply oxygen to the gasoline to which they are added. Methanol and ethanol can be reacted with isobutylene to form methyl tertiary butyl ether (MTBE) and ethyl tertiary butyl ether (ETBE), respectively.

Vegetable oils and their esther derivatives (i.e. methylesthers), which are obtained via methanol in the presence of a catalyst, can be used in diesel engines.

There are several prerequisites to the success of bioenergy

The technology for producing esthers is already at commercial scale and used in the oil-chemical sector. However, esthers derived from biomass suffer from their high production costs and need further improvements in the production and end-uses technologies.

Although substantial progress has been made in these conversion technologies, biofuels do not easily achieve cost competitiveness compared with gasoline. In addition, there are further barriers for biofuel diffusion concerning the infrastructure and car engine modifications required if, for example, a bio-alcohol is used at a proportion greater than 30%.

When bioenergy systems succeed

Bioenergy technologies (and the reasons for their choice) are diverse, and face different socio-economic and ecological contexts that can make them attractive or not. This also includes farming practices, local markets, and societal choices for land use and for energy generation modes. Generally speaking, the reasons for the feasibility of present bioenergy systems, even though they represent a limited total energy generating capacity, can be found in four conditions that often occur all together: local availability of sufficient and cheap industrial by-products or wastes (e.g. straw from food crops, timber from the paper industry; solid wastes from olive mills); employment of an adapted conventional technology, originally developed to accept/produce fossil-derived fuels; implementation of an integrated bioenergy system, producing, for example, from the same raw material heat, electricity, alcohol, and possibly compost and fine chemicals; a favourable socio-economic and public regulatory framework (e.g. subsidies) which allow entrepreneurs and investors to bypass the economic threshold and reduce venture risks.

Barriers impeding the success of bioenergy

R&D funds devoted to bioenergy have not been of great significance. For example, the share of biomass in total OECD energy R&D expenses in 1991 was a mere 0.1%. As a consequence, technology development has not overcome the obstacles that have been impeding the further penetration of biomass in the European (EU-12) energy market.

Additional technical, cultural, and political barriers have played a significant role against a considerable market share of energy from biomass due to the complexity of the biomass raw material-to-energy chain. In fact, the biomass energy industry is today a fragmented agglomeration of biomass fuel suppliers, conversion technology manufacturers, utilities, and industrial, commercial, and residential consumers. This situation reflects the heterogeneous nature of biomass feedstocks and the multiple end-uses for biomass: electricity generation, industrial and commercial heating, production of liquid transportation fuels, and more. Significant challenges remain in bringing biomass to its full commercialisation potential, as each link in the chain of biomass fuel production, delivery, and utilisation should be developed concurrently with the other components.

Lost opportunities and future uncertainties

Meanwhile bioenergy, often considered as a good intermediary energy option over past decades, may have already missed opportunities for its widespread diffusion at the commercial scale. In fact, for many reasons (R&D strategy, public acceptance, etc.) innovation did not provide as many results as expected in this sector given market conditions as favourable as those after the energy crises of the 1970s. The subsidised "set aside" land practice, introduced in the late 80s by the EU Common Agricultural Policy, allows farmers to produce non-food crops in these set-aside lands receiving economic aid[1]. This has been, -and would be- another opportunity for biomass energy.

Nevertheless, in the forthcoming years a simple change in the food demand/supply trend or a radical innovation in a competing energy technology could relegate bioenergy to very small market niches.

In fact, the land competition for food production could be an important constraint for bioenergy implementation (particularly, regarding biofuel for transportation) if large-scale production areas within the EU are withdrawn and/ or the EU chooses to make large quantities of foodstuffs available for international food supply. However, there are still large areas in the EU available for non-food use, and different ways to use the enormous quantities of agricultural waste can be better addressed. Both facts could present an opportunity in future land use scenarios to make food and energy products complementary rather than competing with each other.

