Creating new business models may be as important an innovation as products themselves.

Chapter Two: Knowledge, Decision-Making and Innovation

The value of a business increasingly lies not in factories or fleets of trucks, the sort of assets that appear on the balance sheet and are easy to value and manage. It lies in intangibles: brands, patents, franchises, software, research programmes, ideas, expertise. "Knowledge" assets such as these account for perhaps six out of every seven dollars of corporate market value. Managing any of these assets is difficult, but the hardest ones to deal with are those that employees carry around in their heads.

The company of the future will concentrate on managing people more than on managing physical assets. It will focus on trying to get the best from its knowledge capital. That will mean understanding what knowledge resides with its employees (and, sometimes, with its suppliers and customers) and its other knowledge assets. The importance of pooling the skills of the workforce will grow and new ways of building on the learning that goes on in companies will be discovered.

Happily, the communications revolution presents new opportunities to do this. It also presents new challenges. For example, Internet technologies help to spread and share ideas. But they also allow ideas to move easily beyond a company, creating a need for protection. Yet too much protection of intellectual property rights can stifle innovation. So governments and companies need to be able to strike a
balance between openness and protection.

The development of sophisticated databases and intranets gives companies new opportunities to build a core of knowledge that they can access globally. The enormous capacity that Internet technologies create makes it possible to store vast amounts of information (in text and increasingly in voice and video). Yet most of this information is in cumbersome and unstructured forms. Deciding what to store and how to store it will require more tools and wise judgment.

Internet technologies also provide new opportunities for companies to manage people and their intrinsic knowledge and skills, on which they are becoming increasingly reliant for competitive advantage. One of the biggest challenges for corporate management will be to find ways to maximise the benefits and minimise the costs of the changes taking place in the workplace. Technologies provide opportunities; managers must develop a corporate approach that makes the most of them.

In addition, the focus and the process of innovation are changing. As a result, creating knowledge becomes a vital competitive advantage. Research and development, once concentrated mainly in universities and defense, is now much more widespread. Services, and especially financial and business services, tend to be leaders in information-technology R&D.

For the first time, it becomes easy to coordinate innovation in several locations at once. The number of new patents issued, both in the United States and Europe, has speeded up -- partly because the law has changed to allow patents of new products, such as software in the United States, but partly because companies are simply innovating faster. The pressures of global competition and sophisticated business and consumer demands push companies to speed up the whole process of turning ideas into products.

However, although companies bang on a lot about "knowledge management" and "intangible assets," few are clear about what either concept means. Some interpret knowledge management as training, others as managing an online database. One handy definition is that knowledge management involves efficiently connecting those who know with those who need to know, and converting personal knowledge into organisational knowledge.

Intangible assets, to use the distinction of Karl Erik Sveiby, are of three main kinds. One is employee competence; a second, internal structure such as patents, concepts, models and administrative and computer systems; a third, external structure such as relationships with customers and suppliers, brand names, trademarks and reputation. All three account for a vastly larger share of the value of a company than its physical machinery or premises.
Plenty of evidence suggests that stock-market valuations correlate closely with investments in research, development and other intangibles. For example, the biggest gap between the market and book values of American companies tends to be in those that have most rapidly boosted spending on R&D. However, as high-tech companies constantly grumble, their balance sheets poorly reflect the value of their knowledge assets. Even within the company, good measures simply do not exist to help managers decide where to make future "knowledge" investments. Clark Eustace, who chaired a working group on R&D at the Brookings Institution in Washington, DC, puts the dilemma this way: "With building a factory, there are time-honoured methods for calculating rates of return. But what if you are investing in R&D or software, or deciding whether to buy better people or to train more? There aren't tools for making such (human resource) decisions." Here, then, is a key area of decision-making where managers today lack not only adequate language and accounting principles (they still use investment terms and conventions left over from the industrial age) but also adequate tools.

The company of the future will have to develop these tools, decisions about investing in knowledge and people will matter more than investments in physical assets. Managing people well will be much more important than managing a new machine or office block. And it will present different challenges. After all, uniquely among assets, people can walk out of the door, taking most of their value with them. But they can also walk in the door, bringing a business new talents and stimuli. Once a company has acquired a machine, it will do mainly what it was designed to do, but with a human being, the possibilities are infinite. At the heart of managing knowledge and innovation will therefore be not technology but managing human commitment and maximising the transference from human knowledge to organisational knowledge. That requires psychology, the ultimate management skill.

