alternative to petrol as an energy source for cars. So we are developing a wide range of products based on hybrid-vehicle technology, combining an electric motor and a petrol engine. Our approach is to develop the best cars for the consumer in each different market.

We currently have a strong focus on batteries for future electric vehicles. Although lithium-ion batteries are becoming more widely used, it is hard to see electric vehicles completely replacing conventional passenger cars, even if we push the performance of lithium-ion batteries to the limits. We have to solve problems of energy storage density and cost. We are researching and developing all-solid and metal–air batteries, which are two promising alternatives to lithium-ion.

Another possible game-changing technology is solar power. More and more households are using solar cells. At the moment, some of our hybrid Prius cars have solar-powered ventilation systems that operate while the car is parked, but it may also be possible to use solar power to drive the vehicle if we can achieve a breakthrough in the efficiency of generating electricity from solar energy.

In the long term, we believe that the use of vehicle telematics will revolutionize the car industry. We are seeing rapid development and innovation in automated driving and accident prevention. As vehicle-control technology advances, more cars may be able to avoid collisions. Then it may become possible to change vehicle structures and make cars much lighter. That will in itself reduce energy usage.

The Japanese idea of *monozukuri*, which could be translated as making things, is at the heart of Toyota's approach. We think that new ideas are created by digging into the root causes of problems and by finding out facts through *genchi genbutsu*, which means actually going to a site and discovering the real situation for yourself. It is important that we nurture our employees to take this practice to heart. For the past 50 years, this approach has been the driving force behind the innovation and originality in our development processes.

ROCHE

Collaborate with the public sector

Jean Jacques Garaud, global head of pharma research and early development, Roche Holding, Basel, Switzerland

The recession is diminishing the funding available for research at publicly funded scientific institutions. This compels them to be more open to, and more collaborative in, public–private partnerships. Since the integration into Roche of Genentech, a Californian biotechnology company, in 2009, Roche has operated two autonomous Research and Early Development units, pRED and gRED, with distinctive approaches. In the first 18 months of pRED, we've developed and driven external collaborations, ranging from relationships with individual academics to entire networks with leading academic and health institutions.

At the same time the economic crisis increases the pressure on drug prices and forces us to home in on drug candidates that will add value from a medical and public-health standpoint. We are focusing efforts on personalized health care, because patients with the same condition can react to the same treatment in different ways — and sometimes even receive treatment that is inappropriate for them. To better fit the treatment to the patient, we must concentrate on better understanding the molecular basis of diseases and their heterogeneity.

I'm optimistic that these recessionary challenges can be turned into opportunities to make health care better, safer and more effective.

Our ultimate goal is to understand the biology of diseases and translate this knowledge into the clinic. New technologies that will help include cell-penetrating peptides that may allow the delivery of drugs into cells as well as therapeutic interactions on the cell surface. For peptides in general, we will need to develop synthesis methods to overcome difficulties, such as structural instability, that can weaken peptide interaction with targets and reduce activity and specificity.

Stem cells will also be increasingly important as translational-research tools. With differentiated cells derived from stem cells, we are able to study the effects of drug compounds on clinically relevant targets and observe cellular functions at an early stage.

Finally, computer modelling and simulation could also be game changers, if we can build more reliable drug–disease models to better design experiments and predict their outcome.

To encourage such innovation, Roche fosters an environment that allows our scientists to grow and experiment with new ideas and approaches. One way to do that is to talk about science itself, not just about managing science. We have launched a 'barn initiative' to provide informal environments for kindling creativity in settings from campuses and castles to converted barns. At these 'barns', away from their day-to-day projects, scientists can engage in positive and challenging scientific discussions on a specific theme.

It is also important to provide the recognition and the rewards that scientists deserve. Our publication strategy explicitly encourages publishing in scientific journals and we advocate the exchange of ideas at scientific conferences. ■

CORRECTION

In the Comment article 'The art of conservation' (*Nature* **472,** 287–289; 2011), the 1964 Durrell Wildlife Conservation Trust logo and the 1961 Friends of the Earth International logo were actually from 1999 and the 1970s, respectively.

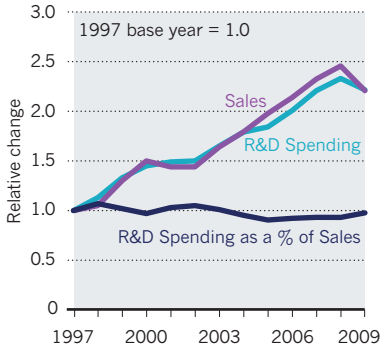
CORPORATE CHANGES

In 2009, corporate research and development (R&D) spending declined for the first year in more than a decade (see graph), according to a study of 1,000 of the world's most research-intensive companies by New York analysts Booz & Company.

SOURCE: BOOZ & CO.

Total R&D spending in 2009 dropped 3.5%, but revenues fell more sharply, by 11%. So R&D is still one of the last places that corporations make cuts. About half of the 1,000 firms cut their R&D portfolio in 2009, but nearly all the cuts came in three industries: car manufacturers, computing and electronics.

R&D AND SALES



THE INNOVATION TOP 5

2009 rank	2009 R&D spend US$ millions (2008 rank in parentheses)	Change from 2008	As a % of Sales
1	ROCHE (3) $9,120 m	▲ 11.6%	
2	MICROSOFT (4) $9,010 m	▲ 10.4%	
3	NOKIA (2) $8,240 m	▼ 1.0%	
4	TOYOTA (1) $7,822 m	▼ 19.8%	
5	PFIZER (6) $7,739 m	▼ 2.6%	

Research spending in the health-care sector grew by a modest 1.5% in 2009, as reflected in the rankings of the top spenders (see table). Toyota Motor Corporation and Nokia both dropped, while Roche Holding climbed two places to take the top spot ahead of Microsoft.