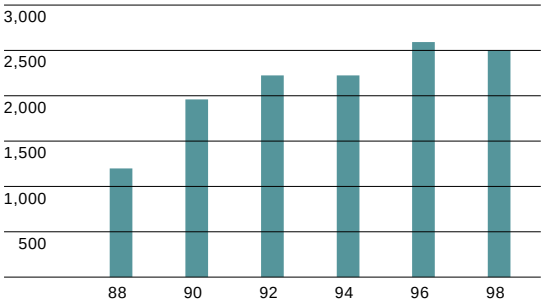
Technology Report 1998

INGENUITY AT WORK

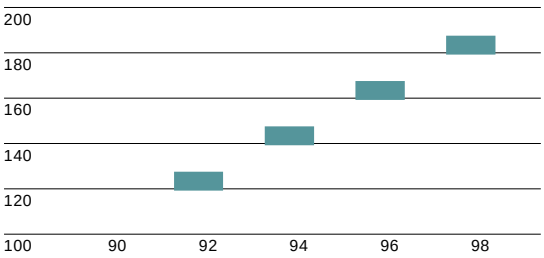
Key Figures

Group investment in Research and Development[1]
(US$ in millions)

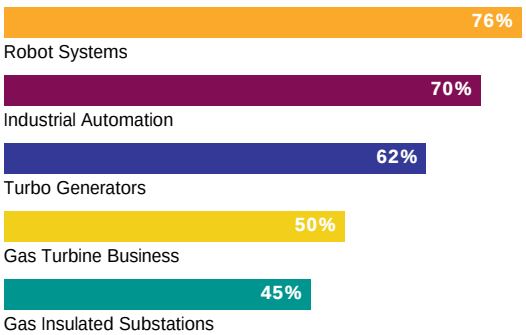


[1] In 1998 without ABB's share in Adtranz rail joint venture.

Increase of first patent filings since 1990
(%)



Percentage of business based on new products developed within the past five years
(examples of product groups)



Contents

Technology for All Our Tomorrows

Göran Lindahl
President and Chief
Executive Officer

The pace of technological development is increasing day by day. As new products and technologies are introduced, with profound impacts on many aspect of our lives, the growing complexity of innovation challenges us to question the efficiency and usefulness of each new development. We are used to seeing technological development as a help to improve our standards of living. Today, we are increasingly alert to their impact as to sustainability, efficient use of energy and environmental protection – for all our tomorrows.

We in ABB – as leaders in several key industrial areas – are at the very center of these challenges. With our leadership role comes the responsibility to secure real and practical innovations. Every year we invest a significant amount of our resources in research and development (R&D) in order to ensure that we remain a leader in our industry. Our aim: to sustain growth and profitability through meaningful innovation. That is the thought behind our ABB group slogan “Ingenuity at Work”.

Over the past several years we have achieved a number of remarkable technological breakthroughs and created a whole range of new products. These results have been achieved in very short intervals and are a significant measurement of our R&D performance.

Behind this success lie the competence, know-how and dedication of some 20,000 ABB engineers and scientists worldwide. They are active participants in the global scientific community and are constantly engaged in finding solutions to the problems facing mankind. We are proud of the fact that their efforts have a direct impact on increasing the quality of life around the world.

The accelerating pace of globalization combined with the rapid swings in world economic markets are redefining the previously established role of R&D in the corporate world. The economic changes coupled with a significant increase in cross-border competition and enforcement of environmental regulations requires complete dedication to technology-based innovation.

ABB is prepared to meet these challenges by enlisting the appropriate R&D strategies. We are working together with the world’s leading universities to develop a broad-based global presence to meet our long-term R&D and financial goals.

In the 1998 ABB Technology Report – published for the first time – we are inviting our shareholders and other interested readers to glimpse the dynamic world of ABB R&D. We want to share with you our vision and priorities for R&D and to inform you about some of our most recent achievements. These achievements spotlight our creativity and in some cases redefine established industry norms. Most of all, our report emphasizes the value of R&D in helping us remain a world industry leader.

Göran Lindahl
President and Chief Executive Officer

The Commitment to Innovation

H. Markus Bayegan
Senior Corporate Officer
Group R&D and Technology

This Technology Report presents some of our most recent achievements in R&D. At the same time, it provides insights into how we manage R&D as a global activity, and how ABB's strong commitment to technological excellence serves as a vital bond in our group. As a market leader with sustainable growth potential in many of our core activities, ABB sees plentiful technological opportunities ahead. We are determined to seize those opportunities, using the resources and capabilities of our group.

Emerging automation systems will use new system architectures, new paradigms for control, and integration platforms with a whole range of intelligent field devices. This will fundamentally change the way industrial processes are managed in the future. With such technologies, we can cut operating costs significantly and boost the productivity for our customers in various sectors of manufacturing, and help them improve their competitiveness.

In the technology-based economy of the future our products will become increasingly more intelligent, and new materials will open innovation paths which previously have been blocked. Low-cost electronics, micro-electronics and sensors will change the very nature of our products, adding comfort, convenience and efficiency for our customers.

We are excited about the fascinating technological challenges that are shaping the future of our industry. Here is a sample of particular relevance to ABB.

■ Renewable energy and distributed power generation will increasingly dominate the development of the power generation sector. In addition, we strongly support our latest innovations in the traditional area of this industry, for example our unique sequential combustion system for gas turbines. Increased efficiency and reliability combined with reduction of emissions will remain major challenges.

■ Major achievements in the area of silicon semiconductor switching and converter devices will revolutionize our ability to develop innovative power delivery systems in industry as well as in the utility sector. This technology combined with the digital control technology will enable us to switch electricity to a wide range of voltages, frequencies and phases with minimum electrical loss and wear.

■ Ecology and environmental technologies are a central focus for our R&D. Most recent international agreements like that of Kyoto have set the stage for the future and defined the agenda for our R&D world. In all areas of our work a central objective will be to increase efficiency and reduce environmental impact. Almost 60 percent of our long-term Corporate R&D efforts are directly or indirectly related to improving the environmental compatibility of our products and systems.

■ Information Technology will create a whole new reality for the way we do engineering and manufacturing: not only through traditional applications such as Computer Aided Design, parametric design and product data modelling, data warehousing and mining, but also in the way it will change the infrastructure of our engineering world. Engineering groups spread over the globe will be able to work

The new Powerformer is an example of the ways in which our R&D investments are helping to shape the future of electrical engineering

in virtual project groups, linked together by the Internet and other high performance networks. Use of multimedia and other powerful emerging technologies will make this approach even more attractive.

We are confident that we will achieve our R&D goals during the coming years because we have highly motivated and qualified R&D people working in an environment that encourages innovation, and supported by significant financial resources.

Against this background, I believe we can further increase the return on our R&D investment through a wide range of innovations and major technological breakthroughs ensuring our future growth and profitability.

Some of our R&D achievements in 1998

■ On June 10, the world's first high-voltage generator, Powerformer™, was installed in Porjus, in northern Sweden. This generator – developed by a committed team of engineers – is expected to revolutionize the power generation industry which in more than a century has been living with the paradigm that generator voltage has to be kept below 27 kilovolts and stepped up by a transformer to the desired transmission voltage. This change of paradigm means a reduction of 30 percent in total lifecycle cost of power generation for our customers. Since Porjus, several new Powerformer contracts have been signed.

■ On August 25, ABB was awarded an innovation prize by ONS (Offshore, Northern Seas) in Stavanger, Norway, for its contract to deliver the world's first commercial Subsea Separation and Injection System (SUBSIS) for installation in Norsk Hydro's Troll C Field in the North Sea. This marks the beginning of a new era in the subsea oil and gas processing.

■ ABB received the first order for its new GTX 100 gas turbine from a municipal utility in Sweden. The GTX 100 provides large turbine efficiency and emission performance in the low- to mid-power range and is well suited for the growing small-scale power market.

■ Another successful product launch in 1998 was our latest medium-voltage drive, the ACS 1000. Using the latest power semiconductor technology, the ACS 1000 is five times more reliable than any competing product.

■ On October 20, ABB's new factory for the emerging generation of power semiconductor devices was opened in Lenzburg, Switzerland. By investing US$ 70 million in this state-of-the-art factory, ABB clearly underlined its commitment to stay at the forefront of a strategically important technology. As we show in this report, we are also making breakthroughs in the technology frontier area of Silicon Carbide semiconductors.

ABB's R&D vision

To develop technological leadership positions which will ensure our growth and profitability – now and in the future.

To transform this vision into technological success, we also need to be clear on how we manage our R&D, a task characterized by a number of major challenges:

1. Achieving results and at the same time exploring uncharted territory

This sounds like trying to square the circle, but it is a key challenge in industrial R&D. At the "fuzzy front end of the R&D" we want to explore and experiment without being too structured. We have allocated a substantial portion of our resources to this phase of R&D. On the other hand, once the options are clear and we know where we are heading, we pick up our pace and work in a fast, result-oriented and structured manner.

In R&D – as in other areas – we provide measurable results. One way is to measure part of the ABB order intake that is related to newly developed products. For example products developed within the last five years account for:

- More than 50 percent of our business in the Power Transmission and Power Distribution segments
- 50 percent of the gas turbine business
- 62 percent of orders for turbo generators
- 70 percent of orders for industrial automation products and systems

In our flexible automation and robotics business, the product age profile is even younger: 76 percent of delivered robot systems have been developed during the past three years. We will continue to push this trend to shorter product development lifecycles to ensure our customers are getting the very latest technology.

2. Developing standardized modular ABB product platforms and processes

The second challenge: standardize to meet the requirements of complexity, which is steadily increasing in a global business environment. Customer needs are changing as fast as their increasingly competitive markets. Products and technologies have to comply with a wide variety of standards, rules and regulations, depending not only on the country but also on the industry sector. We have to satisfy our customers' needs while maximizing the return on our R&D investment. We do this by standardizing and modularizing our product platforms.

On the product development side, this means we focus our R&D efforts on a single platform rather than many, as we have done for our industrial automation systems for example. We can develop solutions faster and of higher quality. It also has advantages on the production side, since we can also standardize the parts we use, the manufacturing processes, even distribution and marketing channels.

At the same time we are still able to offer our customers systems and solutions that meet their exact requirements, that are simple to integrate with their

existing systems, and that can easily communicate with other components.

3. Strengthening our networks

ABB's world of science and technology is global. We have nine corporate research centers in eight countries and our 20,000 engineers and scientists are located throughout the world. We use our wide presence to join forces with the global R&D community.

Information channels such as our Intranet and the Internet are important tools to link into that international technology network, but more important is our commitment to participate as an open partner in the global science and technology community. By cooperating with recognized universities and research institutions throughout the world, we contribute directly to the development of knowledge and its application to meet the needs of the future. At the same time we tap into a unique opportunity to gather the latest scientific results. And herein lies the third R&D challenge: how to gain unique competitive advantage through open cooperation with the global centers of scientific excellence.

4. Balancing the R&D portfolio

In our Corporate Programs we push the development of ABB's current and future core technologies and competencies. Here we work strategically and in a very structured way. In our annual Strategic Technology Planning we look outside, we do benchmarking and study carefully what others are doing in the same areas. We make assessments and decisions regarding what we should do and how to do it. We build on a Strategic Technology Plan describing the course of R&D in each business area for the coming years. We regularly evaluate the entire portfolio of our corporate programs in order to make sure that we have the right balance between short-term and long-term R&D.

A major part of our R&D is carried out in our business units, close to the customers and the markets. In this kind of development we also make sure that the core competencies of our Corporate Programs are used in an effective way. Many of our projects aim at improving existing products or replacing them with new technology.

We support the entrepreneurs and innovators among our researchers through our High Risk, High Impact Projects, in we fund the initial, and risky, phase of an innovation. The fourth challenge lies in striking the balance between long- and short-term projects and using the courage and conviction born out of experience to venture into a high-risk area and at the same time invest in projects that respond to urgent customer needs.

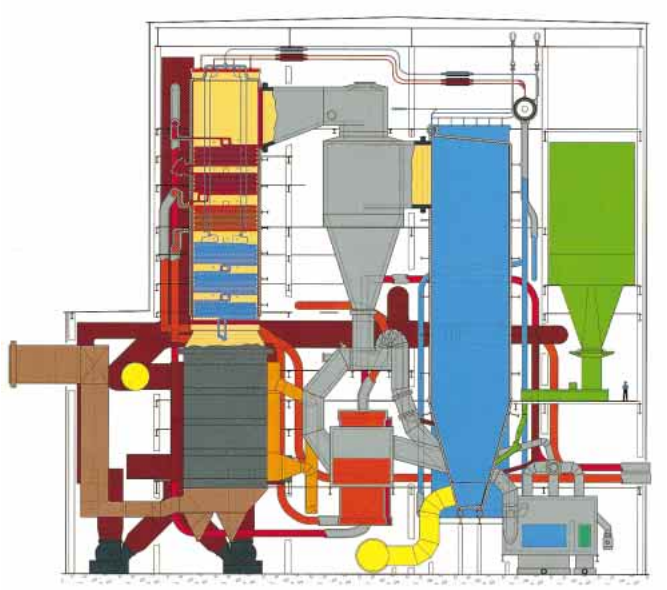
In the end, success will lie in living with and managing these challenges. In R&D we make our contribution of ingenuity in the interest of our customers, employees and shareholders.

