Using innovation to drive sustainable growth in the chemicals industry

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About this report

Using innovation to drive sustainable growth in the chemicals industry is a companion paper to PwC's comprehensive survey report on innovation, *Breakthrough innovation and growth*, which explores the impact that innovation has on growth and examines how leading companies are making innovation work for their organisations. *Breakthrough innovation and growth* explores three key questions:

1. How are companies using innovation to drive growth and what is the return on this investment?
2. How are approaches to innovation changing, particularly in light of a trend towards more disciplined innovation?
3. What are the best practices and critical success factors that deliver tangible business results?

To find the answers we drew on insights from interviews with 1,757 C-suite and executive-level respondents who are responsible for overseeing innovation within their company. Interviews were located in more than 25 countries and work in 30 sectors.

Our sample included 41 chemicals sector executives from 12 countries. Their responses form the basis for our sector-specific analysis, together with two in-depth "featured interviews".

Note on methodology:

This report refers to approaches taken by leading innovators. We define the top and bottom innovators using a balanced scorecard approach based on six factors: the importance interviewees place on innovation; their appetite for innovation; the proportion of annual revenue from products or services launched in the last year; the proportion of annual revenue spent on innovation; the proportion of products and services co-developed with external partners; and their project revenue growth over the next five years.

For more details on our methodology, please see *Breakthrough innovation and growth*.

1,757
C-suite and executive-level respondents

41 executives from companies in the chemical sector from 12 countries

Glossary/abbreviations

The Dow Chemical Company ("Dow Chemical")
BASF SE ("BASF")
Celanese Corporation ("Celanese")
E.I. du Pont de Nemours and Company ("DuPont")
Evonik AG ("Evonik")

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Executive overview

Antione Westerman
Global Chemicals Leader

Volker Fitzner
Global Chemicals Advisory Leader

In our work with chemical companies, we see the critical impact of innovation close up every day. Why is innovation so important?

It helps chemical companies address their customers' challenges. Chemicals innovation is helping the industry's customers get more productive and more sustainable. Ultimately, it's having a profound impact on the daily life of consumers. Nearly every good manufactured—96%—is touched in some way by chemistry.

It creates competitive advantage. By constantly improving products, technology and processes, and working closely with customers and suppliers across the value chain, chemical companies can stay ahead of the competition.

For most of our clients, innovation is already a core part of their internal culture and their company mission. And there's no denying that the sector has made some amazing advances over the past decade.

While innovation is one of the top priorities for chemical executives, it may not yet be delivering all the value it could be. But innovation can, and should, help improve the bottom line. This report takes a look at some of the ways how.

A solid strategy for innovation is the essential starting point—and more than a third of chemical executives say they don't yet have a well-defined strategy. That needs to become a priority. And strategy work doesn't stop once you've articulated a vision. If you haven't revisited your innovation strategy recently, it may be time to take another look. We've identified the following as key ways to improve your innovation efforts.

The chemicals sector is already leading on innovation. But for many sector companies, innovation investments still aren't delivering as much value as they could be.

Are yours?

Broaden innovation efforts beyond products and increase innovation ambition.

Products still top the list as the number one innovation priority for many chemical companies. They're critical, and so is making sure your product portfolio can address the major trends that are transforming the global economy. But it's important to recognise, and drive, innovation in other areas too. In three areas—technology, customer experience, and the supply chain—more than 40% of chemicals respondents expect breakthrough or even radical innovation over the next three years. Those companies that aren't emphasising these areas, or that settle for primarily incremental innovations, may fall behind the competition. And we see business model innovation as vital too.

Get the basics right

In our overall research, we found that the top innovators spend a greater portion of revenues on innovation, compared to the overall sample. Our chemical respondents told us their companies were spending significantly less; some may need to consider increasing their investment. But to make the most of it, chemical companies need to get innovations to market. Technology advances can help, for example by streamlining testing procedures. Building an innovation function across the whole organisation can also help increase overall efficiency.