On the other hand, a possible breakthrough which makes economically feasible the use of an innovative energy source/technology could seriously compromise the widespread diffusion of bioenergy systems. Such a breakthrough would concern, for example, fuel cells (although these might utilise hydrogen produced from biomass) or nuclear fusion. Also, the incremental improvements that will eventually be implemented in existing conventional energy systems could represent another important limiting factor for bioenergy.

Approaching new bioenergy systems

In the medium and long term, political conditions and policy strategy, such as for example agricultural, regional, energy, and environmental policy, will play a key role in the future of bioenergy. Meanwhile, it seems appropriate to approach innovative bioenergy systems in a new integrated and pragmatic way, based on:

a) Analysis of bioenergy prospects: the elaboration and analysis of different future scenarios should take into account variables concerning sources/land availability, economics, technological prospects (both related to biomass and conventional energy resources), policy directions, and identify potential "robust" market niches. The real potential of bioenergy and its comparison to the capacity of other energy sources could also be studied.

b) Promotion of strictly controlled pilot scale projects for the attainment of short-medium findings, favouring commercial implementation of bioenergy scientific outcomes and understanding the principal barriers (technical & non-technical) which prevent bioenergy from succeeding. Pilot scale project activities can be carefully targeted to verify technical feasibility and evaluate the prospects (for possible further implementation at demonstration and commercial scale) of the following:

Biomass Resource and Its Production Chain: Technical preoccupations in bioenergy systems relate often more to the biomass feedstock than to conversion technology. These preoccupations, particularly linked to biomass from energy plantations, could be identified in: the environmental sustainability, yields, prices, discontinuity of supply, physical & chemical characteristics, agronomic practices, harvesting, collection, pretreatment, handling and storage management. New opportunities (e.g. related to bio-engineering) ought also to be taken into account.

Conversion Technology: In the pilot scale experiments, biomass conversion technologies (conventional or advanced) can be tested in a well-defined context (e.g. fuel characteristics, regulatory environment, etc.) and clear indications can be provided in order to point out

Fragmentation and heterogeneity in demand and supply are crucial barriers

Several opportunities for bioenergy have been lost, starting with the oil crises of the' 70s

New bioenergy systems need integrated analyses of prospects and controlled pilot projects

[1] In 1995-96, between 12 and 17% of arable land, yielding the overproduced cereals and oil seeds crops, was set aside by EU farmers

whether or not the tested technology is suitable for introduction at that stage of development in the market.

External Benefits and Damages: A careful evaluation of the employment and other social impacts would enrich the pilot project experiment. The findings could be compared with the socio-economic data related to other energy sources.

Managerial Issues: Pursuing efficient ways to handle bioenergy systems entails exploring: partnership composition, financial practices, logistics of bioenergy chains, and commercialisation of the final bioenergy products.

c) ***Conduct of basic & targeted research***, informed by the results from points a) and b), and improved coordination of national Member States' initiatives in the R&D field.

Conclusion

In summary, there are numerous constraints to the commercialisation of biomass energy systems without public assistance or policy strategy and sectoral organisation modifications. The success of research, pilot and demonstration activities depends upon these changes which in turn will determine over the next years the rate of adoption of biomass energy technologies in the European Union.

The dilemma of the future of bioenergy originates in market & strategy uncertainties, and in advances in new and conventional technologies. In a pessimistic case, a paradoxical situation could come about, in which biomass, as a "new" energy source & technology, might become old without having ever been mature. In a less pessimistic case, conventional technologies will continue to be important energy sources but their dominant role would be slowly reduced while renewables, particularly biomass energy, would increase their share in specific market segments (e.g. biomass as a local power generating source) of the EU. The latter scenario would depend on a precise strategy in that direction and a synergistic convergence of economic and social interests.

Keywords:

Biomass energy, sustainability, pyrolysis, hydrolysis, set-aside land.

References:

- *The European Renewable Energy Study 1994*, European Commission
- *Energy Policy in the Greenhouse* Renewable Power 1995, IPSEP
- *Biomass Power Commercialization* UCS Report, 1994
- *Proceedings of the Second Biomass Conference of the Americas* 1995

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Logistics:

The leverage of collaborative networks and strategic information systems

Christian Heller

Issue: Logistics performance is a key to global competitiveness. Yet, many of the changes which more competitive logistics systems have induced in physical transport patterns may not be sustainable in the long-term.