H. Markus Bayegan
Senior Corporate Officer, Group R&D and Technology

ABB is developing a more efficient and less costly way to clean up harmful acid rain gases from coal-fired power plants. It's a technology that promises to make clean coal more affordable for those who need it most.

CFB

Clean Coal for the World



The world's rapidly growing demand for electricity is still met mostly by power stations burning fossil fuels – mainly coal, oil, and natural gas. With coal still plentiful and relatively cheap to produce – an estimated 3 billion tons are mined each year – it will remain the world's dominant power station fuel for the foreseeable future, especially in emerging markets, where more than two billion people still have little or no access to electricity.

But burning fossil fuels can produce harmful emissions. Combustion of coal is the primary source of sulfur dioxide (SO_2) in the atmosphere and the main contributor to acid rain, which can damage rivers, lakes and forests hundreds of miles from the power plant.

The basic technology to remove sulfur dioxide from power plant emissions has been understood for many years, but so far it has been too costly to implement in most plants. One available option is called circulating fluidized bed (CFB) technology. CFB uses limestone in the combustion process to react with sulfur dioxide to create gypsum. CFB can remove 90 percent of SO_2 this way. However, CFB technology uses large amounts of limestone and generates high levels of waste, both of which are a substantial operating cost burden for most power station operators.

ABB's new FlexTech™ technology tackles this problem head on. It halves the amount of limestone needed to absorb a given amount of SO_2. The process works by blasting steam into the limestone in the furnace. This makes the limestone swell, much like popcorn exploding in a hot pan, and fills it with permeable holes and fissures. This greatly increases the limestone surface area with which the SO_2 reacts, compared to conventional limestone.

The technology – which is being tested in a special facility at ABB Corporate Research – has other major benefits, too. Power plants can be designed more efficiently and built more compactly, offering substantial savings in costly land and construction materials. It is an important step in bringing clean coal technology to the world.

The Natural Choice

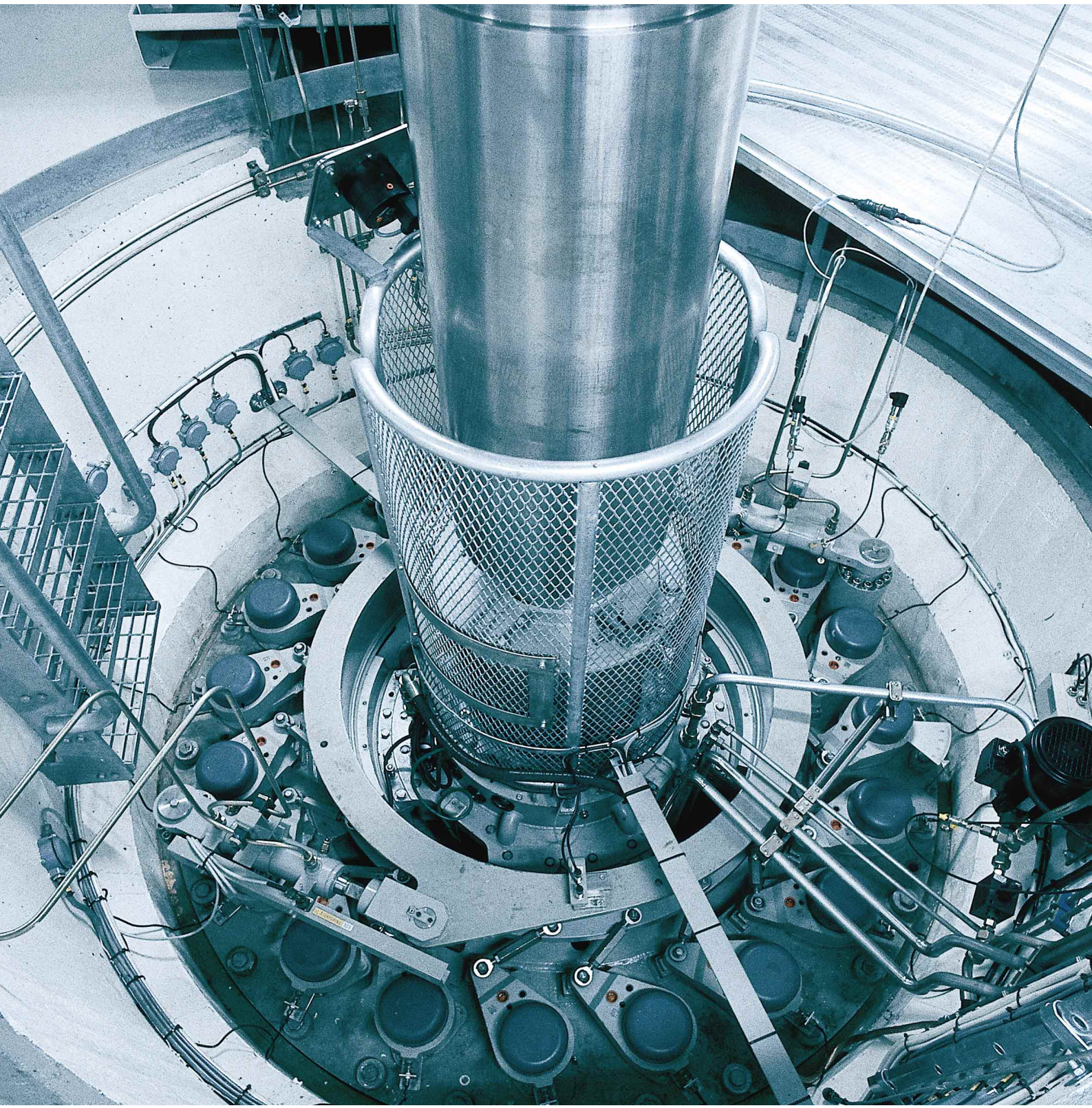
ABB engineers recognized how technological advances in the area of high-voltage cables could transform an apparently unrelated area. The result is a solution to a 150 year-old puzzle and the promise of a revolution in power generation.

In 1998 ABB introduced a radically new kind of generator called the Powerformer™. The Powerformer overcomes an obstacle that has stood in the way of generator development for more than a century. The result is a product that saves customers money, improves the performance of their power plants, and reduces environmental impacts.

The trade-off: Voltage or Current?

The problem traces its roots back to the 1800s, when the basic laws of electromagnetic induction and the characteristics of electrical conductivity were first elaborated in a series of mathematical formulas by people like James Maxwell, the Scottish physicist. One of these is that generators can produce either high voltage and low currents, or low voltage and high currents. Another characteristic of electricity is that only high voltages can be transmitted over long distances efficiently – low-voltage power has a high current that creates too much resistance in the transmission line and energy is lost in the form of heat.

The challenge, therefore, was to create a high-voltage generator. This appeared to be blocked, however, by yet another set of formulas that showed the best solution to be a conductor that is round in cross-section, like a copper cable. The problem was that engineers could find no practical way to provide the



Right: Mats Leijon, inventor of the Powerformer and leader of the development team.

round conductor with enough insulation to manage the high voltages required.

So they settled for the next-best solution, which was a high-current generator instead, using a heavy square conductor. Although it worked, it had some serious drawbacks. For one, the power from the generator had to be run through a step-up transformer to change it into high-voltage electricity for transmission. This is inherently less efficient because power is lost in the step-up transformer. And the square conductor, as Maxwell's formula showed, was not ideal for this type of application and created further inefficiencies in the system that led to high temperatures and high losses.

A new approach

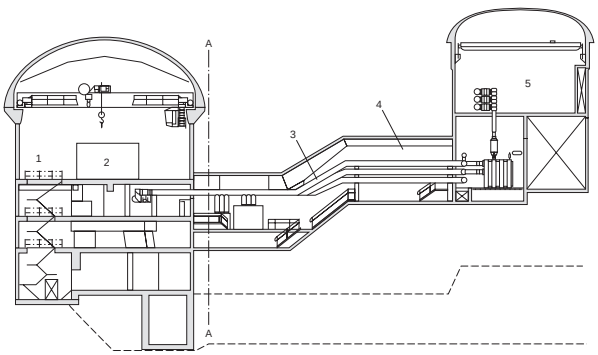
Then in 1993, an ABB engineer working with new insulation and cable technologies, began to wonder whether the solution to the round-versus-square conductor issue couldn't be solved another way. Mats Leijon, working at ABB Corporate Research, saw that the strong electrical field created by the round high-voltage conductor in a generator could be controlled using new polyethylene-based insulation. "From a physics point of view, round conductors are the natural choice," says Leijon who went on to lead the Powerformer development team. Using advanced cable designs and the new insulation materials, the team created a round conductor capable of handling the high voltages.

The impacts of eliminating the step-up transformer and the Powerformer's other design innovations are considerable.

- The Powerformer uses less space. That means power plants can be smaller, which lowers initial investment costs.
- The Powerformer reduces operating and maintenance costs, as well as the environmental and safety risks posed by the oil used to insulate the transformer.
- The Powerformer is made from recyclable and non-hazardous materials. There is no epoxy resin impregnation of stator windings, as in conventional generators. The new cables contain no oil.
- The Powerformer is flexible. It can be sized to provide any output voltage, which makes it useful for a broad range of power plants, from hydro to thermal power.
- The Powerformer has fewer power losses.

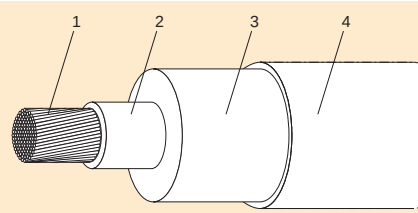
In today's deregulated electricity market these features can significantly improve our customers' competitiveness. The total lifecycle costs of the Powerformer are substantially below those of conventional generator systems. Looking down the road, the Powerformer will play a key role in supporting sustainable economic development worldwide.

The Diagram below depicts a section through a conventional hydro-electric power station. With the new Powerformer technology, everything to the right of the vertical dotted line (A) can be eliminated.



1. Generator Hall
2. Generator
3. Busbar System
4. Tunnel System
5. Transformer Bay

Powerformer's advanced cable and insulation technology made the difference:



The key to the Powerformer is ABB's advanced power cable and insulation technology (above). A typical standard power cable is made up of a conductor composed of uninsulated strands (1) around which there is a layer of semiconducting material (2) for smoothing the electric field close to the strands. On the outside of the semiconducting layer there is a solid insulation (3) typically consisting of cross-linked polyethylene (XLPE), which in turn is surrounded by a second semiconducting layer (4). The outermost layers of a standard power cable consist of a metallic screen and a sheath, which are finally surrounded by a plastic sheath.

Corporate R&D and Y2k Compliance

The so-called “Millennium Bug” or Year 2000 (Y2k) issue has become one of the highest profile topics of the day. For ABB, the potential impact on both internal Information Technology (IT) processes and software is considerable. We are running a dedicated program to ensure that all of our products are either “Year 2000 Compliant” or that adequate steps are taken in advance of the millennium to minimize impact on our customers.

An ABB Year 2000 Task Force created and implemented a concept consisting of strategies, priorities and action plans that address the challenges that Y2k poses to our products and systems.

ABB-Four-Pillar-Concept

Testing. Products with microprocessors are tested according to the standards set by the British Standard Institute and the results are put into an internal database and on an Internet database for standard products (www.abb.com).

Inventory. An inventory of installed products and systems is conducted and a database is created to allow automatic mapping for each product.

Methodologies. Methodologies are developed together with our customers for the remediation of various types of plants. In order to develop the methodology, we have worked through pilot projects for each type of plant, such as steam power plants, paper mills, or network control centers. Our corporate research centers have been actively involved to ensure we use the most advanced technologies in all our processes.

Training. The training is based on the pilot project results. Our various internal training centers are heavily involved.

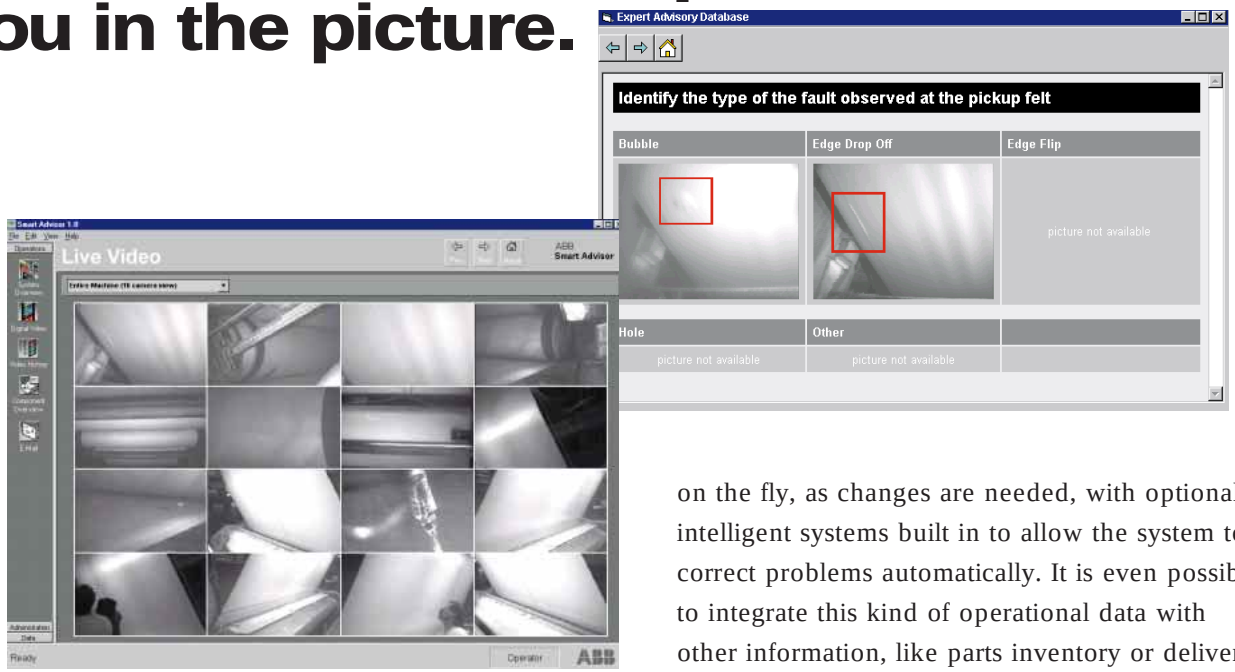
Y2k transition

Based on the knowledge from the pilot projects, we published a general process for Y2k remediation of plants, and a proposal for remediation work in electric utilities. We have informed our customers about our enquires and their results and we are offering them our support. ABB has about 1,000 specialists working on customer plants in this area.

