PRICEWATERHOUSECOOPERS

Pharma 2005

Silicon Rally: The Race to e-R&D

This paper explores the opportunities for automating the pharmaceutical R&D process, with the introduction of *in silico* technologies, e-business operations and new web-based search portals. It assesses the impact of simulation on preclinical and clinical drug development, the emergence of various new healthcare information intermediaries and the creation of networked organisations. It also looks at the transformation of the industry's IT functions that will be necessary to support the move to "e-R&D".

Previous publication
Pharma 2005: An Industrial Revolution in R&D

Contents

1 Introduction

A decade ago a good research chemist could produce 50-100 new compounds a year. Today, with standard combinatorial chemistry, the same chemist can turn out a couple of thousand compounds a year. Meanwhile, high throughput screening has massively accelerated the speed at which compounds can be tested to identify the most promising molecules. In short, technology has transformed the early part of the pharmaceutical research and development (R&D) process.

But this is only the first chapter in a story that has yet to be finished. Pharmaceutical companies still conduct much of their primary science in laboratories and still have to perform studies on people. They have made very little progress in automating the "D", let alone integrating it with the "R".

However, some of the industry leaders have now begun to use *in silico* techniques in development. Companies like Glaxo Wellcome have, for example, adopted "cassette" dosing – concurrent testing of as many as 20 compounds for properties like pharmacokinetics. Other firms like Pharsight are providing the technology to go a stage further, with clinical trials based on virtual patients.

This move towards "e-R&D" – the term we have coined to describe the computerisation of the R&D process – is partly a response to greater financial pressures. *Pharma 2005: An Industrial Revolution in R&D*, the report PricewaterhouseCoopers published in November 1998, shows how soaring R&D costs, sluggish sales growth and shorter lifecycles have all started to take their toll on the sector. But it is also a consequence of advances in chemistry, biology, computing and automation – together with the amalgamation of these disciplines – that would have been unimaginable just a few years before.

With pharmacogenomics – the study of genetic variations between individuals and how they influence the way in which people respond to a particular drug – it will soon be possible to customise drugs for defined sub-populations of patients. It may eventually even be possible to produce bespoke therapies tailored to the biological traits of specific individuals. Since many of the drugs developed today work for 60% of patients at most, this would be a huge improvement.

But though pharmacogenomics promises to deliver numerous benefits, it will also revise the financial basis for much of the industry's R&D. On the one hand, the development of customised drugs for sub-populations with different versions of the same disease or different responses to the same medication will fragment the market. On the other, it will produce new opportunities both to treat patients for whom the existing drugs are ineffective and to resuscitate drugs that have been abandoned because they produce dangerous side effects in a few people, although they work well for many others.

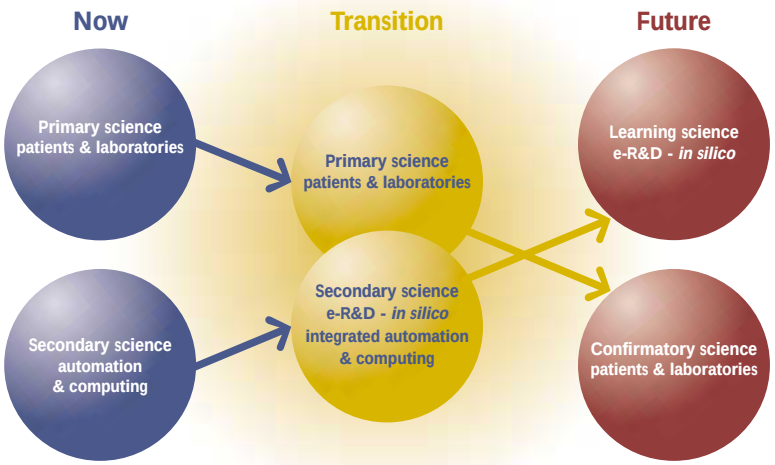
In other words, pharmacogenomics will increase the complexity of the R&D process and potentially reduce the number of patients from whom the industry can recoup its investment in any one treatment, even as it expands the overall number of patients who can be treated. This has major commercial implications. Costs per approved drug have risen steadily over the past decade; indeed, the latest estimate suggests they could be at least $600m. With the impending erosion of the current blockbuster model, the industry must therefore find more economic ways of producing safe and efficacious new drugs.

The introduction of e-R&D is a critical step in doing so. *In silico* technologies will enable drug manufacturers to accelerate the selection process, reduce the cost of preclinical and clinical studies and increase their overall chances of success. We estimate that they could collectively save at least $200m and two to three years per drug.

Yet most pharmaceutical companies are ill equipped to make the transition – partly because their IT is under-funded and overworked. They are already grappling with Y2K compliance, the new technologies involved in early research and the corresponding increase in the output of data. Some companies are also struggling to integrate legacy systems, following the latest spate of mergers and acquisitions. They are doing all these things with smaller budgets than many of their peers in other information-intensive industries.

But if the industry is to exploit the real power of e-R&D, it must invest in innovative new technologies, build networked organisations and harness its knowledge capital. It must reinvent the role of the IT function.[1] Above all, it must jettison the old, empirical way of doing things for systematic, predictive processes based on a more complete understanding of how the human body works.

The transition to e-R&D is underway



[1] All references to the IT function include information systems and information management functions

2 Managing the Data Mountain

The information upheaval

The nature of the digital information stored in most organisations has become much more varied, with databases, documents, e-mail, video, audio and HTML files created on a wide range of systems using a wide range of formats. However, as much as 80% of this information is thought to be unstructured – stored without any type of metadata structure and thus no standard facility with which to conduct searches or analyses.

The volume of data is also growing dramatically. A report on the use of electronic communications in the US by Thomson EC Resources claims that Internet e-mail is rising at an incredible 43% per annum. It also predicts that, in 1999 alone, the number of electronic transmissions (including faxes, e-forms and EDI) will grow by between 5% (the base case) and 16% (should use of the Internet soar).