Sharing ideas

In many different ways, the arrival of Internet technologies is reshaping knowledge management. Knowledge becomes accessible in new ways; it becomes easier to store and to transfer; expertise becomes easier to locate; employees can collaborate more effectively, whether they work in the same firm or time zone or in different ones. But these new opportunities will benefit companies only if they can adapt their management skills and their corporate culture to take advantage of them. New technologies must reinforce existing human patterns of knowledge management; they cannot replace them. Technology is only half the answer; managerial ingenuity must do the rest.

For an example, take one of the basic keys to effective knowledge
management: converting personal knowledge into organisational knowledge. That conversion is a life-or-death matter for companies. Corporate memory is increasingly scattered in many different places: databases, filing cabinets and people's heads. People create valuable ideas, and are sometimes at their most creative when they first arrive in a company, before they become institutionalised into the corporate culture. Companies must have ways to capture these ideas, converting individual knowledge into corporate knowledge.

Companies must also have ways to capture the knowledge of people who move on, taking the corporate memory with them. For the moment, not only are the management techniques primitive; so is the technology. Larry Leifer, a member of Stanford University's Learning Laboratory, describes how information tends to accumulate in a group of people undertaking a project together. Once the project is finished, most of the information and knowledge tends to disperse, and the next project has almost to begin at the beginning. People rarely write good end reports -- most are already embarked on the next project by the time the first one finishes.

A company's best hope here may therefore be to save the accumulated unstructured information: emails, reports, hasty notes of conversations. Inevitably, this is less useful than storing such memories in the human brain: searching ragbags of data is difficult, and yet transferring information into an appropriate form is time-consuming and wasteful. But the alternative may be that new projects begin from scratch. They may thus waste precious time and repeat the mistakes a previous project made (but failed to record), while the only person who understands the quirks of a piece of customised software disappears for two months' sabbatical in Phuket or a top analyst leaves, contacts and all, for a rival firm. The challenge for companies is to find better ways to extract and share such valuable stuff.

Knowledge takes time to acquire, to absorb and to record. But the base on which a company's institutional memory is built may be diminishing. Employees tend to retire early or to move jobs more often. Companies shed staff and overhaul management structures. The result may be a loss of informally held knowledge: the memory of how it felt last time there was a recession, or of why the company decided to get out of some particular market. Nothing yet beats the human memory as a store of knowledge. But, as the workforce alters, companies must learn to use technology in new ways, to manage more effectively the human capital on which their competitive advantage depends.

Companies need their workers to share ideas more than ever before, for a variety of reasons. For instance:

(i) expertise is relatively more expensive: the impact of the widening
premiums for skill is that companies must pay more for top talent. They therefore need to find frugal ways to use it.

(ii) the incessant innovation and refinement of new products and processes requires an endless stream of new ideas.

(iii) just as workers in an old economy factory work together physically to build a machine, so workers in an office need to communicate and co-operate to build a service.

For millennia, the most durable way to pass on knowledge has been by word of mouth. Information that survives for thousands of years is passed on through story-telling; information that lasts for hundreds, through the more modern storage technique of the book. Now, companies must find ways for their staff to share knowledge that replicate the memorable power of the fireside yarn, while overcoming the changes that make such sharing more difficult. For today, workers on the same project may be separated by long distances and time zones. They may work for different companies. The stimulating chat around the coffee machines, source of bright ideas and quick fixes, is harder to arrange.

As tasks become fragmented among different firms, so good collaboration tools also become more essential. Of course, even in geographically dispersed businesses, information has long been shared. Designers at some companies, located in different time zones, have passed work to each other around the clock. But, until recently, they have used proprietary networks. Many of the most interesting Internet applications aim to enhance global team-building. They are designed to encourage collaboration, and the emergence within companies of horizontal communities, bound together by a common function or interest. These communities can now easily float ideas with each other, or gossip, or discuss best practice -- around the clock and around the globe.

But corporate success will depend not just on the use of technology to store ideas but also on finding effective ways to manage the people where knowledge is stored. For instance, even with technology that allows teams from several firms to collaborate, the key to success will be whether the firms -- or, indeed, the country where the teams are based -- have a culture of sharing information outside the company. And an understanding of ways to share ideas, like creativity, must come mainly from the bottom up. In the words of John Seely Brown and Paul Duguid, two of the wisest commentators on knowledge management, "Top-down processes designed to institutionalise new ideas can have a chilling effect on creativity. But they don't have to. Managers can learn to walk the fine line between rigidity -- which smothers creativity -- and chaos -- where creativity runs amok and nothing ever gets to market." Cultural change may thus have to take place before the benefits of new technology can be realised.
Managing knowledge thus entails both the management of experts and expertise, and the management of collaboration. Both require special skills. But the key point is that both tasks are as much about creating the right incentives for talented individuals as about designing software or installing a grandiose Chief Knowledge Officer. Companies must carefully balance two potentially conflicting aims: rewarding their most talented folk enough to keep them on board, and at the same time developing pay structures that emphasise teamwork rather than individual effort. They must also think creatively about sharing knowledge with other companies – suppliers, perhaps, or alliance partners. Success will depend not just on maximising the amount of knowledge shared, but also on the degree of openness between them.