For our internal systems we are taking comprehensive steps to make sure that we minimize any potential disturbances to our business processes. Internal consultants are systematically reviewing our companies based on an extensive checklist.

ABB will continue to support customers in achieving a smooth Millennium transition, and play an active role in governmental initiatives to maintain fundamental infrastructure at the turn of the century.

Process control that puts you in the picture.



Information technology (IT) has had a tremendous impact on the ability of industry to speed product design and manufacturing, improve quality, lower costs, and lift performance in many other areas. But the avalanche of software applications now available has highlighted the downside – how to bring the masses of available data together into a single overview that really allows control of the whole process from start to finish in real time. In other words, getting the right information to the right person at the right time.

ABB's latest generation of its Advant process automation system provides the answer. Process automation systems allow industrial customers to measure the performance of their manufacturing system and automatically take actions to improve productivity. In a paper mill, for example, the system could monitor energy use, how fast different parts of the paper machine are running, the weight, thickness and moisture content in the paper, and many other variables.

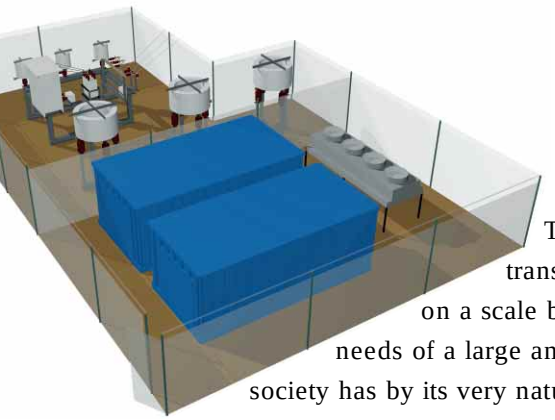
Communications systems link the various parts together and allow operators to adjust the system on the fly, as changes are needed, with optional intelligent systems built in to allow the system to correct problems automatically. It is even possible to integrate this kind of operational data with other information, like parts inventory or delivery schedules so that the whole process can be better managed, and in real time or close to it.

The new generation of automation systems from ABB takes this kind of integration an important step further. For instance, Advant will allow paper mill operators to select one component of the system, part of the paper machine, say, and by a click of a mouse on the corresponding icon, view it using several different applications. Views could be a real-time video, documentation showing technical specifications, electricity consumption, or computer-aided design (CAD) drawings. Advant can also produce status reports on maintenance and run an inventory check on spare parts, and even link to the Internet to order new parts or equipment.

ABB's process control software is already used in a variety of industries worldwide from utilities to pulp and paper, metals and minerals, marine, chemicals, pharmaceuticals, oil and gas, food and beverage and a range of manufacturing industries from automotive to white goods. And as a measure of its reliability, it is used for safety control systems in high-risk environments like oil rigs.

Meeting new needs in

HVDC Light



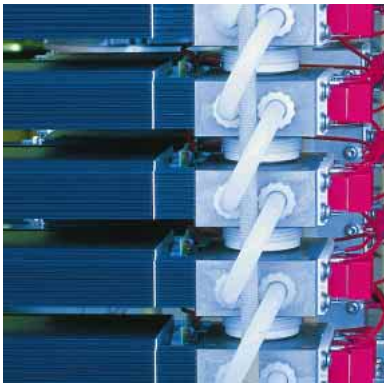
The generation and transmission of electricity on a scale big enough to meet the needs of a large and growing industrial society has by its very nature required massive and costly infrastructure – huge power plants, transmission corridors hundreds or even thousands of kilometers long, and all of the systems and equipment needed to make such a network function.

But with deregulation in the power market driving a sharp increase in competition, and with environmental concerns putting a premium on total system efficiency, many customers are looking for smaller-scale solutions that are more cost-effective in the short-term. That includes new ways to get the most out of all their existing power infrastructure.

ABB has made an important contribution to this effort with the development of a scaled-down version of its high-voltage direct current (HVDC) power transmission system called HVDC Light. Traditional HVDC is the most efficient way to transmit electricity over long distances with the fewest losses, and is playing a key role in expanding cross-border links between national power grids around the world. Such links allow countries to share power and better balance peaks and valleys in electricity demand without having to build new power plants.

HVDC could yield similar benefits in smaller-scale links but, until now, the costs of a full-scale HVDC system have made this high-efficiency solution uneconomical. Examples include hooking small and remote hydro power plants in countries like Canada or Sweden into the national grid, or making small-scale power generated from windmills available to a larger area. Such links not only make the whole system more efficient, thus reducing environmental impacts, they also make small-scale power economically feasible.

electricity



'Its built-in intelligence also allows system operators to schedule power deliveries exactly to meet demand, making it ideally suited for use in privatized electricity markets where power is being traded.'

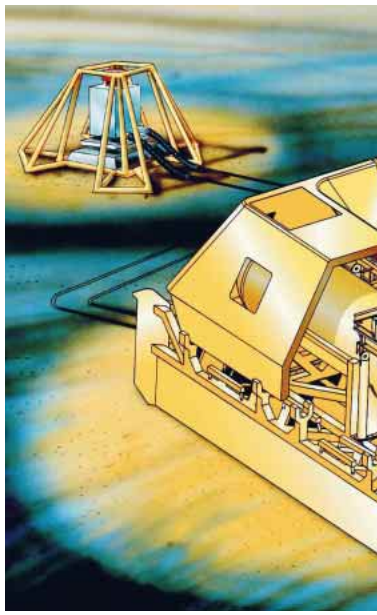
ABB has used new power semiconductor technology, to develop its smaller-scale HVDC Light solution. Because they can handle high voltages in a much smaller size, this new generation of power semiconductors allows the bulky components of an HVDC system – such as power converters, switches, filters and transformers – to be much smaller, while able to do more. For example, they can be programmed much like the smaller semiconductors found in computers, and made "intelligent." That means they are able to recognize important changes in the operation of the system, such as current fluctuation, and respond with a signal to another part of the system to make an adjustment.

HVDC Light technology yields real economic benefits. It requires fewer and smaller components and can be designed as a modular system, which gives customers greater flexibility when making initial investment decisions. That also allows easier service and maintenance and the overall size of the installation can be dramatically reduced.

The compact system is also adaptable for use in crowded city centers where space is short. Another application is on off-shore oil rigs. Excess gas that would normally be burned off could be used to power a small power plant and the electricity then shipped to the mainland using the HVDC Light system.

Its built-in intelligence also allows system operators to schedule power deliveries exactly to meet demand, making it ideally suited for use in privatized electricity markets where power is being traded. ABB has won an order for the first commercial application of this type in a 65-kilometer link that will be used in electricity trading between Queensland and New South Wales, Australia, starting in the year 2000.

Getting to the bottom of things.



How do you deliver electricity reliably at depths of hundreds or thousands of meters?

How do you control and repair the system if something goes wrong?

How do you make a subsea separation system affordable?

Until now, the operators of offshore oil and gas platforms have had to live with the fact that they were pumping not only oil and gas up from the sea-bed, but also water, sand, minerals, compounds used to lubricate the flow, plus a variety of other material that had to be separated out and disposed of at the surface. In some cases, as much as 90 percent of the wellstream is water. Pumping it up to the surface and then either back down to the seabed or cleaning and then pumping it into open water is costly and inefficient.

Putting the separation system at the seabed is an obvious solution, but the technological hurdles are considerable. The system needs lots of electricity: how do you deliver that reliably at depths of hundreds or thousands of meters? How do you control and repair the system if something goes wrong? Most importantly, how do you make all of this affordable?

In January 1996, ABB researchers launched a project with a budget of about US$ 10 million to come up with answers to these questions. In the spring of 1999, ABB won a US$ 25-million order to install the first commercially operational subsea separation and injection system (SUBSIS) on the bottom of the North Sea, some 60 kilometers west of Bergen, Norway, at a depth of 340 meters. The system features:

- A novel “cyclone” inlet to the subsea separation tank. The wellstream, which emerges from the seabed at high speed, is fed through the inlet into a small vortex. This slows the stream gradually and makes separation easier.

- Passive gravity separation of the different elements of the wellstream inside a pressurized tank about 10 meters long and 3 meters across. Passive gravity separation means the heavier materials, like sand and water, settle to the bottom from where they

Left: Assembly detail of the Troll Pilot subsea separation system with the separator tank indicated (1).

Right: The separator tank being loaded onto its container ship for finishing and installation.

are pumped back into the reservoir. The lighter oil and gas move to the top of the tank and are pumped up to the “topside” platform.

■ Water-tight high-voltage connectors, frequency converters, transformers and other electrical equipment for the subsea power distribution system. Each part of the system can be retrieved or serviced onsite by remotely operated vehicles.

Ongoing research is focusing on a number of areas, including new ways to remotely measure the level of oil, water and gas in the separation tank. One option involves sending an electrical current through the material and measuring the conductivity of the different parts of the mix. Since oil and water have different conductivity, this method would allow operators to deduce the levels in the tank. Similar approaches are being explored using different kinds of radiation as a measuring stick.

There are considerable advantages in moving water separation and injection back to the seabed. By removing water at source, more oil and gas can be pumped through pipelines to the surface. The result is a 3-6 percent improvement in recovery and less energy wasted pumping water needlessly to the surface. Reinjecting water directly back into the well also eliminates or mitigates local water pollution. Hazardous chemicals such as corrosion inhibitors, needed to maintain systems for pumping the well-stream to the surface, are eliminated, further reducing environmental impact. Remote-controlled service and repair reduces safety hazards.

All of these benefits together means resource recovery becomes more competitive in both existing sites and more distant sites once considered uneconomical. And overall, it makes much better use of available resources.

Boosting Creativity through External Cooperation

The world of science and technology knows no national boundaries. Science is governed only by the laws of intellectual rectitude; by the ambitions of its practitioners to be useful; and by a universal codex saying that experiments, to count as valid, must be reproducible. Far from inhibiting creativity, these strictures serve as a spur to academic and industrial R&D alike – even more so today as we all focus on the shared key challenges which our societies expect science to address, in resource efficiencies and sustainability.

We at ABB place our own global R&D in this open arena, making it a major mission to create permanent links between ABB and the global scientific community at universities and institutes. We see opportunities in the deepening interaction of ABB scientists, researchers, engineers and product specialists with leading international science and technology experts.

Through this interaction

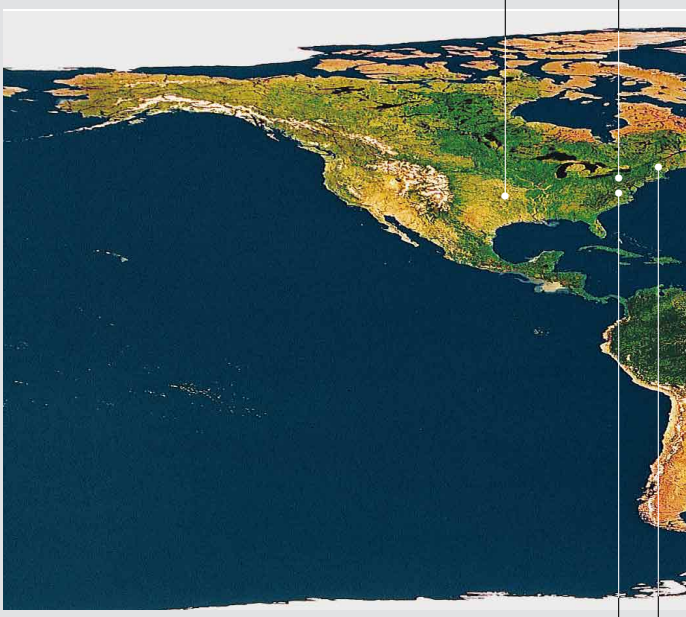
- ABB keeps pace with new and emerging technologies and monitors the development vital to our future.
- ABB develops R&D and business alliances that benefit both ABB and our partners.
- ABB builds a global and truly international network with highly qualified and talented people in different organizations, enabling future recruitment of high-caliber employees.