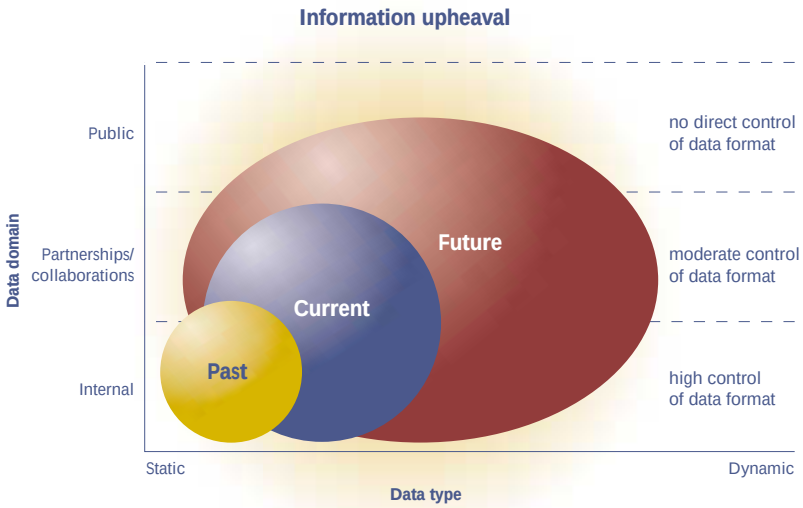
But for the pharmaceutical sector, the sheer quantity of data is *already* a serious problem. Technologies like combinatorial chemistry and robotic screening have greatly increased the number of petabytes (10^{15} bytes) the industry generates. Glaxo Wellcome estimates, for example, that internally produced data will soon expand the load on its computer infrastructure by a factor of 100. The growing complexity of clinical trials has compounded this trend: the US Food and Drug Administration (FDA) reports that the average number of trials supporting each submission for a New Drug Application (NDA) is now 68 – up from 30 in 1984.

Most pharmaceutical companies are also increasingly reliant on information from external sources – including clinical research organisations (CROs), site investigators and biotechnology partners. The number of strategic alliances between pharmaceutical companies and other organisations more than doubled – from 248 to 635 a year – between 1987 and 1997. The percentage of clinical projects involving CROs has risen still more rapidly; it is now 60%, up from 30% just six years ago.

New scientific discoveries and diagnostic tools threaten to dwarf even this mountain of data. Current estimates suggest that the sequencing of the human genome – which is due to be substantially completed by 2002 – could produce as many as 25,000 new biological targets. Even if only 20% of them prove useful, this would represent a 10-fold increase in the number of targets the industry can explore.

Meanwhile, Hewlett-Packard has just launched a new system for monitoring patients with congestive heart failure, based on the daily transmission of accurate clinical data from the home. Although the system has been designed to update clinicians and care managers, it seems likely that portable diagnostics will soon play a role in clinical trials. They may also result in the collection of post-marketing outcomes data – material the industry does not track at present, although it could and should eventually be the most valuable source of knowledge.

This input is likely to be supplemented by feedback from an increasingly vocal public. Research from Cyber Dialogue shows that in December 1998, over 22m US adults searched online for health and medical information – up from 17m the preceding July. Many of them are not content to remain passive consumers; they want a say not just in their own medical treatment but in the R&D process itself. Patients eager to promote research on the breast cancer drug Herceptin, for example, rapidly oversubscribed Genentech's HER-2/neu clinical trials, forcing the company to set up a lottery for choosing candidates. The drug was subsequently approved in record time, less than five months after the application was submitted. A number of patient groups have gone even further and conducted their own "clinical tests", broadcasting the results on the Internet.



The view from the foothills

Ironically, however, this massive inflow, much of it facilitated by the Internet, means that the industry is now swamped with information where once it faced a “fact gap”. The problem is exacerbated by the fact that while some kinds of knowledge remain relevant for years, others have a very short shelf life. Information that could shape the process of identifying a potential lead compound is just such an instance. Here, the value the organisation gains will quickly erode if it does not capitalise on the knowledge. Thus the ability to use such data promptly and effectively is vital.

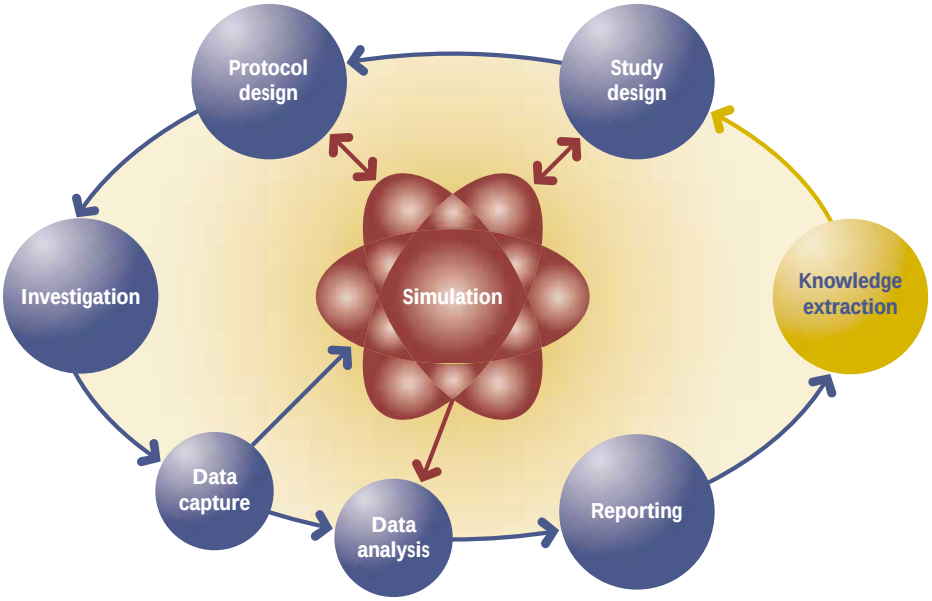
But the industry not only fails to make the most of what it already collects, it is totally unprepared to handle the petabytes that will soon be heading its way. For example, research by Dr Carl Peck, director of the Center for Drug Development Science at Georgetown University, shows that front-loading trials with data derived from testing other, similar drugs would significantly improve the clinical development process. It might eventually also lead to more judicious and more limited data collection.

Take one of the biggest problems – getting the dosage right. The industry has traditionally established the maximum tolerated dose (MTD) of a new drug by giving it to between 12 and 24 healthy volunteers in the early phase of testing. The MTD is then used in Phase II and Phase III trials. But healthy people are generally stronger and more resistant to unpleasant side effects than those who are ill. As a result, some trials fail because the dosage – not the drug – is at fault.

In fact, most companies already have a considerable amount of data on the pharmacological properties of related drugs, including their pharmacokinetics and pharmacodynamics. This is information that could help them to predict the best dosage levels and test those predictions on computers before they begin human studies.