Locating expertise

What do you do when you need some bit of information that somebody else in the company probably has but you do not? It might be the name of a contact or a scientific term – or perhaps something more complex, such as the background to a particular correspondence or the corporate view of a potential business partner? The answer will depend, of course, on the particular kind of information. But often, the obvious approach is to walk down the corridor, knock on someone else's door and ask them.

Finding expertise is an essential aspect of knowledge management. It involves the sharing of knowledge in a particularly precise and important way. Internet technologies offer new ways to structure, store and disseminate immense quantities of important information, thus making it possible for a little expertise to go a great deal further. Finding what you need to know, and at the right level of expertise, is the difficulty. For companies, the question will be, what is the best way to apply technology to make that task easier? The answer will be different for different types of information, depending at least partly on whether the information is structured or unstructured.

For example, for finding certain bits of unstructured information, emailing a friend will always be much better than looking on a database. Just as sharing ideas is about human networks, so is finding expertise: since time immemorial, networks have been the way people tracked experts down. The beauty of asking a person rather than reading a book or consulting a database is that, if people do not know the answer, they will be able to point you in the direction of someone who might do.

So companies must use technology to create effective versions of those networks. Here, the Internet has a great strength: it is very good at widening contacts. Its effect is to make it easier and cheaper than ever before to email a contact on the other side of the world for an
answer to a tricky question. An example: BP, the British oil giant, has
developed an intranet called Virtual Team Network that links
personnel on oil-drilling rigs around the world. If a drill bit develops
a fault, a rig worker can log on to the network and put out a
worldwide request for help to mend it.

The Internet thus offers an ideal way to locate unstructured
information, the most difficult kind to discover. In addition, many
large companies also try to build databases that list each employee's
area of expertise. They quickly learn that this should not be left to the
employee to fill in the information. Some will be boastful, others
modest. Better to include a question or two in the regular process of
employee evaluation, and then get the human-resources department
to write up the results.

Armed with material such as this, people hunting for expertise can
employ increasingly sophisticated software and search engines to
gauge which workers' skills are highly rated by their colleagues and
which are not, or to scour directories of people with special
knowledge. For example, the Media Laboratory at the Massachusetts
Institute of Technology is developing a concept called the Expert
Finder: software that swaps information about various users to
create a list of people it "thinks" might be able to help with a
particular problem. This is, in effect, an attempt to use technology to
mimic the benefits of searching a colleague's Rolodex for names of
people who might have a solution.

Internet technologies also provide new ways to locate information in
more structured forms. For example, big consulting companies,
which trade on their ability to muster knowledge rapidly and
precisely, have all built electronic databases to allow their consultants
anywhere in the world to tap into the company's accumulated
wisdom. Accenture has its Knowledge Exchange, a vast online
compendium of the company's accumulated wisdom accessible
anywhere in the world and at any time to all of its people. Some
consultants insist that, when looking for help, the database is their
first port of call.

To build such assets, the first requirement is that employees should
be willing to hand over their knowledge; the second, that the
knowledge on the database should be of high quality. The more
valuable knowledge becomes, the greater the disincentive to share it
-- for individuals, as well as for companies. Internet technologies offer
a powerful tool for sharing information, yet at the same time they
increase its value and so strengthen the case for protecting it.
Companies must therefore coax people to help with the tasks of
filtering and sharing.

Persuading employees to share their expertise is a theme to which this
book frequently returns, but it certainly calls for incentives. These
need not necessarily be financial. Some companies explicitly reward generous sharing with promotion. IBM evaluates its executives by their willingness to serve the greater good of IBM rather than their particular business unit. Degussa Metals Catalysts Cerdec (DMC) favours employees who (among other things) network and collaborate well.

To ensure the value of information in a database, companies can learn from the process of peer review that filters the quality of knowledge before it appears in an academic journal. Behind the idea is a very long-established version of the fashionable concept of communities of interest. That principle has been strikingly applied by Xerox, which has built Eureka, an intranet linked to a database that allows its 23,000 service staff to share tips on repairing the company's copiers. The reward for a good tip is not cash but the admiration and gratitude of fellow workers. Whereas most databases are top-down creations, like most business processes, the tips on Eureka are effectively peer-reviewed: reps supply and vet the tips. Only once a tip has been vetted by a local expert, and then checked by a centralised review process does a tip make it on to the database. This filtering is what gives the tips their value and has allowed Eureka to save an estimated $100m.