In addition to scores of such research collaboration, some of which are shown opposite, ABB is also a partner in the Alliance for Global Sustainability, a program developing a global methodology for analyzing the true cost of electrical technologies and their environmental impact. Other partners are the Paul Scherrer Institute at The Federal Institute of Technology in Zurich, the Massachusetts Institute of Technology in Boston, and the University of Tokyo. Additional researchers from three institutes in China and ABB China are scheduled to join the program. And, in 1998, ABB joined the Massachusetts Institute of Technology's (MIT) Leaders for Manufacturing program.

ABB's future strategic framework will include the signing of several international agreements for cooperation with various external scientific groups.

Working with Pennsylvania State University, ABB developed a grinding roll design, which eliminates mill vibration and enhances the wear life of grinding surfaces in coal pulverizers.

ABB supports the American-based Tulsa University Artificial Lift Project (TUALP) in Tulsa, Oklahoma and has gained access to world leading expertise in gas lift technology. Other members of TUALP include Shell, Exxon, Amoco, BP and Chevron.



The ABB Electrical systems Technology Institute (ETI) has entered into a partnership with North Carolina State University's Department of computer Science in the United States. Critical areas include requirement management, prioritization of software features, and training of practicing software engineers.

Extensive cooperation agreements in wide areas of joint interest between Massachusetts Institute of Technology (MIT) and ABB as well as Carnegie Mellon University (CMU) and ABB are currently being developed.

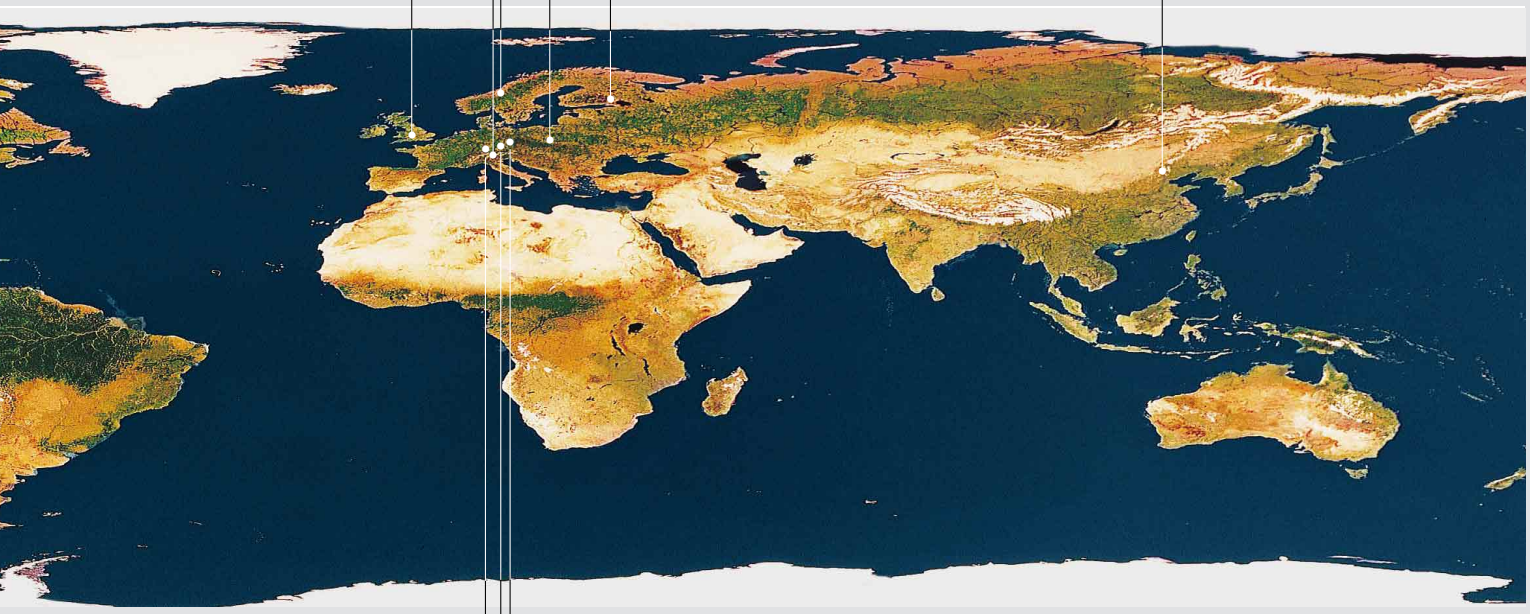
ABB's collaborative efforts also include the support of educational programs, including the establishment of a three year doctorate program in advanced control and optimization in oil and gas production at the University of Trondheim in Norway.

Residues of flue gas cleaning processes in power plants can be further treated and transferred into valuable material for the building industry. ABB cooperates with the University of Mining and Metallurgy in Krakow on these advanced treatment methods.

ABB has for years worked to promote both better environmental conditions and energy production in China, such as the joint research project at Tsinghua University in Beijing to improve the efficiency of industrial boilers in China. The more than 500,000 such boilers in China account for over 30 percent of Chinese coal consumption, and the reduction of pollution is possible with efficient process management.

Our Italian research center is cooperating with the University of Brescia in Italy and the University of Bath in the United Kingdom on special heat transfer problems in innovative motors, with the focus on defining the theoretical base for complex calculations.

ABB operates the Carelian Drives and Motor Center, a bilateral research center, with Lappeenranta University of Technology (LUT) in Finland to research electric machines and drives.



A strategic collaboration with the Swiss Center for Scientific Computing (SCSC) at Manno-Lugano was established in 1994. The SCSC, part of the Swiss Federal Institute of Technology in Zurich, specializes in high-performance computing. This collaboration involves a team of highly skilled scientists and engineers in computational fluid dynamics, working with modern database concepts, advanced visualization techniques and using one of the fastest mainframe computers in the world (NEC SX4). The collaboration now focuses on problems of multi-phase flows with heavy particle loads.

In the electrical engineering domain, ABB has for 10 years engaged in research cooperation with the German Technical University (TU) of Munich, a leading research and educational institution in the area of electrical engineering, specifically with its Institute for High-Voltage and Electrical Apparatus.

ABB and the Technical University of Dresden in Germany work together to compare the most advanced systems like matrix converters and soft switching converters equipped with power electronics. The design of the new ACS 6000 converter family is an example of the results of this collaboration.

With ABB's FlexBell atomizer, particles in the paint are flattened on impact, covering more of the surface and producing color brightness to match that of a spray gun application.

A masterstroke in paint finishing.

A high-quality finish is a 'must' for car makers today. However, the increasing preference of car buyers for a metallic finish creates an added problem: metallic paint has low hiding power and the only way to achieve the required finish has been to use wasteful compressed-air guns to apply the second layer of base coat.

ABB's new FlexLine system, based on robots using the electrostatic FlexBell atomizer, promises to boost paint transfer efficiency by 20 to 30 percent without compromising the quality of the finish.

Electrostatic paint systems force tiny droplets of paint out of an atomizer. The droplets are given a positive electric charge while the car body (or other object to be painted) is given a negative one. The opposing charges attract the droplets onto the car body, where they settle as a smooth film on the surface.

The key to the cost-effectiveness of the new ABB system is the FlexBell atomizer's high transfer efficiency and versatility. This is achieved through the high rotation speed of its turbine – up to 35,000 rpm – which projects the paint particles to the target at 15 meters per second (m/sec) compared to the 1 m/sec of a conventional bell atomizer. This higher velocity, in combination with a reduced spray distance, means the metal particles in the paint are flattened on impact, covering more of the surface and producing color brightness to match that of a spray gun application.

FlexLine can be used for solvent or water-based paints, and for both first and second layer applications of metallic paints. And as the system can use a smaller spray booth, both the initial investment and operating costs are kept low. Paint wasted in color changes is also reduced because of the lower number of atomizers needed per station.

By reducing paint wastage, FlexLine offers car makers the potential to cut costs and environmental impacts significantly.

The fastest picker ever.

The flexibility and speed of industrial robots have revolutionized the packaging process. A wide variety of products can be packaged, and packages can be palletized, speeding up delivery, improving safety, and lowering operating costs. But there has been one persistent limitation – the ability of a robot to detect and reject damaged products consistently and quickly.

ABB engineers have now developed a new kind of robot that overcomes this limitation. The new ABB FlexPicker is the world's fastest pick and place robot. With its vision guided pick and place operations it is a perfect match for modern high-speed production lines. It also has the eyes to recognize a damaged item passing down a modern high-speed production line.

The FlexPicker robot's key design feature is its ability to allow products to be picked one at a time. This is achieved by a unique design of the robot arm, which uses light materials such as carbon fiber-reinforced resin to reduce the moving mass. Combined with its advanced controller software, the robot readily handles 120 picks per minute for products weighing up to a kilogram each. And as each cell along the FlexPicker's conveyor is self-contained, robots or conveyors can easily be added or removed depending on the type of operation.

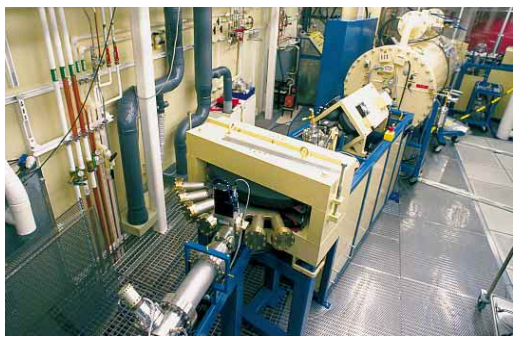
The FlexPicker has a vision guidance system that uses video cameras placed on the production line to capture each product's image. The vision system feeds positional information to the Pickmaster PC-based software. Identifying products passing by at the rate of thousands per minute and comparing them to predefined specifications, the FlexPicker picks and places each acceptable item, while imperfect items are ignored.

The FlexPicker can, for example, arrange the assembly sequence of a variety of chocolates into a chocolate box. The system itself is adaptable and can be configured to handle different combinations of conveyors, robots, and vision systems.

Although FlexPicker can be used in a variety of production lines, ABB will initially introduce the robot into the food industry for sorting and packaging chocolates and cookies. Future applications can include electronic components, pharmaceuticals and hygiene products.

A small silicon carbide chip can handle megawatts of electrical power…

From microchips **to** Powerchips



What if the advantages that microchips bring to millions of computers could be brought on the same scale to millions of industrial machines around the world, making them many times faster, smaller, more efficient and more reliable?

Engineers have long understood the principles behind industrial strength microchips, known as power semiconductors. Like their tiny cousins inside computers, these power semiconductors use the special characteristics of silicon to control the flow of electricity. But there are significant obstacles to making these chips capable of performing in industrial applications.

One is the issue of temperature: semiconductors, as well as metal conductors, resist the flow of electrically charged particles. Moving against this "friction" power is lost as heat, which limits the amount of current that can be passed through the material. At the power levels found in large electrical systems, silicon gets so hot that cooling systems are required. This makes the system large, complicated and expensive.

Silicon can be made a better semiconductor material by adding carbon. But until now, no one has been able to make the resulting silicon carbide into big enough wafers for industrial use. Conventional wafer-making processes have left too many impurities in the material, which reduces its conductivity.

Now ABB researchers, working with scientists at the University of Linköping in Sweden, have come up with a way to commercially manufacture high-power semiconductors of silicon carbide, the first breakthrough in this area. The process uses an extremely strong ion beam to literally blast carbon ions – the particles that conduct electricity – into the wafer.



Stages of the manufacturing of high-power semiconductors of silicon carbide.

Early tests show that the new ABB Powerchips will have the capability to handle up to 10 times more voltage, at working temperatures several hundred degrees higher, and with a few tenths of the energy loss of silicon alone. Because these new Powerchips are smaller and more powerful, they eliminate the need for costly cooling systems.

So far the ABB development remains at a relatively early stage. But already a pilot production line is making silicon carbide power semiconductor chips capable of handling 3,500 volts and 100 to 200 amperes of current. And these will soon be put into commercial operation for the first time when they are incorporated into a 3 megawatt, 10,000 volt power transmission link in Sweden.

Just as silicon allowed computers to be miniaturized, so too will silicon carbide allow drastic size reductions in all kinds of electrical equipment and machinery. Power plants and substations will take up much less space, use less energy, and make less noise. The electric engines in ships and trains could be a quarter of the size they are today. And just as silicon has made advanced computing power affordable to millions of PC users, silicon carbide Powerchips will help make high-efficiency industrial technology commercially available around the world – an important contribution to the achievement of sustainable development.

The Key to Sustainable Development

Sustainable development is a universally recognized goal. At ABB, many of our R&D efforts are focused on contributing to its ultimate achievement.

There is no greater task facing mankind than securing sustainable development, matching the twin needs of economic growth and minimal environmental impact. In emerging markets, more than 2 billion people have little or no access to electricity. Their population growth and rapid industrialization create daunting environmental pressures. At the same time, industrialized nations have great untapped potential to both boost efficiency and lower emissions.

This is a special responsibility for ABB as one of the world's leading suppliers of energy and industrial infrastructure. We see improving the environmental performance of our products and sharing the technology with those who need it most as our key contributions to sustainable development.

We recognize our responsibility in what will require a combined effort for sustainability by government, business, academic and research institutions, non-governmental organizations and the general public.