However, many companies do not even use information they have gleaned from earlier trials on the *same* drug, let alone from trials on kindred drugs. In an effort to keep development times as short as possible, they start further studies before completing their analyses of the results from earlier tests. So decisions to proceed in a clinical development programme are often based on conjecture rather than hard-core information.

Changes in the clinical process will reflect the new technology



Making decisions based on conjecture inevitably increases the number of trials that are needed. Yet the FDA actually requires only two pivotal efficacy trials for approval of an NDA. It also reports that 25% to 50% of all trials fail to meet their objective.

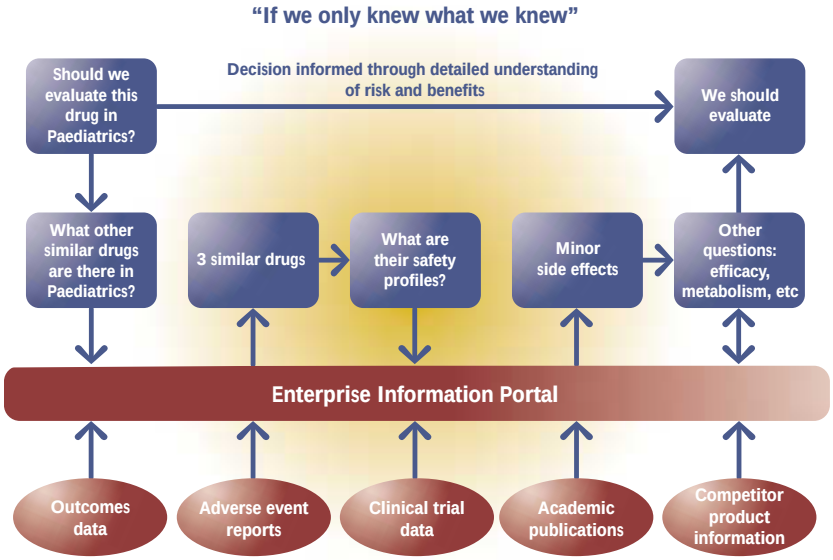
This is a very expensive way of doing things. In 1996, the Tufts Center for the Study of Drug Development calculated that clinical development accounts for about 33% of the costs and more than 50% of the time involved in bringing a new drug to market. Given the average number of trials and average costs per approved drug, this suggests that a typical NDA submission consumes between $50m and $100m in unproductive clinical trials. Moreover, even after spending all that money and collecting all that data, companies still have post-launch problems. Last year, for example, three new products – Posicor, Redux and Duract – were withdrawn from the US market after adverse drug reactions in small sub-populations and previously unknown drug-drug interactions.

Heavenly gateways

It is obvious that the ability to turn data into knowledge – and to do so quickly – will soon be a key competitive advantage. Yet the healthcare industries as a whole have been slow to exploit the benefits of IT. A survey by *Information Strategy* shows that, in 1998, five leading pharmaceutical companies invested an average 3.5% of revenues on information systems. Other sources put the industry's IT spend at a slightly higher 4-6% of sales, compared with 8-10% in many information-intensive industries. This helps to explain why most pharmaceutical companies have few defined data standards, little common architecture and only limited data warehousing facilities from which staff can easily access the knowledge of colleagues elsewhere in the organisation.

However, some of the industry leaders have now begun to redress these omissions. New web-based technologies will also be available quite shortly to facilitate the search for the pass through the peaks. By far the most important of these are Enterprise Information Portals (EIPs) – browser-based systems that provide cross-company access to information in the same way that Internet content portals like Yahoo! provide access to the content displayed on the World Wide Web.

EIPs will enable companies to manage data derived from both internal and external sources, regardless of the format in which it has been produced. They will provide a single gateway via which users can store, retrieve, manipulate and transfer data into different applications. They will operate on an enterprise-wide basis, allowing employees, suppliers, partners and customers alike to exchange information. And they will do all these things without jeopardising the security of that material; individual portals set according to users' clearance levels will ensure that sensitive information cannot fall into the wrong hands.



Nothing so comprehensive is currently available, but products like IDX Systems' Web Framework and Cerner's Health Channel suggest that EIPs will not be long in coming. When they do, they will provide the pharmaceutical industry with the ideal management information systems for clinical development – although the quality of the output will clearly depend on the quality of the pharmacological data that is captured. Together with further increases in processing power, they will also ultimately open the heavenly gateways.

3 Predicting how Drugs Perform

The new pretenders

Many industries use simulation – the process of employing computers to work with a number of defined "what if" scenarios – as an integral part of their R&D. When Boeing built the 777, for example, it used computers to design and "fly" the prototype aircraft for millions of miles before a human pilot entered the cockpit. So comprehensive was the construct that it even included a virtual engineer with the ability to use a torque wrench on any nut in the prototype plane. However, use of simulation has been relatively limited in the pharmaceutical industry.

Things are changing. In 1994, a team led by Dr Michael Hale, director of statistical research at Syntex (now part of Roche), performed the first trial simulation in support of an NDA. Three years later, MGA Software launched *ACSL BioMed*, the first commercial software product designed specifically to apply simulation techniques to clinical trials. Today, there are some 15 such modeling software packages on the market.

Some of the industry's bioinfomatics specialists have also begun to tackle the issue from the opposite end of the spectrum, with prototype programs which simulate the biochemical behaviour of a cell in simplified form. One such example is E-CELL, a model-building kit developed by Masaru Tomita, a bioinfomatics professor at Keio University in Japan. E-CELL is a set of software tools that allows a user to specify a cell's genes, proteins and other molecules, describe their individual interactions and then compute how they work together as a system.

But this is only the start. With *in silico* techniques like single cell differential gene expression and target searches in Expressed Sequence Tag libraries, the industry will soon be able to identify targets possessing the ideal physiological and pathological characteristics. It will then be able to design and test drug candidates using pharmacophore technology, *in silico* lead optimisation, scale-up and preclinical trials.

Computer modeling will even provide the tools with which to perform *in silico* clinical trials based on whole organ body models that test for everything, including side-effect profiles and drug-drug interactions. One such example is the virtual heart developed by Denis Noble, Professor of Physiology at the University of Oxford – a model so lifelike that it behaves almost exactly like a living human heart. The issue thereafter will not be whether, but when, the regulators accept such evidence.