Build and maintain a strong culture to attract and motivate talent

Every kind of innovation is driven by people. When it comes to building a strong innovation culture, chemical executives put the most emphasis on recognition and reward and strong processes. Most are also making sure that employees get opportunities to innovate and setting tone from the top. A strong innovation culture can help with recruiting. Chemical companies will need to win the fight for talent—especially in growth markets like Asia. Some are already supporting math and science education today, to help increase tomorrow's pool of skilled workers.

Enhance collaboration

Around one in five chemicals executives say their companies are already co-creating innovative products and services with customers and external partners. That's good—but it needs to get even better to match top innovators across industries. Many chemical companies see open innovation as the way forward. And some are starting to explore corporate venturing too. Both can be good ways to help open up more collaboration.

We hope this report provides some ideas for improving your innovation process and look forward to continuing the conversation.

Innovating for growth

In our research across industries, we've found a clear correlation between innovation and success in growing revenues. In PwC's global innovation survey entitled *Breakthrough innovation and growth*, we report that over the past three years, the most innovative companies in our study grew at a rate 16% higher than the least innovative.[1] And in the space of only five years, these top innovators forecast that their rate of growth will further increase to almost double the global average, and over three times higher than the least innovative group.

16%

Over the past three years, the most innovative companies in our study grew at a rate 16% higher than the least innovative.

Chemical executives are modestly optimistic about their prospects for revenue growth over the next five years. But they're still lagging well behind top innovators across all sectors.

There's already a strong consensus from industry that innovation can help build revenues. The large majority of our chemicals respondents say innovation is important to their business. That confirms a trend we've seen from industry executives participating in our global CEO Survey over the past several years. And the urgency is growing. More than half of chemicals respondents see innovation as a competitive necessity in five years' time (see Figure 1).

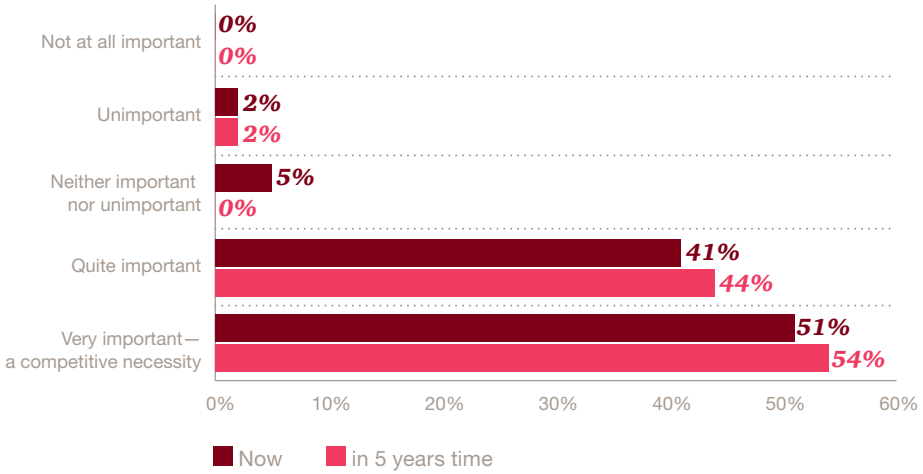
But the bigger question is whether chemical companies are actually doing what it takes to excel at innovation.

In our overall research, we found that executives are revamping their innovation strategies to explicitly focus on growth. In summary, the leading innovators:

- are innovating with a purpose,
- have a well-defined innovation strategy,
- take a more formal and structured approach to innovation,
- are concentrating on a greater proportion of breakthrough and radical innovations,
- are planning a broader range of business model innovation,
- are exploring a wider range of innovation operating models,
- are planning to collaborate much more than the bottom 20%, and
- invest a higher proportion of their revenue to fund innovation.

Figure 1: Chemicals executives view innovation as vital to future success

How important is innovation to the success of your company now? In 5 years' time?



Source: *PwC Global Innovation Survey 2013*. **Base:** Chemicals: 41

1 We defined the top innovators using a balanced scorecard approach based on six factors: the importance interviewees place on innovation, their appetite for innovation, the proportion of annual revenue from products or services launched in the last year, the proportion of annual revenue spent on innovation, the proportion of products and services co-developed with external partners and their project revenue growth over the next five years. For more details on our methodology, please see *Breakthrough innovation and growth*.