Making power more efficient and clean

A century ago, coal-fired power plants achieved a fuel efficiency of just three percent – 97 percent of the energy contained in the coal was lost. Four kilograms of coal yielded one kilowatt-hour of electricity. Today, coal-fired power plants achieve efficiencies of 35–40 percent and produce 10 times more electricity with the same amount of fuel, reducing the emission of carbon dioxide (CO_2), a major contributor to global warming. Further solutions have been developed to reduce emissions of particulates of SO_X and NO_X to very low values. ABB is developing coal power technology to boost efficiency above 45 percent, and further slash emissions radically.

Making industry more efficient

Enormous savings are also possible where the electricity is finally used. Electric motors account for 65 percent of the electrical power consumed by industry. They often run wastefully at the same high speed all the time, regardless of workload. ABB variable speed drive technology, by matching speed to work load, cuts a motor's energy consumption by more than half. With this and other more efficient standard industrial equipment, ABB technology makes industry much more energy efficient, saves costs and increases their competitiveness.

In addition to increasing energy efficiency, "end-of-pipe" emission reduction technologies that ABB has pioneered for power plants, is being developed for other industries. The scope of our research, starting with the needs of the metals and pulp and paper sectors, will broaden to other areas in the future.

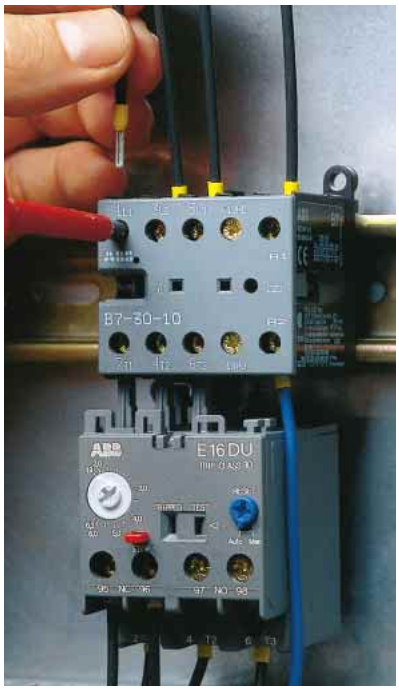
Lifecycle assessment

ABB is using lifecycle assessment (LCA) for ensuring eco-efficient product development. In LCA studies we carefully measure the environmental impacts of our products, from their design and manufacturing stage through their operational lives to recycling or disposal.

We are working together with the Center for Environmental Assessment of Product and Material Systems at Chalmers University of Technology in Gothenburg, Sweden, to develop an LCA data bank that can be shared and meaningfully compared with other similar databases.

Additional information related to ABB and the environment may be found in the 1998 ABB Environmental Management Report, which is available from the addresses on the back cover of this report.

Smarter
electrical motors



By replacing mechanical components with electronic ones using a semiconductor, ABB is able to build intelligence into something as basic as a motor starter. The result is vastly improved efficiency in a much smaller product, and the opening of promising new market possibilities.

ABB engineers tackled the problem of making overload relays in electrical motors more efficient and precise. As their name implies, overload relays serve to protect electric motors from overheating, which results in breakdowns, lost time and expensive repair.

The traditional method of protecting a motor against an overload uses a material called bimetal. Bimetals are made by bonding two different metals together into a single strip. The different metals expand at different rates when heated, so the strip bends. When a motor is too heavily loaded and begins to overheat, this bimetal bending can be used to trigger a shut-off switch.

However, bimetal relays have certain drawbacks. To cover the range of motor sizes used in industry, a large number of different relays are needed. They are also not very precise and sometimes they heat up faster than the motor, cutting off power too soon. They are more maintenance intensive and, because they need so much heat to work, they also take energy out of the system and impair overall efficiency.

To solve these problems, ABB's engineers came up with the idea of using advanced sensors and electronics technology to measure how much current the motor is using. They created a new relay based on an application specific integrated circuit (or ASIC), a semiconductor programmed with a mathematical simulation of a motor being overheated by too much current. When the conditions in the motor (measured by the sensors) match the simulation, the ASIC triggers a small mechanical switch which stops the power supply to the motor.

The result is a "smart" overload relay that requires much less power to work, is far more accurate and smaller. By reducing operating and maintenance costs, they help make ABB's customers more competitive.

Intellectual Property: Protecting our Bright Ideas

As we move from an industrialized society into a knowledge-based one, we are seeing a corresponding shift in the ways companies think about their assets and how they are valued and managed. A company's most important assets are no longer its buildings and manufacturing equipment. They are the creative ideas that can revolutionize a whole industry and bring enormous commercial advantages to those companies who develop them fastest and, just as important, know how to protect them and get the most out of them.

ABB has made the management of intellectual property a key corporate priority. That means not only creating an environment where innovative ideas can flourish, but also knowing how to protect those ideas so that ABB and its many stakeholders get the full benefit from them. Aimed at higher sales and greater profitability, intellectual property management also means a more challenging work environment and the creation of new kinds of knowledge-based jobs.

A case in point: in 1998 a team of ABB engineers made one of the most important technological innovations in the power generation industry when they launched the Powerformer. This completely new kind of electrical generator produces power at voltages previously considered unattainable. In doing so, it eliminates the need for all of the equipment previously required to boost the voltage to the high level required to transmit electricity over long distances. That means that relevant equipment can be made as much as 30 percent smaller and more economical. In a deregulated electricity market, this will make our customers more competitive.

But the innovation doesn't stop there, because what allows the Powerformer to achieve such high voltages is the use of new cable insulation technology. ABB saw the impact this technology could have in other kinds of electrical equipment, such as transformers. So we built a "patent fence" around that innovation, by filing some 200 patent applications, to make sure that ABB gets the most from our engineers' bright idea.

ABB is expanding in other knowledge-rich areas, such as industrial automation. Here the focus of product development is on sophisticated "intelligent" software that monitors and automatically controls complex production systems – like metals refining, chemical processing or paper making – and even integrates operational data with administrative information, such as inventories, orders and deliveries. Intellectual property management will play a central role in our success in this and other areas in the future. Each of our businesses has an intellectual property strategy to ensure we achieve that success.

ABB recognizes how important intellectual property rights are becoming in a broader view of a corporation's total value. The management of intellectual property is in fact becoming a core competence, and we intend to be at the forefront as we head into the knowledge-based global economy of the future.

As we develop measurements to gauge the performance of R&D, the number of patents for every US$ 100 invested in research is one parameter, along with others, such as patent activity and product introduction rates relative to the size and earnings potential of defined customer markets. At ABB, intellectual property management comes in many guises, but with a common mission – stimulating the rate of innovation and securing our bright ideas.


Faculties
Group
Group

A revolution in marine propulsion

Bringing the Advantages Of Outboard Motors to Cruise Ships

Steering a ship has always been done by breaking the flow of water, usually with a rudder. However the ability of a rudder to change a ship's direction is significantly reduced at slow speeds, when a ship, regardless of size, also becomes very sensitive to wind and currents. Which means that when maneuverability is most critical, when docking, for example, or sailing in crowded or restricted sea ways, a ship is actually less maneuvrable because it has to travel slowly.

So, why not adapt the greater efficiency of the swivelling outboard motor, which changes the direction of propeller thrust, to larger vessels? This idea is at the heart of the Azipod® podded propulsion system, developed jointly by ABB and the Kvaerner-Masa shipyard in Finland. This system endows vessels of any size with greater maneuverability, lowers fuel consumption and brings further advantages.

The Azipod unit is actually located outside the hull. It incorporates an alternating current (AC) electric motor driving a fixed pitch propeller, and can turn through 360° on its vertical axis. This movement changes a vessel's direction faster, yet more economically, than a rudder. An Azipod drive also shortens the stopping distance in an emergency, and the ship remains steerable during a "crash-stop" maneuvre.

For ship operators, better maneuverability pays off through shorter times to dock and leave port, and through greater safety, especially in rough weather and in crowded or restricted seaways. Other benefits include lower maintenance needs and reduced exhaust emissions. The unit can be positioned for an optimum wake field for the propeller, which results in less vibration and noise in the ship.

Use of the Azipod propulsion system means savings in weight, space and construction costs. Traditional gearboxes with their lubricating systems and clutches, stern tubes with castings and seals, rudders, steering gear and stern thrusters, all become redundant. As a result, the arrangement of the diesel or gas turbine driven motor in the hull becomes more flexible, making installation and access easier. It also allows shipbuilders to use more of the ship for valuable passenger or cargo space. A new generation of large cruise liners is now being fitted with Azipod systems.


29
28
27
8
25
24
23
22
21
20
19
18
17
7
6
5
3
2

Joint adventures.

Oil and gas wells on the ocean floor require custom-made valves and flow control systems, known as trees, which are located at the end of the subsea wellhead and act like a tap to control the flow from the well.

As conventional trees were aligned vertically from the wellhead, the entire tree had to be removed when any repairs were necessary. So the next step in their development came with the introduction of the horizontal tree, which allows access to the well bore without removing the tree thereby simplifying well operation, service and maintenance.

However, wells have different bore sizes and, because they are at different depths, different pressure and temperature requirements, too. Which means that engineering the trees to fit each well individually is still time-consuming and costly, as is their maintenance and repair.

Now ABB has found a way to design horizontal trees in standardized modules. Because each tree is based on standard parts, the costs of making the components is reduced as are engineering hours, delivery and installation costs. With a full range of these off-the-shelf modules, a wide variety of tailor-made trees can be built to fit most well conditions. But the problem in creating this modular solution was ensuring the integrity of the connections between the components in the extreme conditions found at deepwater wellheads.

Connecting metal to metal securely enough to perform under these conditions required a new metallurgy-based solution. ABB's scientists found that by using the right combination of special metals – base alloy steel and tin-indium – the connecting joints could be squeezed together at extremely high pressure until the metal softened and actually flowed into a seal so strong that it withstands temperatures of more than 100 degrees Celsius and pressures of more than 1,000 bar.

ABB's first horizontal subsea production tree was installed on Hardy's Shasta project in the Gulf of Mexico in 1995. Since then, a further 42 horizontal trees, each based on our customized modular solutions, have been installed around the world. As subsea oil and gas development continues to grow worldwide, the opportunities for ABB's modular horizontal tree technology look promising.

Getting the Chemistry Right

Petrochemicals like ethylene, propylene and styrene are the raw materials for plastics used in everything from soft drink bottles and contact lenses to engine parts and artificial heart valves. In fact, their use is so widespread in modern life that we take them for granted. But making these indispensable compounds efficiently takes sophisticated chemical engineering, and the ability to find new ways to control chemical reactions. ABB engineers have recently developed a technology that will allow chemical companies to make more products using significantly fewer resources.

The focus of their research was catalysis, the technology in which a chemical reaction between two or more compounds can be sped up through interaction with a catalyst. Catalysis lies at the heart of most chemical engineering and nearly 90 percent of all chemical products involve at least one catalytic step during their manufacture.

In industrial applications, catalysts usually are particles in the millimeter range whose size, shape and physical arrangement impact the efficiency of the catalyst. In a conventional catalytic process, chemicals flow through a large vessel called a reactor, which contains the catalytic agent. The problem is that, at the micro-level, the interaction of chemicals with the catalyst is inefficient – not all of the chemicals contact the catalytic particles and much of the catalytic agents' potential activity in the reactor is unused. This results in higher costs and, sometimes, less useful products and waste.

Now a multinational team of ABB chemical engineers working with top university scientists has invented a system that improves reactor and catalyst management. ABB has engineered a catalyst technology that effectively uses catalyst particles on a much smaller scale than currently applied in industry. The Micro-Engineered Catalyst (MEC) technology allows the catalyst system to be tailored for optimum flow patterns resulting in more efficient designs that make more product using much less catalytic material.

The MEC technology – already tested on a semi-commercial demonstration scale – will allow industrial catalytic systems to operate at levels of efficiency previously thought unattainable. This will allow ABB's customers to operate in a more sustainable way – more competitively and, many times, with less impact on the environment.

And there will be major benefits for ABB itself. It is estimated that in petrochemical and refinery applications each one per cent share of the world catalyst market is worth US$ 75 million in annual revenues including license and other fees. And since catalysis is the core of a number of key environmental technologies, like cutting emissions from factories and power stations, ABB will also be able to use the MEC system in some of the plants, making them cleaner and more efficient.

Driving motors to greater efficiency

Electric motors are used in almost every industrial process worldwide, and account for around 65 percent of all electrical energy consumed by industry. Making these motors more efficient therefore offers huge energy savings.

Standard motors have two main weaknesses – starting performance and smooth speed control. Adding a variable-speed drive (VSD) solves both these problems. By starting the motor softly with low starting current and controlling and adjusting speed to suit the application, a VSD can deliver major energy savings (typically up to 50 per cent) in addition to other benefits such as lower maintenance, higher production quality and greater productivity. Yet VSDs only account for less than 10 percent of the market today.

One main reason for this is that up to now, at high horsepower most VSDs had to be custom engineered for each motor. So ABB developed the ACS 1000, a prefabricated standard drive suitable for most medium-voltage applications in many industrial sectors – even highly demanding extruders, mills, mixers and crushers.

Employing recent ABB technological innovations such as the Integrated Gate Commutated Thyristor (IGCT), Direct Torque Control (DTC) and a new low-loss sine-wave filter, the ACS 1000 requires fewer components, is much more reliable, and is the smallest in its class. This is especially important in the offshore sector, where space can be a major cost factor. It can also easily be retrofitted in industrial plants where space is at a premium.