The higher the quality of information on a database, and the more tightly it is structured, the easier it will be to locate. Improving the quality of what goes in will thus raise the value that people extract. Companies find that information becomes truly useful only once it is structured. For example, General Motors uses focus groups to help it design cars that appeal to customers. It videos the groups to ensure that all the nuances of information are correctly recorded and conveyed to the car-design team. The trouble is, each group generates thirty hours of tape, and a dozen analysts each conduct several groups a month. Happily for GM a software company called Virage has devised a way to digitise and analyse the content of the videos. Technicians who previously wrote out the content by hand now spend half as much time on the initial editing process, and product analysts save time finding what they need, such as all the references to a single design feature. Whole new service industries are likely to evolve to turn unstructured information into valuable knowledge or at least to structure the information to make it more accessible.

However well information is structured, it is still often hard for people to find exactly what they want from large quantities of data. Search engines still find it hard to understand what people really want to know, and instead, dredge up vast amounts of irrelevant junk. That problem will pass: all too often, early search engines have been designed not by the folk -- such as corporate librarians and research departments -- who know most about the disorganised and intuitive way that human beings search, but by youthful techies, more interested in software than content and structure. In time, better
search engines, data mapping tools, and agents that scour the Web intelligently for information will largely solve this difficulty.

However, even the best search engine may find it hard to deliver the serendipity that may come from flicking through a newspaper or from hunting through the mess on one's own desk. People sometimes do not know what they are looking for until they stumble across it. One solution: recommendations generated electronically, such as those that Amazon, the online book store, offers readers: "Others who bought this book have also like the following titles." Even here, with the right management, technology has answers to offer.

Collaborating

The information in one worker's head may be valuable, but the value increases if it is shared with colleagues. Collaboration is one of the most important ways that Internet technologies can help to manage the process of sharing ideas and working together.

Much of the everyday collaboration that goes in companies is humdrum stuff. But coordinating people scattered in different places, working for different employers, is immensely time-consuming. The Internet transforms the process. Indeed, collaborative working was the Internet's original function back in the days of ARPANET, when it enabled defence and communications specialists in different universities and government departments to work together on the same project.

All sorts of new collaboration tools now allow people to share a single task. The Internet, with its open standards, makes collaboration easier than ever before. For managers faced with running a large and complicated project, that is a godsend. Online collaboration enormously reduces paperwork, limits the scope for error, and enables companies with many different skills to cooperate seamlessly. Tracking who has done what is essential, if only to identify expertise in the future and to avoid legal wrangles if things go wrong.

Take, for instance, a large building project. The need for collaboration -- not just within a company, but externally, with dozens of businesses (architects, engineers, material suppliers) over periods of months or years is an immense challenge. Without the Internet, each project entails thousands of transactions that must be recorded on paper. A typical $100 million building project generates 150,000 separate documents: technical drawings, legal contracts, purchase orders, requests for information, and schedules. Project managers build warehouses just to store them. Federal Express reputedly earned $500 million in 1999 solely from revenues generated by shipping blueprints across the United States.

To reduce these costs, many companies now create a Website to
which everyone involved in a project, from the architect to the carpenters, has access in order to check blueprints and orders, change specifications, and agree on delivery dates. Moreover, everything from due dates to material specifications is permanently recorded, creating an audit trail that is a particular boon in this famously litigious industry. Swinerton & Walberg Builders, a large American contractor, says that using such a Website has reduced by two-thirds the time needed to deal with requests for information. Using a shared Website in this way allows anyone working on a project to post or update material. That ends the cumbersome business of sending email attachments back and forth, especially irritating for people working on a laptop in a hotel bedroom with a dial-up connection. Good policy also requires that someone be responsible for the site to act as a filter, ensuring that good information is easily entered and faulty information kept out. Once again, filtering is an essential part of good knowledge management.

Mergers and takeovers generate just as much paperwork as building projects. Davis & Co, a London law firm, now uses secure Websites to coordinate teams of lawyers working on due diligence in large mergers or takeovers. A global takeover readily generates up to thirty thousand pieces of paper and involves many different disciplines, from accountants to auditors. A secure Website allows clients and specialists to monitor progress or hold an impromptu discussion of a document using an online "whiteboard" to mark up amendments. One such project coordinated fifty lawyers, fifty accountants, and fifty due-diligence specialists working in twelve cities across nine countries, from Australia to Kazakhstan.