In many of these areas our research suggests that the chemicals industry is already on the right path. Chemical executives say they expect significant amounts of breakthrough and radical innovation, and they're looking beyond just products too. The industry is also already taking a more formal and structured approach to innovation and making collaboration a priority. And some executives tell us they are starting to explore more innovation operating models like open innovation and corporate venturing.

Chemical executives who say they have a well-defined innovation strategy

Top innovators who say they have a well-defined innovation strategy

But there are still key areas where some chemicals respondents are falling short.

One is investment. Chemical companies are spending a smaller proportion of the revenues on innovation compared to the total sample, and they're significantly behind the top 20% of innovators. Given innovation's importance to the sector, it's critical that chemical companies make sure they are making the most of investments. We'll talk more about this topic later in this paper.

The other is strategy. Less than two-thirds of chemicals executives say their companies have a well-defined innovation strategy. That's a serious problem for those without a clear vision, because execution starts with a sound strategy.

Starting with a solid strategy

Many of the industry's largest players are already talking openly about their innovation strategies. Our sample also includes smaller companies which may be less likely to have formulated a vision for innovation than their larger peers. But no matter how large or small your company is, it's critical to clearly define your goals for innovation and to understand what level of innovation you're shooting for. Too much innovation can be a drain on resources. Too little innovation and opportunities for growth are squandered.

In other research, we found that it's absolutely critical for speciality chemical companies to identify new technologies early on and to analyse which ones have strong commercial potential. That reinforces the importance of linking innovation strategy to overall business goals. And while much of innovation may be driven at the business unit level, understanding your innovation priorities across the whole organisation can help make sure that you get the most from investments. So your strategy should include ways to plan and transfer knowledge across the whole business. Decision relevant metrics are important too.

Even if your company already has a clear roadmap, it's important to keep evaluating what's working and what's not—otherwise the competition may catch up faster than you think.

We've identified some fundamental questions chemical executives need to ask themselves when taking a closer look at their company's innovation vision:

1. ***What balance of innovation do we need? What ratio of incremental, breakthrough and radical do we envisage?*** Are we developing chemical substances and products that address important future trends? Can we keep up with competitors on technology and processes? Does our innovation focus enough on customer needs? Have we looked at important areas like services, business models and the supply chain?

2. ***Do we have a good handle on the basics? Are we investing enough in innovation?*** Do we have the right metrics to track and measure innovation success? Can we meet regulatory requirements efficiently? Are we sharing knowledge and skills across the enterprise?

3. ***Can we attract, keep and motivate innovation talent?*** Are we actively working to increase our candidate pool and position our company as a supportive environment for top talent? Will we be able to adequately support increasing research needs in Asia?

4. ***Are we collaborating enough and with the right partners?*** Do we have systems in place to evaluate the relevance of good ideas from other industries? How focused and efficient are we in finding partners with the best complementary innovation capabilities? How strong are our strategic partnerships? Are we making good use of open innovation or other strategies like corporate venturing to identify and develop new relationships and ideas?

Balancing the innovation portfolio

We found that one of the keys to driving growth while still maintaining the health of established products and services, is to focus on a balanced innovation portfolio. That means finding the right mix of investments in incremental, breakthrough and radical innovation across the whole range of innovation areas. That includes products, services and technology and systems and processes, whilst business models, the customer experience and the supply chain are critical too.

Chemical respondents already have ambitious plans. In three areas—technology, customer experience, and the supply chain—more than 40% expect to see breakthrough or even radical innovation over the next three years (see Figure 2). In all three areas the sector is matching—or even surpassing—the expectations of the top 20% of innovators across all industries.

For every other type of innovation we looked at, over 30% of chemicals respondents expect their company to make radical or breakthrough advances. Our experience shows that innovation portfolios have historically targeted more like 10–20% of innovation, so this reflects a profound shift happening in sector innovation.