The ACS 1000 delivers more than substantial energy cost savings. By using standard components and software tools, the ACS 1000 cuts start up time and cost dramatically. On-site installation and commissioning typically take just 1 to 2 days, compared with up to 10 days for engineered drives, so plant shutdowns are held to a minimum. Delivery times are also short – typically 6 to 8 weeks.

Taking the Heat

Measuring the dimensions of red-hot steel as it goes through a mill at a speed up to 100 meters per second has so far defied both man and machine. ABB has developed an elegant solution that delivers the data and survives the harshest of industrial environments.

In an extremely competitive global industry, steel makers cannot afford to be the least bit wasteful. In the steel rod and bar business, for example, every meter of steel that comes out of a mill has to meet exacting size requirements of wire and steel bolt manufacturers. If it doesn't, it's scrap, and that costs money.

But measuring red-hot steel as it emerges from the mill stand at some 100 meters per second has proven rather difficult. Temperatures in excess of 1,000 degrees Celsius, spray from boiling water and dirt have until now made it impossible for either human inspectors or electronic controls to get anywhere near the product, let alone measure its dimensions. As a result, the worldwide steel industry has had to live with an average waste rate of two percent.

After eight years of research and testing, ABB has developed the first commercial solution to the problem, a way to accurately measure steel dimensions as it goes through the mill and instantly adjust mill operation to make corrections. The key is designing a measuring device containing no moving parts, optical equipment or any other temperature-sensitive components.

ABB's Interstand Dimension Control (IDC) system uses a magnetic pulse to measure the steel's dimensions. The device is shaped like a U and creates a magnetic field in the gap between its two arms. As with any magnetic field, this one is distorted as steel moves through it. The more steel passing through, the bigger the distortion. The IDC system automatically adjusts the mechanical set-up of the mill based on the output from the U-shaped measuring device. As a result, mill scrap can be cut in half and much less time is required to recalibrate the mill to make new products with different specifications.

The IDC is the first step towards designing a fully-automated mill. By integrating the data generated by the IDC with other operational information and then linking it into a mill-wide process control system such as ABB's Advant system, steel mills could become self-monitoring and self-correcting.

Using Information Technology to Redefine ABB

Information technology (IT) is redefining ABB both inside and out. IT allows our people to work together better, pooling in real time their expertise from many technical specialties and business backgrounds to focus on specific customer needs.

More profoundly, IT is changing the nature of our core activities. ABB is using information technology to move beyond creating mechanically engineered products to developing proprietary software that controls all kinds of industrial processes. We create virtual team environments to speed up the rate of innovation. Emerging IT-enhanced business processes such as electronic commerce are helping us to exchange information more effectively with our customers and suppliers. ABB is using IT to provide its people in the field with real-time customer, inventory and delivery information. Mastering IT is key to mastering the knowledge-based business of tomorrow.

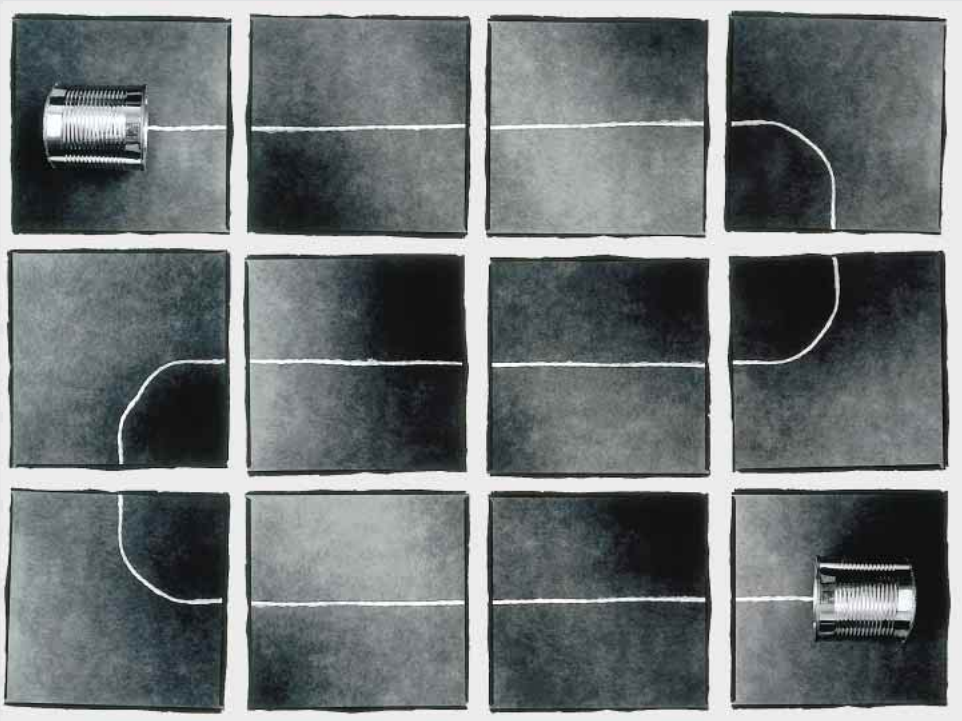
Information Technology at work

Internet product configuration and sales:
NetPrice is an Internet-based application used by ABB sales engineers in the field to respond rapidly to customer requests for new or replacement distribution transformers. By accessing an on-line product catalog, the engineer can see whether the required item is in stock, or whether a different product can be configured to meet the customer's needs. When an order is placed via NetPrice it can be tracked over the Internet right up to delivery. NetPrice will eventually connect to ABB's "transformer factory of the future," a fully automatic robotized manufacturing facility. NetPrice will manage the entire process from order engineering to product delivery, reducing delivery lead times by a factor of 20.

Integrated engineering environments:
Today ABB's worldclass industrial gas turbine blades are designed faster and more efficiently using an advanced computer simulation-based engineering tool called Turbine Design System (TDS). TDS enables engineers to design and simulate the entire lifecycle of a turbine blade from initial requirements, to performance analysis and manufacturing. At each step, they can monitor the various forces at work on the blade and, where necessary, modify the design for improved performance. A complete engineering design cycle that used to take six to nine months can now be done in a matter of weeks.

Logistics and supply management:
The ABB Worldwide Logistics System (WWLS) is an Internet-based application that gives ABB's suppliers, packers and forwarders an inexpensive and totally transparent overview of ABB's global logistics operations. It provides instant updates on material shipments to construction sites worldwide. WWLS eliminates the inherent delays and inaccuracies of the previous paper and diskette based system. By allowing site managers to track deliveries more precisely, work can be scheduled more efficiently.

Service business:
IT has been critical to the success of ABB's aggressive expansion of its service business in recent years. For example, over one million technical drawings of



“Over one million technical drawings of the industrial boiler facilities ABB manages worldwide, have been scanned. Accessible online over the Internet, they enable ABB service engineers to give customers cost estimates and a service schedule within minutes, compared with the weeks required to go through paper drawings.”

the industrial boiler facilities ABB manages worldwide, have been scanned. Accessible online over the Internet, they enable ABB service engineers to give customers cost estimates and a service schedule within minutes, compared with the weeks required to go through paper drawings.

ABB’s IT Future

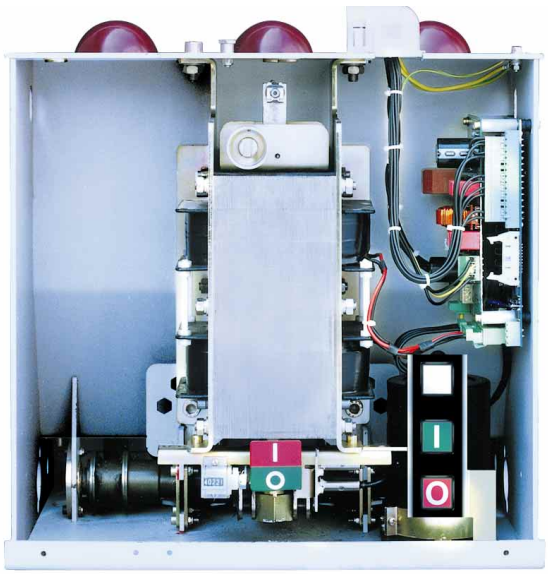
ABB’s vision is to allow designers, development engineers or any member of a product development or project execution team to collaborate on the same solution, no matter where in the world they are. Via the Internet or other IT-based communication tools, these teams will simultaneously view and manipulate 3D product models under design. They will perform simulations interactively and discuss the results and design changes via video/audio links. This process of global real-time collaboration will not only improve product design, but will also make better use of resources. Work on design projects can continue around the clock, with engineers in one time zone handing over to their colleagues in another part of the world just beginning their day.

Similarly, customers can share project data, check parts supply, discuss design or production or review assembly or operational issues.

The use of information technology to design, produce, service and maintain ABB products and systems will make us even faster, further boost our quality and, ultimately, make our customers more competitive.

The maintenance-free circuit breaker

ABB's new solution is a step towards "synchronized switching" in distribution networks.



Maintaining a safe and reliable supply of electricity into towns and large industrial installations requires specialized equipment that can control the flow of power into different parts of the grid and protect the grid in the event of an emergency, such as a short circuit caused by a lightning strike.

That is the role of medium-voltage circuit breakers. As their name implies, circuit breakers are able to very quickly break apart the contacts in a switch should the voltage or current suddenly change. Located in substations, medium-voltage circuit breakers house two metal contacts inside a closed cylinder. The contacts are insulated inside the cylinder either by a vacuum or some other suitable medium, such as insulating gas. Traditionally, the contacts are held together by a complex mechanical construction involving heavy-duty springs, mechanical latches, and position indicators. The contacts are brought together by an operator who physically "loads" the spring by turning a large lever. Changes to the current trigger a mechanism that releases the spring and contacts snap apart. Because there are so many moving parts, however, the system is maintenance intensive and difficult to control.

ABB has developed a new product, the VM1 vacuum circuit breaker, that replaces the spring-driven system with what is called a magnetic actuator. In a magnetic actuator, a magnetic lever that can pull the contacts apart is connected to a powerful electromagnet. When a current surge flows through the electromagnet, its magnetic field becomes so strong that it repels the magnetic lever attached to the contacts. This mechanical force pulls the contacts apart.

The system has several advantages. One is that the number of moving parts is reduced, as is wear and tear, which means less maintenance and repair and greater reliability. Also, the breaker can be reset remotely by running an opposite current through the electromagnet, eliminating the need for an operator to travel to the breaker and physically "reload" it. Should a system operator wish to close the switch again quickly – for example, to reroute power through a different part of the grid – the VM1 can still be operated for up to 200 seconds, even if there is a complete failure of auxiliary power.

Because it's easier to control, ABB's new solution is a step towards "synchronized switching," in which the opening and closing of all the breakers in the system can be perfectly coordinated. This would significantly improve power quality and reduce stress on the whole system.

From complex systems to simple products

Designers of electrical substations face the same problem once faced by personal computer makers – how can you simplify and standardize the design so that customers can just plug in new components and use them right away, without having to make elaborate adjustments first…

Even among engineers, designing high-voltage electrical substations has often been considered something of a mystery. Each one has been engineered from the ground up, with a bewildering array of circuit breakers, arresters, voltage converters, transformers, and dozens of other components, all sewn together into a one-of-a-kind installation. Replacement parts also have to be custom-engineered, making service and maintenance costly and time-consuming.

Until now advances in substation technology have centered on improving individual parts of the system. But as the system continued to grow in complexity, ABB engineers began to ask whether there wasn't a completely different way to think about substation design. With deregulation and privatization turning up the competitive pressures for their customers, one alternative seemed to be to drop the idea of a substation as a unique and complex system and to think of it instead as a single, self-contained product.

To accomplish that, however, ways had to be found to reduce the number of pieces in the puzzle, and to shrink individual components. ABB researchers based in Zurich, Switzerland, focused on applying new technologies in sensoring and system control to reduce or, in some cases, eliminate bulky conventional sensoring and switching systems. Basically, by allowing substation operators to see exactly where problems were likely to occur, many of the shut-off switches and other protection and control systems could be done away with. At the same time, the data collection systems were shifted to fiber-optic cable instead of copper wiring, drastically reducing the amount of cabling needed to control the station.

By reducing the number of components and cables, ABB was able to design a "Plug and Switch Substation" (PASS) that offers customers easy installation and immediate functionality in a much smaller space. The concept can also be applied to substation components, so that existing stations can be modernized without having to replace the whole system. With the generation of electrical substations built in the 1950s and 1960s now needing upgrades or replacement, ABB's PASS system promises to bring greater flexibility and economy to power customers around the world.

Managing pressure

In subsea oil and gas developments, pipeline costs account for a substantial part of the total budget. This is because production flowlines from the well-head to the offshore processing or storage facilities are normally built to withstand the high wellhead "shut-in" pressure, even though under normal operating conditions the pipeline experiences much lower pressure. The costs to build this pressure "buffer" into the system can jeopardize the economic feasibility of such projects.

To get around this problem, ABB has developed what it calls the High Integrity Pipeline Protection System (HIPPS). It works by safely downrating the pipeline pressure, so the economics of subsea oil and gas development – especially for high-pressure fields – can be greatly improved.