Ford uses a similar collaboration technology to handle due diligence when it acquires a company. It developed the system when teams in Sweden, Britain and America collaborated over the acquisition of Volvo; after that, it was used in the purchase of Land Rover. Staff can use instant messaging for quickly checking points. The advantage of such "e-rooms", says Bipin Patel, head of management systems at Ford, is that they are asynchronous. So people can use them when it suits them. They are also always up-to-date.

Other Internet-based tools are even more sophisticated. Zaplet, a company in California, has devised something it calls -- unsurprisingly -- a "zaplet". This arrives in your mailbox like an ordinary email, but when opened, the zaplet becomes a window on to a server. The information you see is therefore whatever is now held on the server, so that you always get the most up-to-date version. The zaplet may also allow you to use an application that sits on the server: a spreadsheet, perhaps, or a way of managing a customer database.

One use might be for managers to share information on recruitment. Normally, piles of applications pour daily into the human-resources department, which sorts them and forwards the best to managers,
who indicate which candidates they want to see. The department then telephones the applicants and goes backwards and forwards trying to find a suitable date for the interview. How much easier, muse Zaplet folk, if the recruiting department can send a single zaplet to the managers who are doing the hiring. Then they can all look at the same application and write in comments or compare diaries on which time slots are free for an interview.

Groove, developed by Ray Ozzie, the man behind Lotus Notes, is a collaboration software that uses an idea similar to that behind Napster, a hugely successful software that allowed people to share the music files on their computers with each other, using so-called "peer-to-peer links that by-passed a central server. Instead of collaborating in music piracy, Groove Networks' software allows all sorts of files to be shared directly over a corporate network or the Internet itself: including chat, video conferencing and instant messaging. Users can simultaneously look at and edit shared files, while gossiping with each other about the boss or the weather.

"This is based on the notion that most work is about people connecting with other people," says Mr Ozzie with admirable simplicity. It is, according to an enthusiastic review in that high-tech bible, Wired magazine, "great for small and spontaneous project collaborations where users don't care to spend the time or money on a heavy-duty platform." As so often, the mark of an innovative technology is that it makes available to everyone something that had previously been there only for the wealthy elite.

These various collaboration tools have another advantage: they will allow the sort of information normally available only in corporate back offices to be readily accessible to people in the field. A salesperson might be able, while heading for a customer's office, to discover whether the customer was happy with the relationship so far, or to pull up a record of the customer's past transactions.

The effect will eventually be to turn a company's customers and suppliers into one large collaborative network. That will transform the relationship among companies. But it will also raise plenty of awkward issues -- not least, questions of corporate privacy and trust: when your suppliers and customers can have easy access to your database, you need to be sure that their security is as good as your own. And most companies will find the whole process technically harder than the enthusiasts would have them believe.

Decision-making

Understanding how decisions are made and building efficient decision-making processes become more important to companies, as things happen more quickly and there is ever more information available -- good and bad. In addition, companies must frequently
deal with new and unknown players -- and with new and unknown technologies too.

Internet technologies can help to improve the quality of decision-making in several ways:

1. By increasing the amount of information available to managers, from which they can choose.

2. By speeding up the access to information so that decisions can be based on more up-to-date data.

3. By allowing managers quickly -- and from any place -- to reach people who can offer advice and expertise.

4. By bringing people together to discuss a tricky point.

5. By searching for previous decisions taken in similar circumstances.

Internet technologies may also encourage group decision-making processes. People who normally hesitate to voice a view in a meeting, or who are on the road or located in another office, may now add their thoughts from their computer. Shy participants may be able to add a view anonymously through group decision software. Of course, anonymous feedback should be treated cautiously and is open to abuse. But, wisely used, it may give a corporate community a greater sense of democracy. On some issues, group software makes possible voting over the corporate intranet.

In addition, software offers managers increasingly sophisticated tools to help understand reasoning processes, and it can do calculations based on rules, algorithms, and game theory that would be well beyond the capacity of an individual to handle. But both the Internet and the programs have an obvious limitation: they are not responsible for the final outcome. Responsibility for a decision is taken not by the program, nor by its creators, who can always argue that the manager failed to appraise all possible moves or indicate all possible outcomes. Leave out some vital bit of information, and software follows the usual principle of "garbage-in-garbage-out". As one author on game theory puts it, "The program can do no more than turn a bundle of hopelessly complex interrelationships into a more concise form that the decision-maker intuitively finds easier to handle."