Megatrends have mega implications for products and services

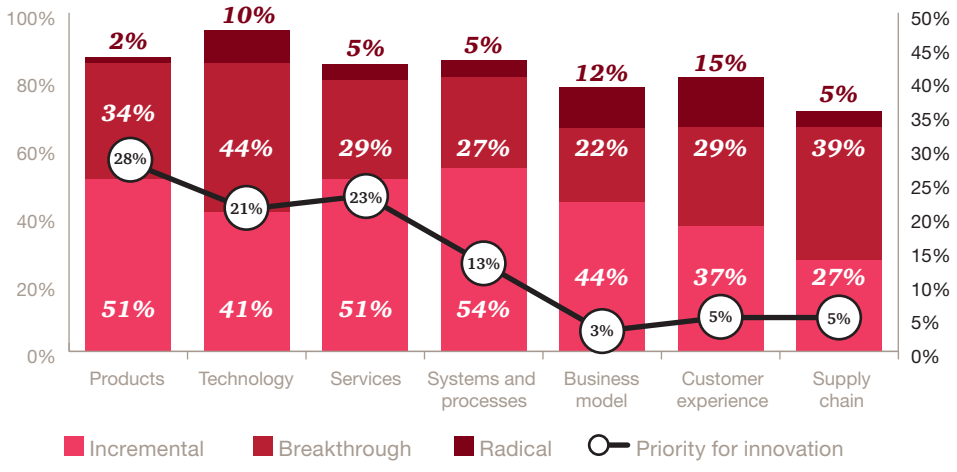
Chemical companies don't expect as much breakthrough and radical innovation in products, but they are still the number one innovation priority. That makes sense since chemicals is a product-driven business. But exactly which products get priority has been changing in recent years.

Many chemical companies have been proactively looking to shape their business portfolio around "megatrends"—big issues having a global, long-term impact, like the shift to alternative energy, urbanisation and the need for better nutrition. And some chemical companies are explicitly using innovation to drive how their companies address these issues. For example, BASF says the company is spending around a third of its R&D investments on projects for increased energy efficiency and climate protection.[3]

In some cases, chemical companies are working on radical innovations with the potential to disrupt the market. Take solar power. Dow Chemical has developed a new POWERHOUSE Solar Shingle, which Jane Palmieri, Vice President of Dow Solar, calls "..a disruptive innovation for homeowners as well as the building industry. This pioneering product is reinventing the roof by turning it into a source of value for the homeowner. Builders now have the opportunity to differentiate their high-performing homes with a solar product that does not compromise the home's overall aesthetics. In addition, a simplified installation process allows roofing professionals to participate in the growing solar marketplace, which is a real game-changer for the industry."[4] It's the primary reason that Dow Chemical was identified in the field of Energy and Materials as one of 2013's 50 Disruptive Companies, MIT Technology Review's annual list of the world's technology companies whose innovations are having the biggest impact

Figure 2: Chemical companies are most ambitious about technology innovation, but products and services are still the top innovation priority

How significant will your innovations in the following areas be over the next three years? Of these areas, which is your priority for innovation the next 12 months?



Source: *PwC Global Innovation Survey 2013*. **Base:** Chemicals: 41

3 http://report.basf.com/2012/en/managementsanalysis/innovation.html

4 Dow company press release, February 20, 2013, http://www.dow.com/news/press-releases/article/?id=6174

Throughout this report, we refer to incremental, breakthrough and radical innovation:

- **Incremental innovations** are changes to an existing product or service. The changes to technology and business model are primarily aimed at protecting market share and maintaining margins. Competitors usually respond quickly to incremental innovations.

- **Breakthrough innovations** make much more substantial changes to technologies and business models. Often called game-changers, breakthrough innovations create greater competitive advantage than incremental innovations.

  Competitors have greater difficulty responding to breakthrough innovations. As a result, a company with a successful breakthrough innovation increases revenues and margins.

- **Radical innovation** creates drastic changes to the competitive environment for a product or service, or creates entirely new businesses. Radical innovations occur infrequently but can generate explosive growth in major new categories of products and services.