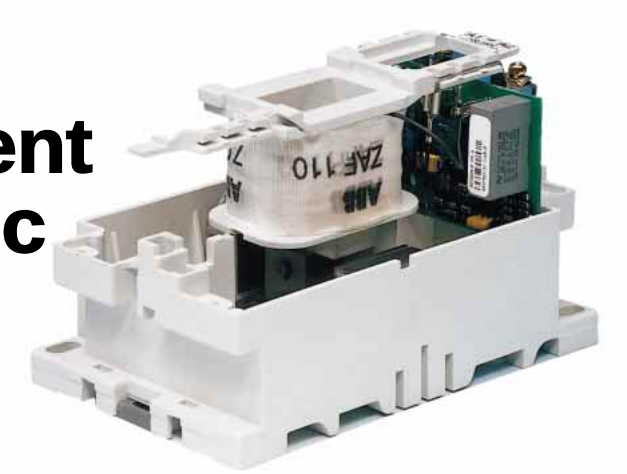
By automatically (and continuously) monitoring the pipeline pressure, HIPPS instantaneously closes the pipeline when the pressure rises to a preset level. This is done using a choke to maintain a continuous pressure drop, with barrier valves which close if the pressure increases, managed by a control module or 'trigger unit' which activates the protection system.

Choke reliability – the key to HIPPS' effectiveness – was achieved by upgrading the sealing systems to metal-to-metal joints, which ensure it will withstand the high pressure and high temperature typical of subsea oil and gas development.

HIPPS' modular structure means it can be equipped with a variety of valve and control systems to suit a wide range of operating conditions. In all, ABB's HIPPS and its associated concept evaluation soft-ware, which can compare the grade of material needed for any given pipeline, can achieve project capital cost savings of up to 30 percent.

HIPPS is a complete, flexible, modularized and safe system. A full scale working prototype has been built and successfully tested, and the system is now qualified and ready for the market.

AF The intelligent electromagnetic contactor



Electromagnetic contactors are small, simple, robust and very versatile devices that control the operation of a wide range of low-voltage electrical equipment – like small industrial motors – by making or breaking an electrical current. Problems can arise, however, if the contactor and the equipment it is controlling share a common power source.

If there's a sudden current surge, for example, conventional contactors can malfunction. The result is at best a loss of control and predictability in the system, at worst serious damage to the equipment the contactor is designed to control. An additional limitation is that contactors operate in a narrow range of voltages and currents, so you need different contactors for the individual electrical systems in different countries around the world. ABB's solution is to use new semiconductor technology to build intelligence into the small space available in a contactor. The result is greater control and reliability, longer contactor life and a significant increase in efficiency.

Conventional contactors work by running an electrical current through a coil around a movable magnet. If the current is sufficiently high, it creates a magnetic filed strong enough to move the magnet and compress a spring that pulls the contacts together. To ensure reliability, however, conventional contactors can only be used within narrow control voltages. The voltage has to be high enough to guarantee that the contacts close properly, but not so high that it causes the closing contacts to bounce and generate extra heat, which reduces the contactor's lifetime.

ABB has now developed a new type of intelligent electromagnetic contactor to overcome this limitation. The so-called "AF" contactor achieves this by replacing the spring mechanism with an application-specific integrated circuit (ASIC). Working together with monitoring and control devices located at various parts of the electrical system, the ASIC electronically controls voltage monitoring, current regulation and magnet position monitoring.

Because its ASIC chip is programmable, the AF contactor can operate on a far wider range of voltages. Consequently, far fewer product variations are necessary to cover all the different voltages world-wide. ABB estimates the AF contactor can reduce the number of product variants for each size of contactor to four compared with 60 today – a significant advantage to customers who build equipment for different markets and different fields of application.

And, thanks to the electronics, the AF contactor consumes around one-third of the power of a conventional equivalent contactor – which means lower energy cost and environment impacts. ABB has already successfully introduced electronic control in contactors from 50 to 110 amperes, and is now developing the technology for contactors up to 750 amperes.

Corporate Research Programs

Corporate R&D programs deal with the technology foundation of ABB across all its core competencies. To maintain our business leadership we continously develop future technologies through a globally managed network of corporate programs. The network serves as a bridge between ABB's business areas and the external science and technology

Program	Automation Technologies	Electronics, Sensors, Communication and Instrumentation	Electric Power Technologies	Power Generation Technologies
Core Competencies	Control strategies Human machine interaction Embedded software Mechatronics Model-based monitoring, Diagnostics, control and design	ASIC design and MEMS Field bus technology, wireless and power line communications Fiber optics and sensors Machine vision	Electrical systems Engineering Insulation technology Current conduction, limitation and interruption Electromagnetic computations and models	Combustion and fluid dynamics High temperature materials

Examples

Early Fault Detection and Prevention (EFDP)

ISOMAX series low-voltage circuit breakers

The EFDP project sought to develop a new electronic protective relay for ABB's low-voltage circuit breakers (CBs), comprising very fast fault detection and guaranteed selectivity.

Information on both the current value and its derivative is used to safely detect an evolving short circuit at an early stage. Proper noise filtering is important to prevent short noise spikes opening the CB.

The design has been implemented as an Application Specific Integrated Circuit (ASIC), which is thoroughly tested in system configuration with short circuit currents up to 66 kA.

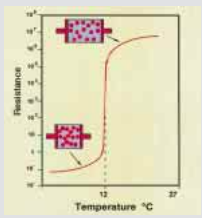
Fiber-Optics Technology for High-Voltage Current Sensors

New optical current sensor (in scale to a conventional 380 kV instrument transformer)

Instrument transformers reduce high voltage (HV) so it can be measured more easily. The large-voltage step down, however, requires significant space for insulation.

ABB's "full fiber" solution is technically far superior to other solutions. The new fiber-optic current sensor exploits the magneto-optic, or Faraday, effect, in a coil of optical fiber around the current-carrying conductor. The technology breakthrough is achieved by replacing the coating of the sensing fiber by placing it in a gas-filled capillary.

Resettable Fuse for Power Applications

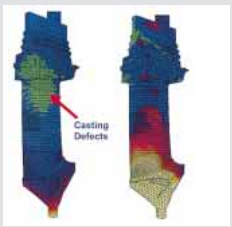


A small increase in temperatures separates conducting particles and increases resistivity 100 million times

Fuses and circuit breakers are widely used today to limit and interrupt fault currents in low-voltage power applications,

Fuses only work for a single shot. Circuit breakers are multi-operation devices, but let more current pass before interruption. A new resettable fuse based on new polymeric PTC current sensitive materials has been demonstrated to be feasible. It combines the advantage of fuses with the advantage of circuit breakers: a fast current limitation with a repetitive and reliable operation.

Innovative Casting Technologies for Single Crystal Blading



Casting defects highlighted in the old process have been virtually eliminated with the new ABB process

The maximum size for high-efficiency, single crystal superalloy turbine blades is limited by the temperature gradient that can be maintained during solidification in the casting mold. Tuning the cooling effects to the solidification profile for each component requires expertise in fluid dynamics, heat transfer and casting simulation. A newly developed high temperature gradient casting technique reduces the production time and extends the economic size range of single crystal blades. The "Gas Cooled Casting" (GCC) process is currently being used to make large blades for our latest gas turbines.

communities. ABB's Corporate Research has nine programs covering the company's core competencies and technologies.

Power Electronics

Power semiconductor materials and devices

Electrical power conversion

Electrical motor technologies

Oil, Gas and Petrochemicals

Separation technology

Pressure containment

Lifecycle system design

Flow assurance

Offshore materials

Catalysts and reaction engineering

Environmental Technologies

Gas absorption

Particulate removal

Water treatment

By-product conversion and handling

Mechanics

Noise and vibration control

Grinding

Lightweight design

Bearing technology

Smart materials

Engineering Systems

Integrated engineering environments

Simulation-based design and analysis

High-performance computing

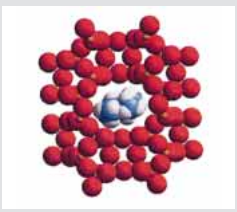
Compact Power Conversion

Silicon Carbide clean room

Power electronics systems are today being used in many areas in society to handle and control the flow of electricity.

ABB has developed new technologies for high efficiency silicone based semi-conductors (IGBT) as well as novel concepts to package these into extremely compact power modules with a high degree of functionality and reliability. These modules will drastically reduce the design time needed for new power converters and significantly shorten the time to market for new components and systems.

Development of Breakthrough Zeolite Catalyst

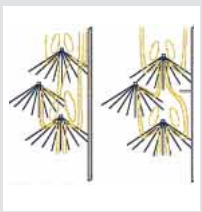


Zeolite structure with an adsorbed reactant molecule

Most chemical processes employ catalysts to speed the reaction. A family of catalysts, called zeolites, is often used to convert petrochemicals or to produce gasoline from oil (cracking).

ABB has developed a breakthrough synthesis process, designed to improve zeolite performance by creating ultra-small zeolite crystals in a highly accessible matrix. The new process improves performance enabling smaller reactors, increased chemical selectivity, ultimately reducing chemical plant capital and operating costs. In addition, the synthesis reduces zeolite manufacturing cost.

PEP: Up to 30 percent Reduction in Power Consumption of WFGD



Flow pattern within WFGD towers with and without PEP

Wet flue-gas desulfurization (WFGD) in coal-fired boilers is the dominant method of achieving compliance with SO_2 emission regulations. ABB has developed a new concept to enhance removal efficiency. Using patented guide vanes along the wall, Performance Enhancement Plates (PEPs) block gas to prevent it passing untreated and redistribute the scrubbing liquid back into the spray zone. SO_2 removal efficiency has been increased from 89 to 97 percent and power consumption lowered by reducing the level of amount of liquid required to absorb the SO_2.

Compact Silencer System (CSS)

CSS prototype for marine applications

ABB has patented a new type of noise silencer system for use on ship engines and in gas turbines.

Recognizing that all exhaust system parts must function from an acoustic *and* fluid dynamic point of view, the Compact Silencer System (CSS) is the acoustic equivalent of a stop band filter. CSS gives the same damping as a standard application, and improved low frequency for the gas turbine base. The system boosts low frequency damping for the gas turbine case by up to 10 dB, an improvement only possible in standard designs with a large pressure drop increase.

Steam Turbines Design-to-Manufacturing Time Reduced by 75 percent

Turbine blades

ABB has developed a simulation-based design and analysis environment allowing the time from initial design to manufacturing of steam turbine blades to be reduced by 75 percent. In addition, it significantly reduces the time to market for new steam turbines, which allows for many more design iterations and optimization, resulting in higher efficiency and quality components. The advanced steam turbine design system is part of ABB's efforts to develop common engineering design and analysis platform, useful across the entire spectrum of ABB's products.

As a major force in global markets, the ABB Power Generation segment provides a complete offering: turnkey power plants and components, steam plants and combined-cycle power plants, nuclear and hydro plants, combined heat and power plants, district heating installations, and air pollution control systems. Retrofit, maintenance and complete service round out the segment's business.

Technology opportunities

Customers need plants with lowest first cost and shortest delivery time, highest guaranteed performance and reliability in addition to lowest life-cycle cost. In this challenging business environment, Power Generation has a number of significant and promising technology opportunities.

A strong shift from coal- and oil-fired power plants to more efficient and more environmentally compatible gas turbine combined-cycle plants.

The market for new coal-fired steam power plants has increasingly moved to Asia, especially India and China, where ABB is firmly established.

Significant life extension, re-powering and service opportunities are being created by the high age of the installed base of coal-fired plants in the developed countries.

Deregulation in most countries is resulting in the growth of Independent Power Producers and "merchant" plant projects and in the fast development of smaller distributed power generation installations.

To meet these trends ABB's Power Generation is following a clear technology vision. We are focusing our resources in the following areas and aim to develop:

- the most advanced gas turbine combined-cycle power plant
- the most cost-effective coal-fired plant with the highest thermal efficiency and the lowest emissions possible
- distributed power generation plants from 100 kilowatts (kW) to 2 megawatts (MW)
- the high-voltage generator ("Powerformer") that eliminates the need for step-up transformers.

R&D focus

- Process and product improvements of our advanced Circulating Fluidized Bed Technology (FlexTech) by introducing compact inverted cyclone separators, the steam reactivation process for enhanced limestone utilization in SO_2 removal – all contributing to weight and size reductions of 30–40 percent, and substantially lower operation costs.
- Highly efficient and compact large steam turbine frame with 40 percent fewer stages than conventional units. In the size range of 100 MW and smaller, we have developed a new family of very flexible, modular industrial steam turbines, called the ATP family.
- Advanced air-cooled generator technology up to 310 megavolt-amperes (MVA) with efficiencies of 98.85 percent, and very high reliability.
- NID (Novel Integrated Desulfurization) technology with installed cost much lower than conventional flue gas desulfurization.
- Reheat technology with sequential combustion for our gas turbine machines towards higher output and efficiency. The GT24B (60Hertz [HZ]) and GT26B (50Hz) machines with 183 MW and 265 MW generation capacity, respectively, in the single cycle mode will go into commercial operation mid-1999.
- Combined heat and power plants with an ambitious product development program.

R&D in Power Transmission

The electricity business worldwide is presently undergoing some of the most profound changes seen in the history of industry. In the past, the development of power systems was determined by technology being fitted to customers' demand for reliability. Today, economic and environmental demands are growing, and at the same time new technologies create possibilities to fulfil many of these demands. This shift is substantially altering the operating environment of the electric power industry.

Technology opportunities

In privatizing and deregulating power transmission markets, utilities are abandoning their traditional product-oriented buying pattern and now focus mainly on cost-optimized system solutions and turnkey business.