Relevance: While "punitive" regulatory measures can be used to limit the negative externalities (e.g. congestion), they often also have a detrimental effect on logistics performance. Rather, the solution to more sustainable logistics may lie in the exploitation of two trends which are forced upon logistics service providers and their customers anyway: extended collaboration and the substitution of physical movements through information. Both require seeing the logistician's profession in a new light.

The forces shaping logistics strategies

There is an increasing variety of consumer products on the market, which, once designed for mass markets, are becoming increasingly differentiated to satisfy the demand of increasingly sophisticated market segments. Two mutually reinforcing forces are behind this trend. The tendency in rich economies towards a stronger individualism on the part of consumers, and new forms of competition that have developed on the supply side: differentiation is seen as a more sustainable strategy than price cutting. The average value of goods increases, while the miniaturisation of goods has led to a partial decoupling of economic growth and growth of transport volumes (Gottschalk 1995).

Yet, this does not suffice to prevent overall goods flow volumes from growing. With shorter product life-cycles, the need to shorten the design-to-market time for new products to avoid competitive disadvantage increases. The retail sector is developing into a powerful interface between manufacturers and final consumers because of its function of concentrating demand and supply and offering high service levels. With falling trade barriers, and different locations having different cost structures and advantages, the worldwide division of labour is increasing, and local or national sourcing has given way to regional or global sourcing. Production depth in many companies has decreased, i.e. companies tend to concentrate on their core capabilities where they can add most value and to contract out functions which were previously performed in-house. The pilot plants of BMW and Mercedes in the USA, for example, will have a company share of production of between 15% and 20% only (Hausherr 1995). Given the increasing complexity of logistics networks (more products, more subsequent actors in a value

Tailor-made products to suit individual tastes increase emphasis on logistics

Manufacturers aim to reduce their supplier base and engage in long term relationships with few suppliers

The more valuable the product the more widespread is just-in-time delivery

Logistics planned before European integration may no longer be cost optimal

Few service providers can offer a full service range to every possible customer

chain), there is a desire among manufacturers to **reduce** their supplier base and to engage in long-term, mutually-beneficial relationships with a limited number of suppliers.

Consequences for logistics systems

These changes have consequences for the requirements on logistics systems. A larger number of different products have to be brought more rapidly from the points of production to the points of consumption. The higher the value of goods, the higher the need to keep stock levels as low as possible in order not to bind too much capital. Yet to maintain the service quality, delivery frequencies are increased and consignment sizes decreased, resulting in a natural preference for road or even air transport. Today the more valuable the goods, the more widespread is just-in-time or even real-time delivery. Streamlining physical goods flows, or even replacing physical goods movement through adequate information flows, has become a key challenge in logistics. In conjunction with the emerging opportunities of multimedia and the Internet, information technology may also be used to reduce the number and extent of intermediaries in the wholesale and retail chains, offering new opportunities for more direct manufacturer-to-consumer communication.

The increase of intra-European and international trade has led to longer transport flows and a restructuring of logistics systems in Europe. Warehouse structures established before the Common Market and mainly dictated by countries' borders are no longer cost optimal. The geographical concentration of demand, market volumes and product structures of today require "European sourcing" for supply logistics and "European clustering" for distribution logistics, based around a few large regional warehouses (Fiege, 1995). The resulting longer transport distances and increased transport costs are compensated by the savings in fixed costs because of fewer warehouse locations.