Looking to technology to drive growth

An impressive 95% of chemical executives say they'll innovate around technology over the next three years, and over half expect breakthrough or even radical advances. Why such a strong focus on technology? In the chemicals sector, it is often inextricably linked to process innovation. The American Chemistry Council's (ACC's) Director, Mike Walls, points out that if a new technology for producing a commodity chemical can help save even just .01 per pound in production costs it can have a significant impact on the bottom line (see Interview, p. 17–18).

95%

of chemical executives say they'll innovate around technology over the next three years, and over half expect breakthrough or even radical advances.

In some cases, developing a cheaper or better process can actually open up significant new markets. One example is Celanese's TCX® process. Building on its acetic acid technology platform, TCX® Technology allows Celanese to produce ethanol at the lowest cost compared to alternative liquid fuel technologies.[5] That's especially appealing to countries with fossil fuel resources, but lacking arable land for biofuels. Celanese has already signed Memoranda of Understanding (MOUs) with PetroChina[6] and Pertamina, the state-owned energy company of Indonesia,[7] to jointly develop synthetic fuel ethanol projects.

Changing feedstocks isn't the only possible disruption on the horizon. Chemical production is currently highly capital intensive. But if modular production technologies gain traction, chemical companies could build smaller production facilities in more locations around the world. Evonik AG's Dr. Felix Müller, VP European Research Policy—Corporate Innovation Strategy & Management, points out that they could potentially mean big disruption for the industry's supply chains and business models (see Interview, p. 12–13).

5 Celanese, company press release, September 20, 2012. http://files.shareholder.com/downloads/AMDA-10Q93V/2089295067x0x601019/7f4f0eff-4eef-4a7a-aa3a-753806d2e9cb/CE_News_2012_9_20_General_Releases.pdf6

6 Celanese, company press release, August 21, 2013 http://www.celanesetcx.com/sites/default/files/Celanese%20PetroChina%20MOU%20News%20Release%208-21-13_0.pdf

7 Celanese, company press release, July 12, 2012 http://files.shareholder.com/downloads/AMDA-10Q93V/2089295067x0x583991/5a663507-1d00-47e4-afea-a0312df61bf3/CE_News_2012_7_19_General_Releases.pdf

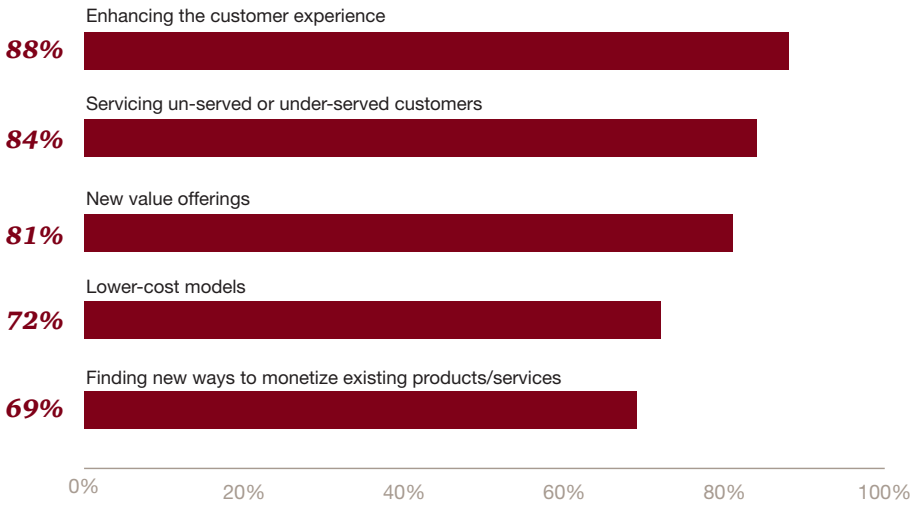
Re-shaping the business model to better serve customers

Nearly all of the top innovators across industries expect to revisit their business models, and around half anticipate breakthrough or radical changes. In the chemical sector, around a third of sector executives say they'll make significant advances around business models over the next three years.