The most important technological development is taking place in the field of secondary equipment and power electronics. Together with the introduction of fiber optics, microelectronics is now profoundly reforming the traditional structure of power transmission systems.

Conventional hardwired electromechanical control systems are being replaced by microprocessors with optical connections. New combinations of novel solutions for all primary high-voltage switching and measuring functions, together with integration of smart electronics into the primary equipment, are revolutionizing the basic construction of substations.

We create completely new opportunities in optimizing substation and network configurations as well as system operation.

We aim to capture the opportunities created by the fundamental changes in our markets, to develop innovative approaches that further enhance our position as the global trend setter in transmission technologies.

R&D focus

Ongoing strategic R&D investment in the Transmission Segment has led to a stream of innovation in products and systems. Today, more than 50 percent of our products are younger than five years.

ABB engineers developed a series of new integrated modules that are standardized for easy installation and are compatible with existing equipment. These "Plug and Play" modules are for use in system solutions such as Intelligent Air Insulated Substations (AIS), Smart Gas Insulated Substations (GIS) and Plug-and-Switch Systems (PASS) for substations with integrated electronics and sensors for control, protection, monitoring and diagnostics.

Another major technology step has been the introduction of HVDC (High-Voltage Direct Current) Light, offering economical and environmental improvements in a wide range of long-distance DC transmission.

On our standard products such as breakers, bushings, disconnectors, surge arresters, transformers and line suspension insulators, we are increasingly replacing old ceramic insulators by polymeric material. Today most of our products have a polymer insulation version, making them maintenance free and explosion safe.

Power Distribution serves customers who bring electricity from high-voltage substations to the end user, with substations to lower voltages further, and power line and cable infrastructure to deliver lower-voltage electricity to customers. We provide all the systems and equipment needed to bring the power from the line into factories, homes and other buildings.

Deregulation of the electricity supply industry is changing the fragmented market of power distribution. Partial solutions are offered by many small companies. ABB, as a total solution supplier, can utilize these trends to seize unique opportunities. Our aim is to play a key role in electrification projects – both new or retrofit – not just for urban utilities but also rural areas and in industry.

Technology opportunities

The key opportunities increasingly lie in harnessing our capabilities to combine and integrate primary equipment into an automated total system solution, including control, protection, fault location, automatic meter reading, communication, scada systems – all at a competitive cost.

Using the combined R&D and engineering resources of ABB, we can promote further innovation in distribution markets and set new standards in a rapidly changing area.

R&D focus

We are developing flexible optimization tools, with features assisting the long-term load forecast in given areas, and we can offer customers a distribution infrastructure that optimizes cost from both an investment and an operational viewpoint.

ABB is also focusing on the development of complete feeder automation solutions for medium-voltage networks and on low-voltage distribution systems interfacing with the distribution control center and the local area network. Feeder Automation is based on flexible standardized modules comprising Remote Terminal Units, Circuit Switchers, Sectionalizers, each equipped with integrated smart motors, sensors, electronics, controls and communication interfaces.

All of these blocks are interconnected by a system of scalable and adaptable communication media and are remote controlled and monitored by a PC in a distribution control room. Information Technology is used for energy management, automated metering and load management.

In product development for medium-voltage substations, a highlight has been the introduction of magnetic actuators in combination with vacuum breakers as a substitute for conventional mechanical spring drives.

The Automation Segment is one of the largest global suppliers of automation solutions. Our customers include utilities, the metals, pulp and paper, marine, chemicals, and petroleum industries, pharmaceuticals, manufacturers of consumer products, and the automotive industry. Following the acquisition of Elsag-Bailey, ABB is either No.1 or No. 2 in most of our activities.

Our solutions portfolio covers most process industry and manufacturing applications. Our broad product portfolio ranges from sensors, actuators, motors/machines, drives, protection to PLCs, OCS, QCS, SCADA, MES, advanced control and simulation, plant optimization and ERP integration.

Technology opportunities

With our broad product portfolio, solution capability and industry-focused organization, ABB is uniquely positioned to provide the productivity advantages needed in today's dynamic business climate, where:

- more pressure than ever is put on manufacturers to increase productivity, flexibility, and profitability of their operations
- business is changing rapidly; product lines are constantly being expanded, altered, and improved
- products have shorter lifecycles and more variations
- demand is increasing on quality, cost and environmental impact.

Our technology vision is to:

- increase the value of our products and solutions based on continuous technological innovation
- provide world class scaleable "plug and play" products for all automation needs
- provide a consistent user-plant interaction and navigation environment, fully integrating the engineering, operation, planning, maintenance, asset management aspects throughout the plant life cycle
- fully integrate our intelligent field devices through field buses, process buses and wireless communication
- be based on open standards and technologies to provide easy integration of other vendors' components
- provide automation as an integral part of our customers' business process and IT environment
- expand the concept of automation to "Industrial IT", addressing not only the operational aspects, from the field equipment to the business integration, but also plant lifecycle aspects, from planning and design to continuous improvement and asset optimization

R&D focus

Examples of our R&D focus in key products and solutions technologies:

- Software technologies: NT/CE, COM/DCOM, OPC, Internet, Web
- Hardware for intelligence: electronics, ASICs
- Communication: Networks, field bus and wireless
- Advanced control and simulation
- Sensors: wide range – micro sensors to analytical instruments
- Computational methods: simulation and analysis, CFD
- Power electronics: IGBTs, IGCTs, Silicon carbide
- Mechanics and mechatronics
- Protection of electrical networks
- Selected materials: insulation, composites, and plastics.

PLC	=	Programmable Logic Controller
OCS	=	Open Control System
QCS	=	Quality Control System
SCADA	=	Supervision Control And Data Acquisition
ERP	=	Enterprise Resource Planning
MES	=	Manufacturing Execution System

The Oil, Gas and Petrochemicals Segment serves customers in the exploration, extraction and refining of oil and gas, the vital energy resources. We build subsea and floating production systems, refineries and petrochemical plants. We manufacture pressure containing equipment, and modify and maintain entire offshore and onshore facilities.

The Oil, Gas and Petrochemicals Segment has launched a number of technological programs to capture the opportunities in our vibrant markets, aiming to:

- Establish a superior portfolio of process technologies
- Achieve global leadership position in the subsea market
- Become a major player in floating production
- Develop environmentally friendly production technologies
- Expand after-market services

Technology opportunities

In the upstream, or exploration, market, our technology programs aim to increase both economical and environmental performance for our customers. Our current development programs relate mainly to subsea production and processing. We see opportunities in:

- Subsea power distribution
- Novel separation systems
- Capital drilling equipment
- Downhole instrumentation & control
- Water and gas treatment
- Flow assurance

In the global downstream markets, ABB Lummus Global Technologies serves the refining and petrochemical industries.

- We develop and license process technologies, catalysts and proprietary equipment
- We aim at securing advanced engineering and construction projects through proprietary technology positions

To explore our technology opportunities, in the upstream area we are focusing on a number of core competencies:

- Process technologies
- Production chemistry
- Pressure-containing equipment
- Automation and control systems
- Electronics and instrumentation
- Materials
- Mechanical design
- Lifecycle optimized systems

In downstream technology, our vision is to achieve leadership through the breadth of our technology portfolio and the technical superiority of our individual process technologies. We pursue an innovative approach to technology and growth through our own development, partnerships and acquisitions.

R&D focus

Upstream: Subsea processing systems, including power distribution systems; deepwater subsea production systems; next generation topside main separation system; new deepwater, moored, turret-less floater, downhole control and instrumentation, deepwater capital drilling and workover systems, environmentally friendly processing systems, oilfield composites (risers and structures); flow assurance methodologies for prediction, monitoring and mitigation of problems in the flowing of produced fluid.

Downstream: Basic petrochemicals; catalytic distillation (CD) hydrogenations for ethylene; ethylene heater designs; catalytic routes to olefins; petroleum refining; solid acid gasoline alkylation process; CD hydro desulfurization; petrochemicals and chemical intermediates; advanced zeolite catalyst; styrene reactor concepts; enabling catalyst technologies; micro-engineered catalysts; thin layered catalysts.

This ABB segment manufactures key components for electrical installations and heating, ventilation and air-conditioning systems, industrial applications and machine building. We design and build complete installations for industrial and commercial buildings. We operate and maintain building systems. We also offer service, maintenance and repair of industrial equipment and processes, including ABB products and systems as well as those of other other manufacturers.

This business segement serves a wide variety of customers, from large multinationals to small local businesses. It is a market with an increasing demand for modern, cost-effective and energy efficient installations and systems, both for new construction and for upgrading existing installations.

Technology opportunities

Increasingly, customers want to buy complete solutions rather than single products. The service content of these solutions is often very high, including not only design and installation but also preventive maintenance, repairs and even operation of facilities.

Air handling

Our strategy calls for providing high performance air handling equipment with low environmental impact (high efficiency), noise reduction and optimized conditioning of air and controlled distribution of air flows.

Service

We aim to secure less down time and higher efficiency, for processes, machines, and equipment. Automation, diagnostic equipment and maintenance methodologies improves overall equipment effectiveness.

Products and Systems

We deliver better monitoring (more accurate, more process data) and process control using autonomous intelligent devices integrated into a distributed system, that is easy to install and cost effective.

R&D focus

Air handling

- Acoustics/active noise control to provide low noise products
- composite material for higher performance fans
- computational methods and simulation for more efficient design process
- applied aerodynamics/applied heat transfer for efficient climate control and air movement in rooms.

Service

- Information Technologies with a focus on knowledge management.

Low-Voltage Products and Systems

- Current sensing to measure and control electrical current
- Arc behavior to control current interruption
- Electronics using of ASICs, microprocessors, firmware
- Polymer material in current limitation
- Plastics and contact material for switching higher loads, more compact product design, higher endurance, and more environmentally friendly products.

Technology Management

Group Management	
Senior Corporate Officer Group R&D and Technology	Markus Bayegan
Corporate Programs	Gernot Gessinger
Technology Evaluation	Klaus Ragaller
High Impact Projects	Friedrich Pinnekamp
Intellectual Properties	Katarina Lundblad Vannesjö
Technology Reviews	Even Bakke

Segment Technology	
Power Generation	Tony Kaiser
Power Transmission	Georg Schett
Power Distribution	Georg Schett
Automation	Lars Krantz
Oil, Gas and Petrochemicals	Rune Stroemquist
Products and Contracting	Jürgen Fuchs

Corporate Programs	
Automation Technologies	Peter Terwiesch
Electronics, Sensors, Communication and Instrumentation	Dagfin Brodtkorb
Electric Power Technologies	Arne Hjortsberg
Power Generation Technologies	Gernot Gessinger a.l.
Power Electronics	Christer Ovren
Environmental Technologies	Charlotte Brogren
Oil, Gas and Petrochemicals	Pål Jahre Nilsen
Engineering Systems	William Grossmann
Mechanics	Chun-Yuan Gu
Manufacturing Technologies	Mika Kuhmonen
Software Engineering	Peter Kolb
High-Voltage Electromagnetic Systems	Mats Leijon
Energy and Global Change	Baldur Eliasson

Corporate Research Centers	
Finland	Juhani Pylkkänen
ABB Corporate Research Oy	Tel +358 10 224 2304
Virtaviiva 9E / P.O. Box 608	Fax +358 10 224 1045
FIN-65101 Vaasa	
Germany	Kurt-Volker Boos
ABB Corporate Research	Tel +49 6221 59 6100
Speyer Strasse 4	Fax +49 6221 59 6103
P.O. Box 101332	
D-69003 Heidelberg	
Italy	Glandomenico Testi
ABB Ricerca S.r.l.	Tel +39 2 262 32159
Viale Edison, 50	Fax +39 2 262 32160
I-20099 Sesto San Giovanni (Milan)	
Norway	Jan Bugge
ABB Corporate Research	Tel +47 66 84 3349
Bergerveien 12	Fax +47 66 84 3540
P.O. Box 90	
N-1361 Billingstad	
Poland	Franz Schmaderer
ABB Corporate Research	Tel +48 12 429 5027
13 A Starowislna Street	Fax +48 12 422 4906
PL-31-038 Krakow	
Sweden	Harry Frank
ABB Corporate Research	Tel +46 21 32 3001
Gideonsbergsgatan 2	Fax +46 21 32 3157
S-72178 Västerås	
Switzerland	Maurice Campagna
ABB Corporate Research	Tel +41 56 486 8211
Segelhof	Fax +41 56 493 5401
CH-5405 Baden-Dättwil	
United States	Jaime Trevino
Electric Systems Technology	Tel +1 919 856 3853
1021 Main Campus Drive	Fax +1 919 856 2458
Raleigh, North Carolina 27606	
United States	Allen Pfeffer
Power Plant Labs	Tel +1 860 285 5639
2000 Day Hill Road	Fax +1 860 285 2565
Windsor, Connecticut 06095	

ABB Asea Brown Boveri Ltd
Corporate Communications
P. O. Box 8131
CH-8050 Zurich Switzerland
Phone +41 (0)1 317 7406
Telefax +41 (0)1 317 7958

ABB Asea Brown Boveri Ltd
Corporate R&D and Technology
P. O. Box 8131
CH-8050 Zurich Switzerland
Phone +41 (0)1 317 7111
Telefax +41 (0)1 317 7991

www.abb.com