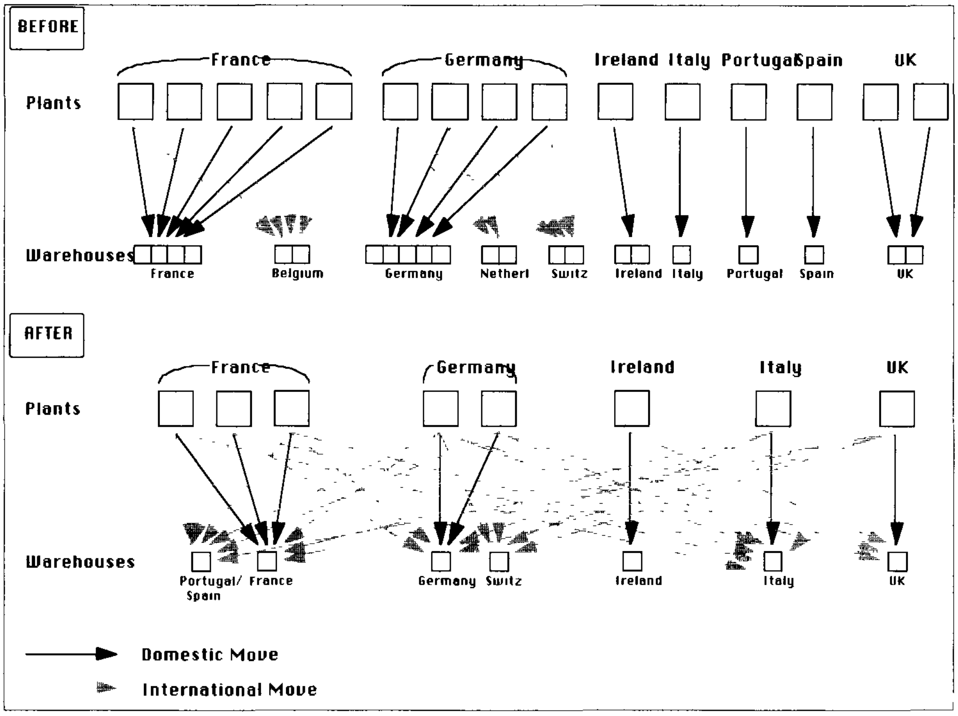
With a share of fixed costs to variable costs for operating a transport fleet of about 3:1, and with 40% of trips by company-owned fleets made empty, forwarders, who usually keep their empty trips below 25%, claim that companies could reduce their logistics costs by 20% to 30% through outsourcing. (Aden 1995).

The opportunities opened up for logistics services providers through the outsourcing trend are not without challenges. The wish of many consignors to work together with only one logistics services provider requires that the latter provide a tailor-made service package which at the same time incorporates a broad spectrum of services. The number of logistics services providers who can offer a full service range to any possible customer is very limited. In particular, smaller ones or those who want to attract customers from different logistics market segments have to co-operate with others. Thus, the ability to collaborate with other logistics services providers has become a major competitive advantage or even prerequisite for survival; often the alternatives are either takeover by a more powerful rival or bankruptcy.

Information and collaboration - key components to sustainable logistics?

The environmental impact of today's logistics strategies, increasing road freight volumes, can be mitigated with policy measures such as road charges, vehicle taxes or incentives for the use of alternative modes. This may do more than just ease the symptoms: when transport price increases are seen as permanent the logistics structures/strategies are likely to adapt to them in the long-term, e.g. by replacing transport by stock holding. Yet, as long as not introduced on a worldwide level, such measures will always have a detrimental effect on competitiveness. Hence the easiest approach (although in the long-term probably not sufficient by itself) is to follow the way where consensus is most likely to be achieved between the different stakeholders.