How are business models changing? Top innovators in particular are looking for new value offerings like expanding services; the least innovative companies are more inclined to focus on lower-cost models. For chemical companies, business model innovation is strongly focused on the customer; 88% of chemical respondents looking to innovate around the business model told us that they plan to improve the customer experience; 84% want to service unserved or underserved customers.

Figure 3: Responding better to customers is the biggest priority for business model innovation in chemicals

Which of the following types of business model innovation will be you implementing over the next three years?



Source: *PwC Global Innovation Survey 2013*. **Base:** Chemicals: 41

PwC partner Steffen Gackstatter spoke with Dr. Felix Müller, VP European Research Policy—Corporate Innovation Strategy & Management at Evonik AG about our survey results and his company's innovation initiatives. Here's a summary of their discussion (translated from German).

SG: In our research, we found that the chemicals industry overall is lagging behind top innovators across industries in two areas. The first is investment. Do you think the chemicals sector is investing enough in innovation?

FM: Some areas require more investment in innovation than others. For commodity chemicals, there's less need to innovate. But in the speciality chemicals area, there's a lot of change happening. Concerns around sustainability in particular are going to be driving some fairly dramatic transformation over the next decade. To keep up, chemical companies will need to increase their investments.

SG: The other area is strategy. Less than two-thirds of our respondents say they have a well-defined innovation strategy. How important do you think it is to have a clear vision for innovation?

FM: A strong innovation strategy is very important. With lots of change happening in the industry, it's difficult to know where to go, so it really helps to set some direction.

SG: Can you tell us more about the key aspects of Evonik's innovation strategy?

FM: We want to enhance the value of our innovation pipeline and address shorter innovation cycles, more complex problems, and more demanding conditions. One way we're addressing that is through our, Leading Innovation' initiative which promotes a culture of innovation across the whole company.

Evonik works to balance the innovation efforts of our business units with our corporate R&D. But it's important to remember that over four-fifths of our innovation activity is actually driven at the business unit level. There are good reasons for that, as different business units have very diverse priorities. They set their own innovation priorities accordingly. For example, our consumer specialities business unit develops some highly complicated products that are based on the needs of our customers in specific industries like cosmetics. So they are focused coming up with innovation products that address specific customer issues. But some of our other classic chemicals areas are now more commoditised. For them, innovating around processes and technology is much more important.

SG: Measuring innovation can be challenging. What metrics do you use to track innovation success?

FM: This is one area we're still working on. One metric we're using across the whole business is revenue from new products. In 2012 we generated 1.5 billion € in revenues from products developed over the past 5 years. But even that measure isn't as clear cut as it first sounds, because we do a lot of incremental innovation in product areas where it's not always easy to decide what constitutes a new, rather than just improved, product. We also track patents. In 2012 our portfolio of patents and applications filed was over 26,000.

It's important to remember that we do a lot of innovation that responds directly to the needs of our customers. That's absolutely core to our business model—but it is not always easy to measure. For example, let's say an automotive OEM comes to us with a request to create a different type of dashboard for a vehicle update. We'll work with them to develop modifications to a particular plastic so that it fits their needs. That may not get counted as a new product—but it is definitely a case where innovation has added value for our customer. So ultimately it's an innovation success that is difficult to measure quantitatively.

SG: We believe it's important to find the right balance between incremental, radical and breakthrough innovation. That's not always easy. How does Evonik manage this tension?

FM: It's a reality in our business that there will always be a lot of incremental innovation, particularly working together with our customers to improve their products. At Evonik we've set a goal to focus 15% of our corporate R&D on breakthrough and radical innovation. That's one reason we've established our Creavis incubator. And as of January 1, 2014 we're realigning Creavis, allowing for longer innovation project durations. We'll build its strengths in technological expertise and project management and increase efficiency.

SG: In our view, innovation needs to go beyond just products and processes and include areas like the supply chain, business models and the customer experience. How does Evonik manage innovation in these more, non-traditional' areas?

FM: Some of the areas you mention are more difficult for chemical companies to address due to the regulatory environment. For example, shipping and storage of chemicals is generally highly regulated, which can limit the opportunities for supply chain innovation.