In silico preclinical trials and simulations for the design – if not actual implementation – of clinical trials will transform the way in which development is conducted. Good portfolio management decisions on candidate selection and attrition require high-quality information about safety, efficacy, development costs and profitability. Under the current clinical development model, such information is only available late in the development cycle. But simulation will massively accelerate the development process, facilitate the selection of drug candidates and reduce the risk of failure. In short, it signals the shift from empirical to predictive science.

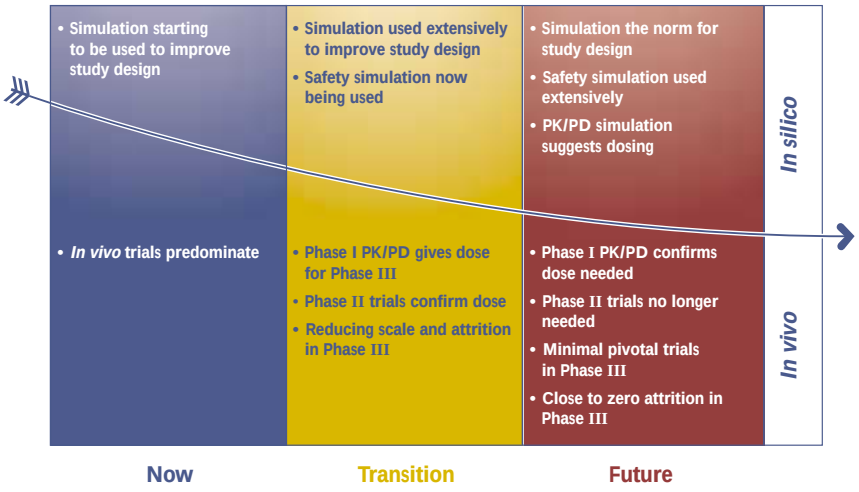
Trial runs

It will also improve the quality of preclinical and clinical trials, by enabling development teams to test their designs and assumptions in advance of the trials themselves. This "learn, confirm" approach – propounded by Dr Peck and Dr Lewis Sheiner, Professor of Laboratory Medicine at UCSF, will cut both the number of observations that are made and the number of trials that are carried out. Indeed, once they are confident of the technology, the most astute clinical project managers will use it to move rapidly towards the two pivotal trials required for registration, reducing both the time and cost of Phase IIIa studies without compromising the quality of the clinical programme.

Precisely how much money simulation – together with a better understanding of drug outcomes gained from advances in new discovery technologies – will save is difficult to quantify, since estimates of expenditure on Phase III trials vary widely. Given average operating costs and the fact that the typical Phase III trial lasts between six and 12 months, we estimate that every flawed or unnecessary late-stage trial wastes between $5m and $10m.

What is clear, however, is that simulation will help to reconfigure the financial basis of clinical development at precisely the time when the industry most needs it – although the speed of the transition from *in vivo* to *in silico* testing will vary according to the particular disease and therapeutic category. In total, we calculate that *in silico* technologies will enable the industry to bring products to market for 50% to 66% of today's average cost per drug.

Clinical development - transition to simulation



4 Meeting the Cyber Challenge

The big e

The popularisation of the Internet has produced all sorts of e-terms – e-commerce and e-business among them. The two are often used interchangeably, although they are actually quite different, so it may be helpful to define them. By e-commerce, we mean the marketing, selling and buying of products on the Internet. By e-business, we mean the use of electronic information to improve performance, create value and facilitate new relationships between companies and customers. E-business is thus a very much larger concept than e-commerce – which the OECD predicts will be worth about $1 trillion by 2005 – and one, moreover, that is profoundly relevant to pharmaceutical R&D.

The potential for e-business is enormous. Forrester Research estimates that 20m US employees – 14.9% of the working population – now have access to the Internet from their business computers. This is 55% more than last year. In Europe, work-based access is growing at a slightly smaller 40% per annum. The trend towards corporate "webification" clearly enhances the appeal of the Internet. As Metcalfe's Law states: "The cost of a network expands linearly with increases in network size, but the value of a network increases exponentially." It also offers various ways of enhancing the value chain.

The digital value chain

The single biggest benefit is the effect on the cost of interaction – the time people and companies spend searching, coordinating and checking, whenever they exchange goods, services or ideas. Costs of this kind account for as much as a third of all economic activity in the US, according to Nobel prize-winning economist Ronald Coase.

With intranets and e-mail, it is very much easier to perform all sorts of recurring administrative tasks, including internal recruitment, management of the pay roll, data collection for clinical trials and materials purchasing. It is also much easier to manage relations with external contacts such as CROs, satellite biotech operations and customers. Moreover, the savings can be substantial. Cisco Systems, a US developer of networking equipment, reports that it has saved $535m in areas ranging from back-office processing to customer service – almost enough to pay for researching and developing a new drug.

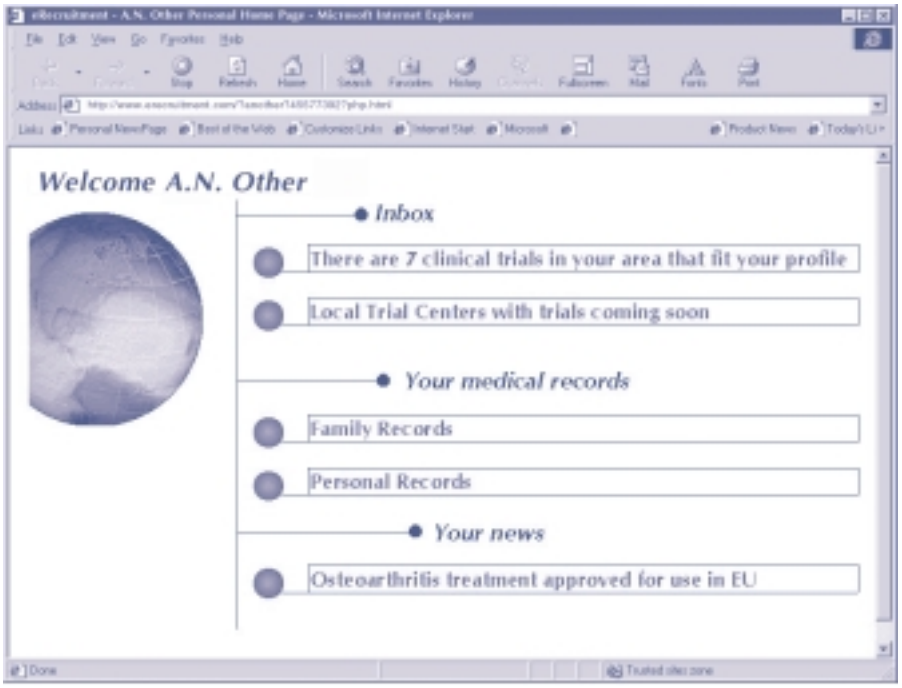
However, the pharmaceutical industry has been slower than many other sectors to break into the world of e-business. Some companies may therefore try to accelerate their progress by joining forces with other organisations already well down the digital road. They will do so partly because of the opportunities for reducing interaction costs and partly because it is easy to see how they might be able to profit from e-business in several quite specific respects.