Figure 1: Impacts of changes in fast-moving consumer goods distribution networks

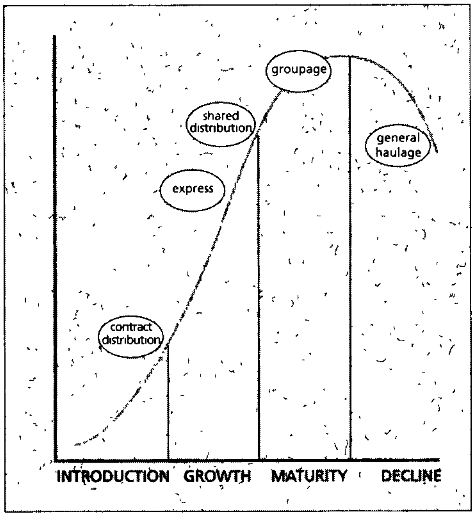


Source: Adapted from Council of Logistics Management [1993], p. 158

Box 1: Reasons for the externalisation of logistics services

- Through the variety in customers and products a logistics services provider can achieve better seasonal and regional capacity utilisation.
- The logistics service provider can bundle goods from different customers and thus achieve a higher capacity utilisation. A large share of empty trips due to no back loads (unbalanced goods streams) can be avoided, too.
- For the customer, fixed storage and transport costs are converted into variable distribution and supply costs.
- Quality assurance systems make the logistics services provider's capability and performance transparent.
- The continuous dialogue between customer and logistics services provider can lead to a continuous improvement of processes and innovation through learning.
- The customer can concentrate on his core business and on new tasks such as intensive customer care or quality improvements; liquidity can be improved through the release of capital bound in logistics operation (stocks, warehouses, equipment).
- The logistics services provider can react more flexibly to market changes.

Figure 2: Product life-cycle for logistics services (northern Europe)



Source: Adapted from Council for Logistics Management [1993], p 76

Regulation can mitigate environmental impacts but may reduce competitiveness locally if not adopted globally

Two means have the potential to reduce the environmental impact: improved collaboration among logistics actors and the deployment of information technologies (IT). Yet these two lines of action are certainly more difficult for policymakers to implement: both require an in-depth understanding of, and action at, the micro-economic level rather than regulatory action. They cannot be enforced but only encouraged and facilitated.

An example requiring extensive will for co-operation and consensus among actors is so-called city-logistics. Soon in Nürnberg an 18 month trial period will start for a city logistics concept called "Isolde" (Innerstädtischer Service mit optimierten logistischen Dienstleistungen für den Einzelhandel in Nürnberg). Strategically-placed Isolde logistics centres will be serviced early in the morning by suppliers who used to supply the retailers directly. The depot manager, who acts on behalf of the retailers in the logistics centre, will receive, control, sort and consolidate the goods which are then bundled and distributed with environmentally-friendly trucks to the retailers according to their requirements. Additional services such as short-term storage and packaging waste management will also be offered. Furthermore, the participating retailers will offer to dispatch customers' purchases at a certain time to special collection points such as underground stations, multi-storage car parks, kiosks or hotels in the old city centre or even to have them delivered to their homes. Participation in the scheme costs DM 100 per month for retailers with up to 100m² of floorspace plus a one-time payment to become a shareholder of Isolde of DM2,500. The initiators think these costs will be recovered through a decrease in storage costs and reductions which distributors will be ready to give due to shorter delivery times. Altogether DM1.5 million will be invested, of which the state of Bavaria will provide one half for the first year. Afterwards Isolde should become self-sustainable. Yet, it does not seem to be clear at this stage how many retailers are ready to join the scheme. (VDI Nachrichten 29.10.95). To date, few city-logistics projects can show measurable success (However, a scheme in Bremen has shown 12.7% fewer trips and 27.8% higher vehicle utilisation (Heinrich, 1995)). Many may have failed not least because of the opposing interests of the various actors in the distributive sector.

Three examples illustrate the potential of IT to reduce physical transport:

(1) A German forwarder uses a new technology that links sensoring with communication technology to control stock levels of liquids, bulk goods and other solid goods ("Füllmengenkommunikationssystem (Fükos)"). A measurement unit - e. g. installed in a tank for liquids - reports at regular intervals the stock level via modem and e-mail to the forwarder and supplier. Using consumption statistics, the system automatically checks whether a new delivery is required. At the same time the computer calculates the expected delivery time and signals the central computer of the supplier the volume and latest permissible delivery time. The computer then automatically starts a counter-inquiry to find out the stock levels of other customers in the vicinity of the one that needs to be supplied. It continues to enlarge the inquiry radius until an eco-

nomic production and delivery lot size is reached, leading to better transport capacity utilisation and route optimisation. (Dt. Verkehrs-Zeitung, 12.10.95).