The industry has also historically depended on large, capital intensive factories. That may change in the future though. Evonik was one of the participants in the EU funded F3 factory project that focused on developing flexible, continuous, modular production technology. The first successful demonstrations have already taken place and the concept now needs to be optimised and applied in coming years. These new types of techniques will help Evonik become more flexible in production capacities. It also opens up the possibility to use different feedstocks. That could reduce ime-to-market and thus have big implications for the supply chain, and potentially for business models too.

SG: Providing recognition and rewards and having well-developed and accepted innovation processes were considered the most important factors in developing a strong innovation culture by our respondents. How is Evonik enhancing its innovation culture? What do you find most important?

FM: We're very focused on building the culture—as I mentioned we launched our "Leading Innovation" programme last year. Recognition is certainly important—we do an innovation award every year. So is giving our people the chance to interact with top scientists outside the company which we do through our, Evonik Meets Science' forum.

I think one of the most successful things we've done to build the innovation culture at Evonik is introducing an ideation system internally. We collect ideas from around the company. The programme has already been around seven years and there's no sign of the ideas drying up yet—we continue to get great, creative suggestions from our people. We provide feedback to all of them and some of them we then explore further in a workshop setting. That's proved to be very productive.

SG: We see collaboration as vital for innovation. In our overall research, the top innovators were collaborating 3 times as much as the laggards. How important do you see open innovation in this regard? Is open innovation a priority for Evonik?

There's no question that open innovation is very important for the chemicals industry, particularly collaboration with customers and with academia. Evonik is piloting an approach where we issue calls for research proposals to a select group of university professors. That's already proving to be a strong source of good ideas that have clear commercial potential.

We're thinking more broadly too. In 2012 we organised our first Open Innovation Fair, where experts compared notes on open innovation, open ideation, crowdsourcing, and the use of social media platforms.

And we're looking outside the chemical industry, especially around megatrends. For example, to discuss scenarios involving megacities, Evonik experts have met with scientists, architects, and urban planners in Darmstadt and Shanghai.

Getting the basics right

On average the chemical companies we interviewed actually spend a smaller percentage of their revenues on innovation than do companies across the sample as a whole. It's important to remember that there is significant variation within the industry. Specialty chemical companies tend to spend more than basic or commodity companies; both are included in our sample. And there are regional variations too. According to the European Chemical Industry Council (CEFIC), Japanese chemical companies spend a higher percentage of their revenues on R&D than do European chemical companies, and both spend more as a percentage of revenues than companies in the US.[8] CEFIC's data also suggests that the overall trend over the last two decades is downward.

8 http://www.cefic.org/Facts-and-Figures/Investment-and-RD/International-comparison-of-RD-spending-intensity/

Other research suggests that even the top spenders aren't investing as much as companies in other innovation-dependent sectors. According to Booz & Co, five of the top 20 R&D spenders in 2012 were automotive OEMs and seven were healthcare companies (including pharmaceuticals companies).[9] Not one was a chemical company.

In *Breakthrough innovation and growth,* we found that the top innovators are spending significantly more than the overall average. But more importantly, they're also innovating more effectively.

Making sure you're getting your money's worth

The real trick is to make sure you are getting the most out of your innovation investment. One key is tracking and measuring innovation; our research shows that chemical respondents find this less of a challenge than peers in many other industries. We've seen that many chemical companies are already tracking a wide range of metrics, including KPIs on patents and pipelines.

Many are tracking revenues from new products too. The chemical companies we surveyed generated 12,2% of their revenues from products or services launched in the past year, compared to 15,7% across the total sample. But given industry dynamics, many chemical companies see the percentage of revenues from new products over a 3 or 5 year period, rather than in the previous 12 months, as a more accurate metric. That points to one of the industry's biggest challenges—commercialising innovation.