The consumer as king

One such example is the chance to court patients directly. In a recent speech at a healthcare conference in Washington, Jan Leschly, chief executive of SmithKline Beecham, made precisely this point when he said: "We need to throw out the old healthcare delivery system and accept that the consumer, the patient, is king – and we [sic] better service the king." Companies keen on "servicing the king" will aim to extend their traditional portfolios by delivering profitable new products and services. E-business is the ideal medium for this purpose.

They can use web-based technologies to devise and deliver compelling customer service tools such as access to outcomes data and “e-help lines”. They can then use the information collated from customer “hits” and e-mails both to generate further sales and to improve the R&D function’s understanding of what those customers want. Moreover, valuable as such services will be in differentiating a company from its competitors, they will also build customer loyalty.

Certainly, the enfranchisement of consumers wrought by the Internet will have a major impact on formularies and treatment regimes. But e-patients (those who use the Web) will do more than influence what drugs are prescribed; they will also influence the kind of drugs that are developed and the way in which they are developed. Again, e-business offers the ideal vehicle for soliciting their views – both informally and formally through e-recruitment for local clinical trials.

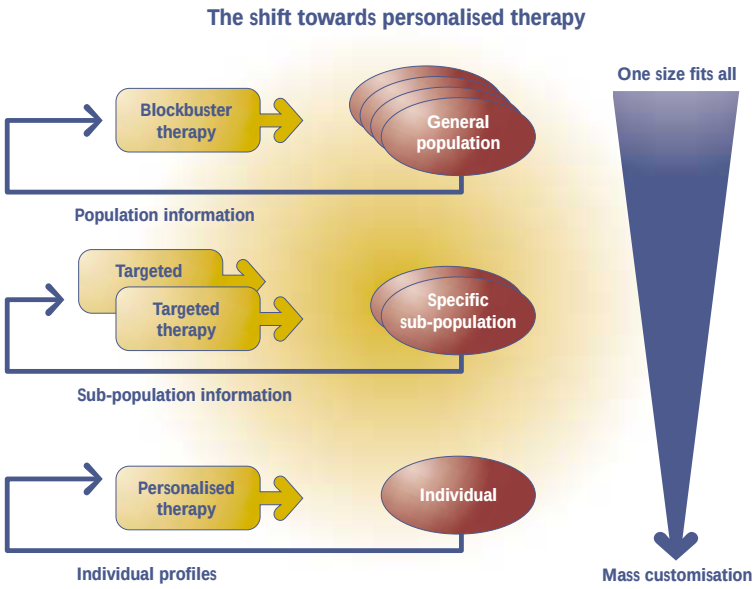


This has some obvious advantages for the companies, too. Reduced development times and higher success rates in discovery and preclinical testing are likely to effect a nearly six-fold rise in demand for patients and investigators – although simulation and pharmacogenomics will eventually ameliorate the pressure. E-recruitment could help many companies to address this short-term shortfall (although they would then have to screen many more patients). It would also enable them to eliminate some of the administrative pain involved in searching for, and managing, large numbers of trial personnel.

5 Dealing with the New Infomatics Players

The electronic go-betweens

If e-business provides new opportunities for the industry to reach patients directly, however, it will also produce new intermediaries to manage the boundaries between the two. For, as the industry moves towards the development of targeted (and ultimately personalised) therapies, so the sort of patient data it requires will change.



Where once it was sufficient to compile a profile of a particular patient population or sub-population, it will soon be essential to compile profiles of small groups and eventually of individual patients. But it is already clear that consumers are increasingly determined to control the terms on which they release personal information.

Microsoft was forced to abandon its practice of collecting details about customers' software without their permission, when they registered online, as a result of the public outcry it engendered. Netscape sparked similar hostility, with the news that a web site owner could use the "cookie" technology in users' software to track previous visits to that site. Yet frequent flier programmes remain as popular as ever, suggesting that concerns over privacy are not the sole issue; consumers will divulge personal details if they feel they are getting something valuable in exchange.

This trend will extend to healthcare. Patients will want to benefit from the information they provide, including their genetic bar codes; personal and family histories; purchasing patterns; and willingness or otherwise to participate in clinical trials. They will therefore be reluctant to release such information unless they can see what's in it for them.

We anticipate that this will result in the development of an entirely new category of healthcare information intermediaries. In return for access to detailed medical profiles, these electronic go-betweens will trawl the Internet for products and services tailored to the needs and pockets of their clients. They will pass that information on to the industry in the form of blinded profile analyses and market research. The pharmaceutical companies will then pay for access to the data and for marketing their products.

In short, the go-betweens will create a virtuous circle of bucks and bytes. Consumers will get discounts or other forms of improved value from the product and service vendors they use, in return for providing access to their profiles and being prepared to accept marketing messages. Pharmaceutical companies will get the data they need and generate extra sales revenues, in return for enhancing the value of the products they offer. The go-betweens will get marketing fees from the industry, take a cut on everything that is sold and generate additional income from market research, in return for collecting that data and providing a sales channel which shields consumers from unwanted intrusions.

There are signs that this is already beginning to happen with the development of Healtheon, the healthcare information service launched by James Clark, co-founder of Netscape. Healtheon, which has just agreed to merge with healthcare information site WebMD, uses advanced Internet technology to connect all the participants in the healthcare chain – including, patients, physicians and healthcare management organisations. Other potential go-betweens include a handful of US freelance statisticians – specialising in the aggregation and sale of publicly available data – and organisations like drugstore.com, the virtual pharmacy backed by online bookstore giant Amazon.com. Although drugstore.com and its rivals (including Planet Rx, Soma.com and Rx.com) all have strict rules on confidentiality, it is easy to envisage how one or more such ".coms" could eventually expand its remit from products to patient profiles.