Ultimately, the most important aspect of decision-making is "not about WHAT you decide, but HOW you decide." Education should therefore be more about training how to learn and analyse and make decisions, and less about teaching specific skills, which may rapidly change. Decision-making managers have always needed analytical skills, but now, in addition, they need good "pattern-recognition" abilities. The reason is that much of the additional information that
Internet technologies offer them will be conflicting and wrong. Also, more data comes in all the time. A continuous inflow of information can bewilder a poor decision-maker. Managers need to be able to spot trends, to pick out what matters from data that is constantly being updated, and to know when new material is grounds for reviewing a decision and when to remain on course.

**Innovation**

Corporate competitiveness is rooted in finding new products and new ways to do things. "Innovation is now at the core of economic activity," argues the Paris-based OECD, in a landmark study of the role of information technology in economic growth. New ideas -- such as XML, or Groove, or zaplets -- create a double dose of value, both for the companies that design them and for the companies that use them to do old tasks in more efficient ways. Technologies readily leap between companies -- and across national borders. Many travel in the heads of those "knowledge nomads" described by Rosabeth Moss Kantor. Without bright folk on board, and the ability to manage them sensitively, companies lose this key competitive strength.

But innovation also raises questions about the way companies develop and share ideas. Not surprisingly, companies spend lots of time trying to encourage innovation. One fashionable notion is to give entrepreneurial employees the finance and freedom to "think like a dotcom" -- although the demise of so many dotcoms has made that sound less enticing. So has the realisation that the dotcom business model -- to grow fast and then cash out -- is the wrong one for an established, conventional company to pursue. Even if it were, the effect of distancing innovation from the main company may be to lose something. An interest in innovation needs to infuse the whole business, not just a few clever geeks in a skunk works.

Another approach, practised by companies such as Microsoft, Cisco Systems and Intel and emulated in Britain by Reuters, is what Peter Job, the British media company's former boss, once dubbed, "Buy, Don't Build". The idea is to take advantage of the more innovative, entrepreneurial climate in small companies by buying a stake in a portfolio of little businesses with good proposals and helping them to develop and launch their products. The effect is to turn the big company into a venture capitalist, outsourcing both innovation and some of the risk.

In general, it is easier for companies to "buy in" innovation, rather than "making" it all in-house. Sometimes, this involves strategic alliances between companies in different fields; sometimes, the purchase of business services that incorporate new ideas. The OECD's study found that the demand for business services was growing rapidly and that services such as consultancy, training, research and development, and computing all played an important
part in diffusing new ideas. These service companies not only help other companies to understand how to make the best use of new communications; they are often big users of information technology themselves.

However, in the excitement of launching something entirely new, companies must also remember how much extra value -- for both company and customer -- can often come from tweaking the existing range. Sometimes, this process of refinement may lead a company to realise an asset as marketable. In Europe, the ability to send short text messages to mobile telephones has been just such an innovation. Immensely profitable, it now accounts for almost a tenth of the revenues of Vodafone, the market leader. The introduction of prepaid cards for cellphones is another such refinement. It has opened a vast new market of people whose credit ratings would never allow them to take out a cellphone contract, and gives companies a stream of revenue without the expensive need to bill for calls.

Creating new business models may be as important an innovation as products themselves. This is partly because so much innovation now involves finding ways to make use of the Internet to deliver an existing service in new ways: sell books online, build cars, run an airline. For instance, Britain's EasyJet budget airline, with many ideas borrowed from America's Southwest, fills aeroplanes faster by doing away with numbered seats, sells onboard drinks and snacks, gets staff to help clean the plane for faster turnaround times. The Internet throws up all sorts of opportunities for trying out new business models, and cut the costs of experimenting. Europe's biggest low-cost airlines, Britain's EasyJet and Dublin-based Ryanair, use the Internet to sell around 80 percent of their tickets. Europe's established airlines, sticking with an older business model, sell perhaps 5 percent of tickets online.

However a company sets about innovating, Internet technologies can help.

1. Information and communications technologies themselves have the highest rate of innovation of any industry, when measured by patent applications. That swiftly spreads into innovation in other industries, especially services, which are increasingly built around software, computers, communications networks, and data banks. All told, about a third of the research and development carried out in the services sector is related to information technology.

2. Innovation feeds on shared knowledge. Because the Internet allows many different specialists to work simultaneously on a new project, development is increasingly modular, rather than sequential. A classic instance is the "set-based" process used at Toyota. Its people no longer design the engine and then pass it on to a second group to produce the casing, which discovers problems with the engine design
just as the first team has moved on to its next project. Instead, they develop sets of solutions in parallel and gradually narrow down their respective sets of solutions as new information emerges from testing, customer trials and so on. A gradual convergence to a final design avoids the need endlessly to redesign an earlier stage to fit in with what subsequently emerges.