(2) Accurate and timely information about the status of a consignment and/or vehicle while on its way from the consignor to the consignee allows for a higher and more flexible fleet utilisation and the avoidance of costs in case of transport irregularities. With much transportation taking place between continents and using different modes, the ideal tracking & tracing system is one which is globally available, multimodal and integrates the different interlocking tracking levels, (e. g. consignment, pallet, container, vehicle) and techniques (e. g. satellite, automatic equipment identification, bar code). Until now in German domestic transport only 60% of forwarders are able to tell their customers whether their consignment has arrived at its destination in time (Meyer 1995).

(3) The main advantage of multimedia does not lie in impressive representation of advertising information but in the interactive link of the customer to information, stock control and production control systems down the line to the manufacturer. New ways of direct marketing will be opened up by broadband communication and multimedia, leading to the partial substitution of physical processes ("virtualisation"): all unnecessary physical functions are eliminated from a process and incorporated in the information model which is being tuned to correspond to an optimum user/supplier relationship.

Examples indicate that information technology can crucially reduce the need for physical transport

Conclusions

Of all the levels at which logistics performance can be improved, the strategic configuration and reconstruction of flow systems, process chains and networks have the largest potential leverage on costs and performance. R&D is needed with respect to new models of (virtual) organisation for processing chains and logistical processes and networks above the individual company level (Zänker 1995). Education needs to look at the requirements for the next generation of logistics pioneers. For network managers, the challenge is the construction of manageable and adaptive networks:

(1) identification of goods and information flows whose combination and reconfiguration leads to cost reductions, and improvements of speed and flexibility;
(2) selection of matching co-operation partners;
(3) facilitation, moderation and maintenance of co-operation in complex networks; and
(4) organisation of physical and data flows according to the principles of short-term value-added maximisation and long-term viability and adaptability (Klaus 1995).

Strategic configuration, reconstruction of flow systems, process chains and networks have the largest leverage on costs and performance

Keywords

logistics, transport, change, outsourcing, externalisation, co-operation, information technology, tracking & tracing, multimedia, virtuality, networks, value chain, education, sustainability

References

Council of Logistics Management: *Reconfiguring European logistics systems,* 1993.

Deutsche Verkehrs-Zeitung, 12 October 1995.

Deutsche Verkehrs-Zeitung, 17 October 1995, articles of: Aden, Fiege, Gottschalk, Hausherr, Klaus, Meyer, Zänker.

VDI-Nachrichten, 29 September 1995, article of Heinrich.

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Seminar on Research, Technology and Employment in El Escorial

The Spanish presidency of the EU organised this seminar in the small town of El Escorial near Madrid on 6-8 December 1995, with the support of the European Commission. Participation in the seminar was reserved to the 40 or so invited experts in order to facilitate open and deep brainstorming-type discussion on the seminar theme and selected sub-topics over the three day period. The format chosen included opening and closing plenary sessions, with the rest of the time devoted to parallel working group discussions. The working group themes were: (1) R&D for Sustainable Development; (2) R&D to live and work in the information society; (3) R&D for better health care systems; (4) Foresight Studies; (5) R&D for the new Food/ Agriculture/ Agro-industry/ Agro-environment clusters; and (6) Generalists. The combination of this diverse list of themes with an equally diverse list of participants (which included economists, scientists, businessmen and industrialists, academics, representatives of public administration and policy makers, and some non-EU experts - from the US, Japan and Australia), made for a correspondingly rich and varied treatment of the principal "Research, Technology and Employment" theme. Each invited expert prepared a written contribution in advance as input to one of the groups. A rapporteur appointed for each group had the charge of making a preliminary summary of the group discussions to report to the final plenary session. The IPTS assumed the role of rapporteur for groups (1) (Per Sørup) and (4) (Herbert J Allgeier), and gave an invited contribution (Dimitrios Kyriakou) to group (2). In due course, a publication will be produced containing the individual contributions, write-ups of the group rapporteurs' summaries and an overview summary to be prepared by the General Rapporteur for the seminar, Joan Majó - former Spanish Minister for Industry. During the seminar, participants were addressed by the Spanish Minister for Education and Science, Jerónimo Saavedra, and the event was finally brought to a close by the Director General of the European Commission's Joint Research Centre - of which the IPTS forms part - (J P Contzen) and the Spanish Secretary of State for Universities and Research (Enric Banda).