The rise of the infomaticians

The move towards e-R&D is likely to result in the emergence of other new players specifically to service the needs of the pharmaceutical IT market. Specialist software developers will move downstream with systems to simulate whole organ body models (or even, perhaps, whole body models) and upstream with systems to simulate the entire clinical programme.

Specialist information managers – or "infomaticians" – will also arise to manage the vast quantities of data generated by the new *in silico* technologies. In fact, they have already started to appear. In October 1998, Compaq entered into a strategic alliance with Celera Genomics that covers all its IT infrastructure and service needs, including data management.

Outsourcing to third-party infomaticians has several potential advantages. It reduces the burden on the in-house team responsible for data management and maintenance. It might also promote the exchange of non-competitive data (such as evidence of toxicity), with licensing fees for use of one company's data by another. This would, in turn, create an additional revenue stream and cut down on the number of internal simulations the industry needs to make.

Naturally, however, such arrangements require a relationship based on mutual trust. And here, despite the history of antagonism between the two, it is arguable that CROs could make a significant contribution. Some of the best CROs are already well placed to provide "infomatics" services, since managing large quantities of trial data in different formats is, by definition, one of their core skills.

But be they CROs, software providers or anything else, it is clear that the new infomaticians must be able to manage information better and more cheaply than their clients. It is equally clear that most companies will adopt multiple strategies for coping with the information they produce. They will design for reuse – thereby reducing the number of simulations and volume of data they require. They will also set up data warehouses to manage and maintain any competitive data that has to be kept in-house.

6 Building a Networked Organisation

Exponential connections

It is difficult to manage the links – and the knowledge – within one organisation. It is far harder when the enterprise is extended and this is increasingly the case in the pharmaceutical industry. Apart from any relationships with new intermediaries entering the market, most big drug manufacturers already have multiple alliances with biotech and genomics specialists, CROs and so forth. The same is true of their suppliers; indeed, a large CRO may well have more than 200 clients.

The number of communication paths needed to support a networked organisation rises exponentially with the number of partners. The complexity of the infrastructure it requires also grows dramatically. This includes both the technological and structural foundations, since the members of an extended enterprise do not naturally share a corporate purpose, values or even the same profit goals. However, we believe the key attributes for success can be grouped under three broad headings: Management; Organisation and work processes; and Culture.

Management

Successful extended enterprises will be characterised by management systems that provide clear direction, responsibility and accountability. Thus the partners in the network should have common and interdependent objectives that are consistent with the aims of the network as a whole. This means that they will need to articulate a shared vision and put an integrated strategy in place.

They will also need to agree legal terms which all believe to be fair and workable, determining the extent and duration of the enterprise; allocation of costs; governance arrangements; and who owns the intellectual assets generated in the course of their activities. This includes patents, trademarks, copyrights, trade secrets, drug discovery technologies, production processes and other forms of know-how.

Organisation and work processes

If the right management systems are crucial, so are clear business processes. This is particularly challenging when a product development process is split between various members of the network; properly delineated milestones and careful scheduling will be vital in such circumstances.

The technical infrastructure to sustain an extended enterprise – including appropriate hardware and shared applications – will also be critical. A client server architecture is unsuitable for geographically far-flung enterprises, since it becomes less efficient over distance. Conversely, web-based technologies are location-independent. Their open architecture also overcomes some of the problems of working with heterogeneous legacy systems, although it does not address differences in language and culture.

But the tin and wires are only one of the aspects to be considered. The partners in an extended enterprise must also agree on the processes, tools and data they will share in the course of their work. This means modifying the current practice of creating large intranets and protecting them with firewalls, which impedes communications between people sitting outside the company and those working from within. It is, for example, far more efficient for a CRO to have direct access to a client's clinical database system than for the two to pass files back and forth. A better approach is thus to maintain a tiny intranet which protects what is genuinely sensitive information and a much larger extranet which is open to all the partners in the network.

Culture

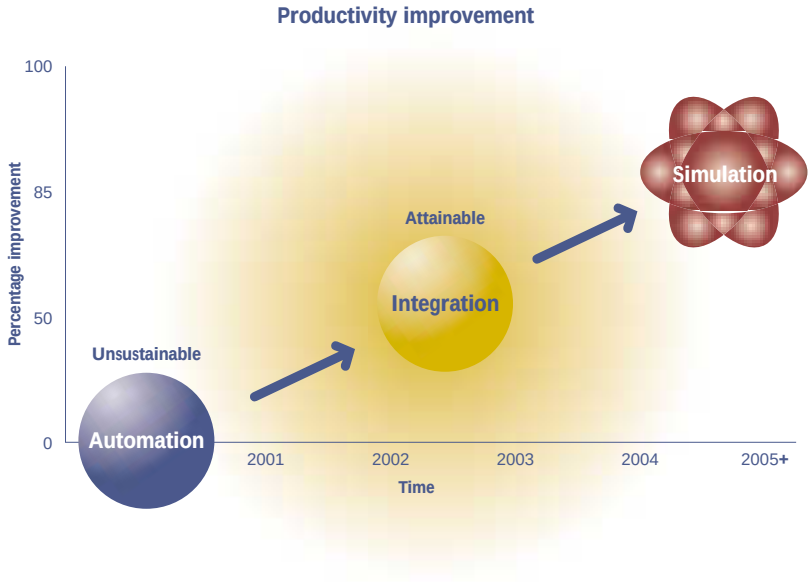
Extended enterprises need to be underpinned by cultures that support their strategies and goals, cultures that place trust before security and value candid, open communications. This requires ethical behaviour and mutual respect rather than a regime of fear and finger pointing. It also depends on a common sense of purpose and cultural compatibility between the respective partners. Without continuing and visible support from the top management, employees will otherwise be tempted to place their own immediate interests and those of their individual functions or departments before the needs of the networked organisation they are supposed to be building.

However, putting the right management structure in place is only half the battle. Most organisations reward people for possessing knowledge as distinct from disseminating it; in other words, they unwittingly create a culture that reinforces secrecy. This has the disastrous effect of inhibiting the creative process. The pharmaceutical industry is no exception. The prevailing culture within the scientific community is relatively open – with the publication of research papers, conferences and the like. But what clinicians share are conclusions, not raw data. This prevents other people from generating other forms of knowledge from that data.