3. Another effect of the Internet is to make it easier for companies to monitor what their rivals are doing and to watch other companies around the world and in different industries. This monitoring has become an important part of the innovation process. New ideas applied by one industry in one market, such as mass customisation or B2B exchanges, are quickly taken up and applied by others in other sectors.

Ownership and ideas

An effect of Internet technologies is to underline the value of information and knowledge. Companies say that they are keen on the idea of sharing ideas and on cultivating openness. And yet many now see intellectual-property rights as a key source of income. To secure it, they rush to patent any novelty that seems likely to bring value in the future.

Innovation in particular confronts corporate managers the fundamental tension between the virtues of openness and the difficulty of protecting intellectual property. One of the most interesting developments of the Internet has been the Open Source movement, which sprang up in the mid-1980s and advocates the unrestricted and free release of software, including the underlying "source" code, enabling users to make their own modifications to suit their needs.

The movement, effectively denying the need for intellectual-property rights, has had a powerful influence on innovation. It has given birth to the Linux operating system, to the Perl programming language, to the Apache server and to Sendmail, an email program. Linux is particularly remarkable. Initially created by one man, Linus Torvalds, it has been developed by thousands. Individual programmers all over the world develop the code and comment on each other's code, in a giant, voluntary peer-review process. A group of "core" developers decides which of the codes is good enough to include in the core code.

The astonishing thing about open-source software is that most of those who develop it give their ideas free. Thousands of geeks around the world who have never met work together, unpaid. Could this be a model for collaboration and innovation in future? If so, the model requires a workable kernel (in this case, the initial 10,000 lines of code written by Linus Torvalds) to which people can easily add; a
modular design, so that different people need to understand only the part they choose to work on; and a small team at the top to set broad guidelines and select the best ideas.

The most valuable development, says Alan MacCormack of Harvard Business School, who has studied the model closely, is that contributed by users. For what reward? Global recognition, "because software code is a universal language, if I make a good patch, the world knows". In addition, there is the satisfaction of seeing their ideas discussed (often at slashdot.org, a Website boasting "news for nerds") and then adopted.

So the process brings three key benefits: hundreds of eyeballs checking all the development for bugs; an evaluation and approval process; and a reward in terms of getting a code in the core and winning the recognition of your peers.

Many of the people who come up with these ideas do so outside a corporate framework. Eric von Hippel, professor of Innovation Management at MIT, calls them "lead users" and observes: "They face general needs in a marketplace but face them months or years before the rest of the marketplace encounters them. Since existing companies can't customise solutions good enough for them, lead users go out there, patch things together and develop their own solutions."

This concept of collaborative innovation is one that many companies envy, and wish they could emulate. Indeed, in several ways, corporate innovation resembles Linux code-writing, with its scattered teams and its modular design spread across a network of specialists. But could companies inspire the sort of altruism that has gone into developing open-source software? That is harder, for two reasons. First, employees are well aware that their ideas are what bring home the bacon. Even the open-source developers may not indefinitely review code for nothing, especially once an industry begins to make money from their ideas. Secondly, companies worry about how they can make money from the approach. There is a basic ambiguity in the concept. "Think free speech, not free beer," urges Richard Stallman, founder of the Free Software Foundation. But most free software is also distributed free of charge.

To foster innovation, a pat on the back, and a sense of recognition, are both wise parts of any reward structure: everybody likes to feel appreciated by their colleagues. A review of practice at thirty companies -- fifteen judged successful at innovating and applying their new ideas, and fifteen not -- by McKinsey found that the successful companies used all sorts of devices to coax more brainwaves out of their staff. They used technology constructively, building and regularly updating procurement databases that could be read by product developers, for instance.
Many did more gimmicky things. They ran ideas contests and offered opportunities to work on projects not directly linked to their usual work. One global machinery company assigned product developers to the shop floor to supervise the production of the things they had designed. A big electronics company even developed a "virtual Hollywood and got employees to present "scripts", or improvement ideas, to "investors" or general managers. This device apparently resulted in submissions from 200 teams in the first year -- although the study does not record how many were turkeys rather than box-office hits.

So money is not everything. But it certainly helps. The McKinsey study found that more than two-thirds of the successful companies linked individual incentives to product development targets; only a quarter of the unsuccessful ones did. Indeed, one high-tech American company gave employees cash incentives to file patent applications, whether or not they are successful. The aim is "to bring ideas into the open and discourage the hoarding of knowledge" -- and, no doubt, make some money if the idea succeeded.