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Dr Song Jian visits the European Commission

In October 1995, Dr Song Jian, State Councillor and President of the State Science and Technology Commission (SSTC) of China visited, accompanied by Ambassador Ding Yuanhong and an important delegation of the SSTC, the European Commission and met with President Santer and Commissioners Brittan and Cresson.

Throughout his meetings, Dr Song Jian expressed China's satisfaction with the achievements made during the last ten years of EU-China S&T cooperation in terms of joint research projects, training activities and, in general, the reinforcement of the link between the EU and Chinese scientific communities. He expressed the wish that S&T cooperation be given an important place in future EU policy regarding China, and be expanded to cover new sectors in the areas of biotechnology, health, information and telecommunication technologies, energy and environmental protection. Besides research, Dr Song Jian would also like, in the future, to attach more importance to the development of industrial initiatives in these sectors through the participation of industry in large demonstration projects, and to the transfer of European technology and know how.

The establishment of a sub-committee on S&T cooperation under the joint EU-China economic and trade cooperation committee was discussed, as was the possibility of signing a specific EU-China S&T cooperation agreement at a later stage.

The EU-China Working Group on S&T Cooperation, which met on November 17, 1995 in Beijing, further explored these ideas. It was decided that SSTC would introduce a request via the appropriate government channels to establish a sub-committee on S&T cooperation.

The IPTS is one of the eight institutes of the Joint Research Centre of the Commission of the EU. Its remit is the observation and follow-up of technological change in its broadest sense, in order to understand better its links with economic and social change The Institute carries out and coordinates research to improve our understanding of the impact of new technologies, and their relationship to their socio-economic context

The purpose of this work is to support the decision-maker in the management of change, pivotally anchored on S/T developments In this endeavour IPTS enjoys a dual advantage: being a part of the Commission, IPTS shares EU goals and priorities, on the other hand it cherishes its research institute neutrality and distance from the intricacies of actual policymaking This combination allows the IPTS to build bridges across EU undertakings, contributing to and coordinating the creation of common knowledge bases at the disposal of all stakeholders. Though the work of IPTS is mainly addressed to the Commission, it also works with decision-makers in the European parliament, and agencies and institutions in the Member States

The Institute's main activities, defined in close cooperation with the decision-maker are

1. **Technology Watch** This activity aims to alert European decision-makers to the social, economic and political consequences of major technological issues and trends. This is achieved through the European Science and Technology Observatory (ESTO), a European-wide network of similar organisations operating at the national level IPTS is the central node of ESTO, coordinating 'joint ventures' in technology watch towards understanding technological change

2 **Technology, employment & competitiveness.** Given the significance of these issues for Europe and the EU institutions, the technology-employment-competitiveness relationship is a driving force for all IPTS activities, entailing analysis of the potential of promising technologies in terms of job creation, economic growth and social welfare. Such analyses may relate to specific technologies, technological sectors, or cross-sectoral issues and themes.

3. **Support for policymaking**. IPTS works in support of the Commission services and other EU institutions in response to specific requests, usually as a direct input to their decision-making and/or implemenation processes Such activities are fully integrated with, and take full advantage of Technology Watch activities.

IPTS works with the policymakers to understand their concerns, benefits from the knowledge of actors, and promotes dialogue that involves them, and collaborates with scientific community to assure accuracy In addition to its flagship *IPTS Report*, the work of IPTS is also presented in occasional prospective notes, a series of dossiers, synthesis reports and working papers

The IPTS Report is published 10 times per year, on the 15th of each month with the exception of January and August. It is presently available free of charge in four languages: English, French, German and Spanish.

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