One plus one makes three

But hard though it may be to manage an extended enterprise, the evidence suggests that it will be well worth the effort. In a recent Forrester Report on companies using electronic connections to support simple commercial activities, 63% of respondents achieved cost savings; 31% revenue increases; and 31% cycle time reductions. The saving in interaction costs and time to market – a critical issue for the pharmaceutical industry – looks likely to be even greater when organisations are fully networked, not just connected.

This is not all. Carried to its logical conclusion, the extended enterprise will enable the partners to concentrate on their core skills – liberating resources and working capital for further R&D. It will also enable them to leverage knowledge and skills they do not possess. In short, the extended enterprise will prove greater than the sum of its parts.



7 Transforming the IT Function

Bit part players

What is abundantly clear from all the changes taking place within pharmaceutical R&D is that most IT functions are quite unprepared to meet the needs of the industry in the year 2005. Sometimes, this is a question of focus; a company that spends $50m or more on back-office applications which arguably add little value – at the expense of investments in e-R&D – clearly has priorities that are at odds with its future needs.

But the issue is more often one of budgets. The "squeaky wheel gets the grease" syndrome ensures that short-term problems are fixed but rarely leaves the IT function with sufficient money to assume a more proactive role. Take the use of bespoke clinical data management systems that have long outlasted their real life span. Companies regularly pour money into patching up such systems to support just one more submission, rather than exploring new options. This cycle is hard to break.

The problem is compounded by the fact that most IT functions necessarily operate in a piecemeal fashion. They are called in by the business units to provide help with projects that focus on fragments of the R&D chain and are often expected to produce solutions funded from the budgets of those same business units – an approach that means they can only deliver stand-alone systems. Indeed, in some instances they cannot even do this; we know of several cases where enthusiasts have developed their own systems for particular processes, effectively hijacking control of the IT.

However, "adhocracy" is not an adequate way of tackling the challenges the industry leaders face over the next few years. Nor, for that matter, is the provision of value-adding solutions that enable them to do better things. By the year 2005, Big Pharma will need to do things that are altogether new – not simply better. It will need to study completely new biological targets and conditions, using completely new sciences, technologies and processes. In short, the IT function now has an opportunity to provide its R&D customers with support on a scale it has never been able to deliver before. In order to do so, it must identify how to help scientists steeped in their own disciplines to create new knowledge and insights.

The challenge for the IT function

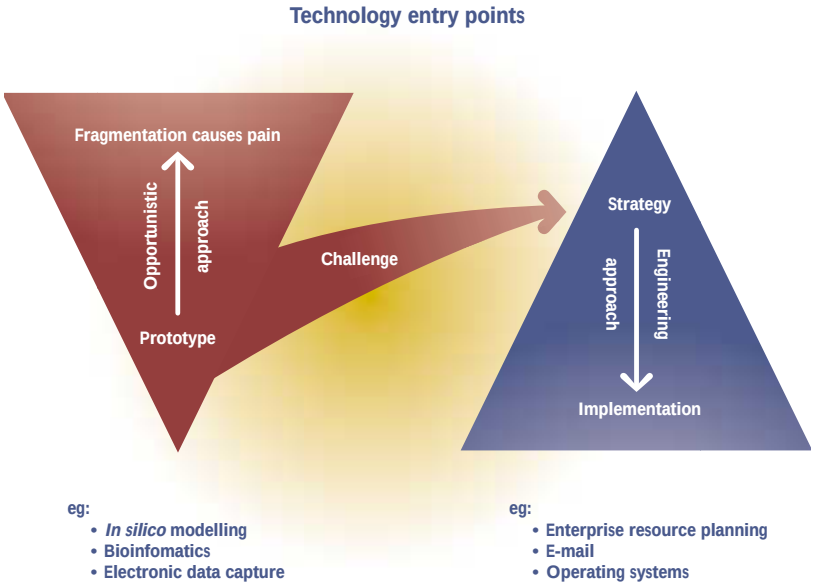
	1980... → 2005...		
Focus	**Automation**	**Integration**	**Innovation**
Role	Enabling the business to do things better	Enabling the business to do better things	Enabling the business to do new things
Performance measure	Reduce costs (efficiency)	Improve business performance (effectiveness)	Improve business capability (breakthrough performance)
Challenge	Technical competencies	Technology management	Service management

Information system brokers

Most IT teams are currently charged with finding suitable solutions, buying or building the necessary systems and benchmarking them. In other words, they act as direct service providers. In future, however, they will need to become service managers – evaluating technologies, buying services and managing relations with external providers. Indeed, Gartner Group predicts that 75% of IT functions will focus on brokering services and facilitating business-driven demands by the year 2003.

They will also have to adopt a much more rigorous approach to the identification and selection of promising new technologies. Many pharmaceutical companies currently rely on highly motivated individuals who lobby for internal support once they have identified an opportunity that appeals to them; this is a slow and rather haphazard process.

However, the speed and diversity of available new technologies means that it is difficult to maintain a stable IT infrastructure, even though technology architectures are increasingly designed and configured to provide flexibility. There is thus a danger that some of the best ideas may be stifled simply because they upset the technological apple cart. An even bigger challenge is the need for strategic implementation – and exploitation – of those new technologies. In the past, such systems have typically been introduced as prototypes and implemented on an opportunistic basis, often by business functions which have omitted to include the IT function until very late in the process. The issue, then, is to integrate such opportunities with the IT strategy and to engineer enterprise-wide solutions.