From a company's standpoint, the value of new ideas has grown, thanks to a vast expansion in patenting, principally in the United States, where every innovation, whether for computer software or even for business methods, now seems to be legally locked up. For some companies, "intellectual capital" has come to mean, not the brainpower of their employees, but the commercial value embedded in patents for products, business processes, and dreams of processes yet untested. Among the ideas to which America's patent office has given monopoly protection are such simple ones as group buying, the matching of professionals with other people seeking their advice, and one-click shopping. "Software and algorithms used to be unpatentable," complained James Gleick in an article in the New York Times. "Recent court decisions and patent-office rule-making have made software the fastest-growing category, and companies are rushing to patent the most basic methods of doing business." No wonder that every self-respecting e-commerce company now has a tame patent lawyer.

An example is that of Dell Computer, which in the mid-1990s lodged several applications to patent, not its PCs, but its new way of doing business by building machines in response to orders. By 2000 it had seventy-seven patents protecting different parts of the complex building and testing process involved in its build-to-order system. Henry Garana, vice president of intellectual property at Dell, confesses that, at the time, many people regarded these patents as a waste of effort. Now, he says, "They make people go away. In this business, that's what matters."

Companies initially saw such patents as Mr Garana did, as a way of defending a good idea -- or even a business. Both Texas Instruments
and National Semiconductor avoided bankruptcy in the early 1990s by the aggressive use of patents. Gradually, companies have realised the commercial value of patents as a form of property and become more systematic in their patenting policies. IBM, for example, claims to get ten patents every working day, and to have generated $30 billion in revenue from licensing the use of its patented technologies. Financial-services firms and accountants are starting to patent their techniques (a classic instance is the patented Merrill Lynch Cash Management Account), something that in the past would never have occurred to them. Companies even patent ideas that require technologies that do not yet exist. If a company can plausibly describe how something might be done, then it can patent it.

The authors of a famous study of the strategic use of patents call them the "smart bombs" of the business war and add, "Companies that treat their patent portfolios as a strategic asset and a new core competence will enjoy a big advantage over those that don't." Again, the Internet will help them. Automated systems can help companies to organise and analyse their "Rembrants in the attic" and to describe their innovations more precisely and speedily.

This excessive proliferation of patenting is surely bad for competition. In the long run, too, the fragmentation of knowledge will harm research. The excessive protection of proprietary knowledge will distort the cultures of openness that companies must foster to make the best use of Internet technologies in other ways.

Moreover, it will ultimately rebound on companies. Each time a company's successful innovation, patented and exploited, makes money for its shareholders, the people who made that innovation possible will wonder whether they were right to give away so much of their own intellectual capital. The greatest challenge for innovative companies will be more fundamental than developing an innovations strategy or a patents database. It will be getting incentives right.

The future of knowledge management

Internet technologies have the power to transform the collection and accessibility of knowledge and information. Companies must find ways to ensure that knowledge and ideas bubble up from the bottom, as the clearest symptoms that a company has a healthily creative culture. They need to be constantly aware that the most vibrant and useful ways in which people share knowledge online will often be electronic versions of the ways human beings have always contacted each other and picked each other's brains.

The decreasing cost of communicating information does not mean that everything should be put online, or should be stored in a random and unstructured way. Knowledge in a database is like food in a freezer: nothing ever came out in better shape than it went in. If
knowledge is to be truly useful, it must be collected and stored with great attention to how it will be used in future. That may be hard to predict, but it may be worse to store for too many contingencies than for too few.

Knowledge must therefore be filtered at the point of collection. However, that in turn requires difficult decisions about what to store and what to leave out. The task of setting guidelines for filtering the input of knowledge in this way is not one that wise managers will delegate to junior staff, any more than they would delegate the task of deciding what make of computer to buy. Corporate knowledge is an asset the value of which will be determined at least partly by how skilfully it is harvested and structured.

In looking for ways to capture and use good ideas, companies face a trade-off. They must balance wide access and freedom to contribute with the need to filter and structure. Many areas of corporate activity will have to confront this consequence of Internet technologies: real benefits will flow only when the centre first provides order and structure and then devolves access throughout the organisation.

Companies must also think about how to reward those who produce ideas. The ownership of ideas is at the heart of many commercial ventures. But ideas spring not from companies but from individuals. The more companies seek to profit from ideas, the more they will have to split the takings with those who first produce them. People are not like machines: they can easily discover what their intellectual output is worth, and take their creativity elsewhere, if they feel insufficiently rewarded.

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