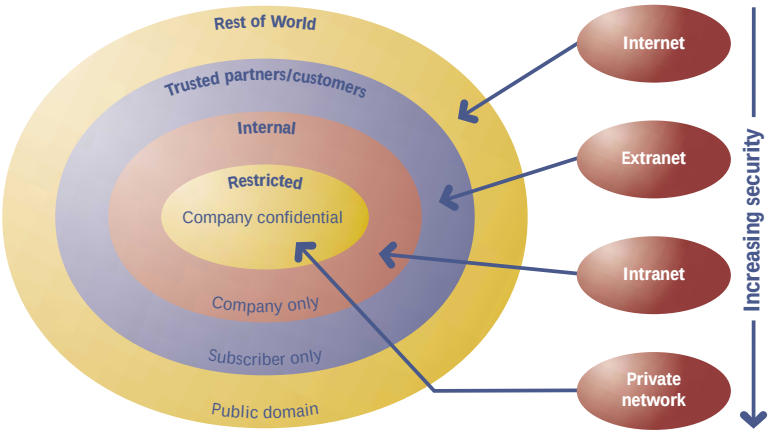


Agents of external IT

The shift from service provision to service management has other implications. For a start, it will require a radical change of perspective with regard to outside suppliers. At present, most pharmaceutical companies see outsourcing as a defensive tactic for transferring assets, not a strategic weapon for getting access to valuable skills and liberating them to concentrate on their own core activities. The result is that they tend to treat third-party service providers – be they IT suppliers or CROs – as “hired hands” rather than expert resources. They outsource only when internal pressures dictate the need for supplementary assistance, and they choose suppliers on the basis of prices and lead times rather than synergies, ethos and cultural fit.

But managing the systems and services required by the R&D function will take more than a change of attitude to outsourcing. It will also necessitate much greater proximity between the R&D and IT teams. IT staff typically work with particular business units on a project-by-project basis. By the year 2005, they will have to implement processes and technologies that interact seamlessly with each other and with those of external providers. In order to do that, they will need a much more intimate understanding of the whole R&D process. They will also need to look outwards rather than inwards – beyond the confines of the company to the many networks of which it is a member.

The external IT environment



To sum up, the core demands of R&D will alter dramatically, with the evolution of knowledge management systems and extended enterprises engaged in e-R&D. What it will most need then is a flexible, cost-effective way of knitting networks of business partners and IT service providers together. This new form of IT has been dubbed "external IT".

New skills for old

External IT involves a very different set of skills from those historically associated with IT. Knowledge of a particular system, application or programming language will become far less important than the ability to manage external suppliers. The industry will also need process and change management experts, integration specialists, business liaison managers and project managers to ensure that its R&D processes flow smoothly across fuzzy internal and external boundaries.

This is likely to be a major problem. Our research suggests that Pharma will need to replace about 65% of its current IT skills base. Given that the top seven IT spenders in the pharmaceutical industry employ some 14,000 people in IT or IT-related activities, that means they must replace or retrain some 9,000 staff. Moreover, since the number of candidates with the skills required for external IT will be quite limited, many companies will need to grow a significant proportion of their expertise in-house – even with extensive outsourcing of commodity IT services.

They will also need to employ R&D scientists who are very much more computer-literate. As wet chemistry gives way to the "lab on a chip", so the ability to perform pharmacokinetic/pharmacodynamic modelling, Monte Carlo simulations, pharmacometric estimations and the like will become much more important.

8 Living in a Virtual Community

In 1969, the US Department of Defence set up a network to pass data between military sites and academic institutions. As many as 190m people now have access to the Internet, and various forecasts suggest that by the end of the year 2002 there could be some 320m citizens online.

This transition has been possible because of the enormous increase in semiconductor capabilities and advances in the telecommunications industry.[2] Over the past 30 years, the speed and processing power contained on a single chip have doubled every 18 months. Personal computers have ousted the massive mainframes for which IBM first made its name and the average CD-Rom holds 600 megabytes of data – at least 30 times more than could be stored on a desktop computer just a decade ago.

Meanwhile, telecommunications charges have plummeted with the deregulation of many Western markets and increasing competition. Global teledensity has almost quadrupled and, by the turn of the century, there are likely to be nearly one billion telephone lines – although the bulk of them are in the developed world. The installation of new submarine fibre optic cables and satellite systems is expected to produce a fourfold increase in the bandwidth available for international traffic over the same period, and a number of telecoms carriers have started building packet-switched networks to manage the huge increase in digital data.

All these advances have made it very much easier for companies to gather and share information – itself a critical tool in making better products and getting them to market as fast as possible. They have also made it very much easier to reach the most important customers. In the US, 50% of all households with incomes of more than $75,000 have Internet connections, suggesting that the Internet will have an impact out of all proportion to the size of cyber sales. Many of those with the ability to pay for their medicines are already on-line.

To sum up, the digital revolution of the past three decades has created a virtual community that is rapidly expanding to cover the globe. The information technologies that sustain this community have become the central nervous system connecting companies, networked organisations and their customers. But it does not take much in the way of medical knowledge to realise what happens when the spinal cord is broken. Paralysis ensues.

The pharmaceutical industry cannot afford this risk. It can no longer afford its present approach to IT – the "make do and mend" mentality; piecemeal systems development; and haphazard search for new technologies. By the year 2005, only those companies which have invested in the emerging *in silico* technologies and cyber-business opportunities, learned to mine the knowledge they contain and made the transition to e-R&D will be able to function properly. That is the scale of the challenge the industry now faces.

[2] For a comprehensive analysis of the changing technological environment, please see the PricewaterhouseCoopers *Technology Forecast: 1999*

Who to contact for further information:

Europe

Steve Arlington
steve.arlington@uk.pwcglobal.com
tel +44 171 212 8689
fax +44 1895 273 315

Guy Lefever
guy.lefever@be.pwcglobal.com
tel +32 2 710 4642
fax +32 2 710 4699

Alistair Shearin
alistair.j.shearin@uk.pwcglobal.com
tel + 44 113 289 4552
fax + 44 113 289 4474

Michel Legrand
michel.legrand@be.pwcglobal.com
tel +32 3 240 3061
fax +32 3 240 3089

North America

Sam Barnett
sam.barnett@us.pwcglobal.com
tel +1 215 963 8349
fax +1 215 963 8225

Jay Hamilton
jay.hamilton@ca.pwcglobal.com
tel +1 416 941 8319
fax +1 416 941 8419

Chris Kelly
chris.kelly@us.pwcglobal.com
tel +1 973 236 5411
fax +1 973 236 7005

Terri Cooper
terri.cooper@ca.pwcglobal.com
tel +1 416 941 8297
fax +1 416 941 8419

Or visit our web site at:
www.pwcglobal.com/pharma/

For further copies of this report, please contact:

Michelle Fichtl
michelle.fichtl@uk.pwcglobal.com
tel +44 171 804 6530
fax +44 171 804 4939

Art Karacsony
attila.karacsony@us.pwcglobal.com
tel +1 973 236 5640
fax +1 973 236 5711

Wendy P Hall
wendy.p.hall@uk.pwcglobal.com
tel +44 171 212 8688
fax +44 1895 273 315

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