Getting to the marketplace

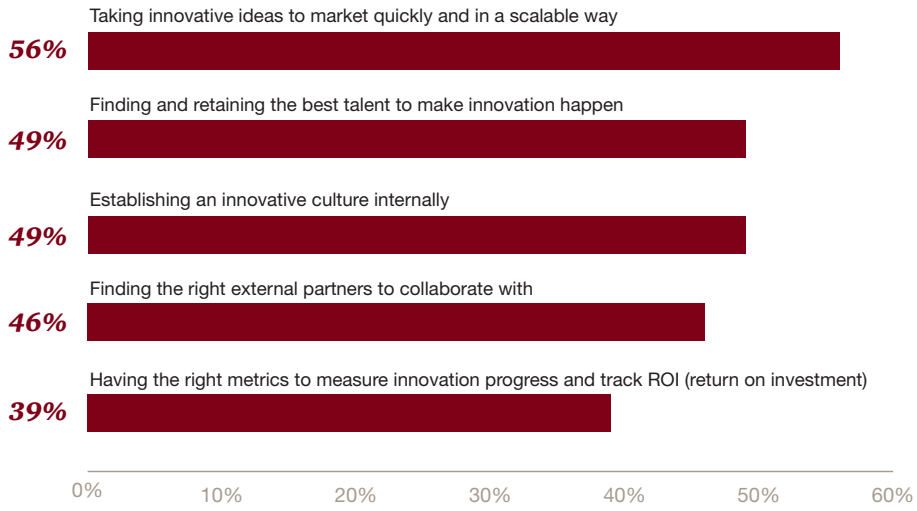
Taking ideas to market quickly and in a scalable way is the single biggest challenge faced by the chemicals executives we surveyed (see Figure 4). That's in part due to the nature of the chemical business. New chemical compounds need to pass rigorous testing for safety before they can be marketed. They also need to be extensively documented. And new products or services sometimes take time to catch on.

Technology advances can help streamline some of these steps. For example, when we spoke with the ACC's Mike Walls, he talked about how new computational methods are speeding up the process of testing chemicals for toxicity (see Interview, p. 18–19). And it's another reason why technology innovation is so important for the industry.

Walls also points out the impact of the differing regulatory environment in the US, Europe and Japan on innovation. In our *17th Annual Global CEO Survey*, 32% of chemical CEOs said that regulation had prevented them from innovating effectively over the past 12 months. But another 28% believe that regulation helped, and 39% just aren't sure. Wherever you're based, it's important to understand and plan for the compliance process up front.

Figure 4: Taking ideas to market is the biggest innovation challenge for chemicals executives

How challenging do you find the following aspects of making innovation happen within your company? Respondents who said "very" or "somewhat" challenging.



Source: *PwC Global Innovation Survey 2013*. **Base:** Chemicals: 41

9 http://www.booz.com/global/home/what-we-think/global-innovation-1000/top-20-rd-spenders-2013

"The biggest problem is time to market and the reason is the enormous documentation need. 30 years ago, we needed 28 pages for quality assurance, today we have more than 2800 pages."

Dr. Felix Müller, Evonik, VP European Research Policy—
Corporate Innovation Strategy & Management

76% say they have formal innovation structures in individual business units

73% say that individual product areas or services are responsible for their own innovations

Business unit innovation helps keep the focus on customers

Our chemical respondents are placing a high level of responsibility for innovation at the business unit level. More than three-quarters (76%) say they have formal innovation structures in individual business units and 73% say that individual product areas or services are responsible for their own innovations. In many cases, business units are driving the bulk of innovation activity; Evonik's Dr. Felix Müller told us that more than four-fifths of innovation in his company takes place at the business unit level (see Interview, p. 13–14).

That makes sense, given the big differences between the innovation needs of specialty vs commodity chemicals, for example. It also reflects the sector's emphasis on innovating together with customers and keeps commercialisation anchored in market needs.

But sharing across the enterprise can boost efficiency too

Still, our experience suggests that there is also significant benefit to making sure that structures are in place to drive innovation across the entire business. By looking more broadly, chemical companies can make sure they are well-positioned to address new research areas that may go beyond their traditional areas of expertise.

They can also identify synergies to make innovation more effective. And the central innovation function often serves as a facilitator to make sure that process and product know is shared across the enterprise. While successes at the business unit level naturally get a lot of attention, projects that are scrapped can deliver important insights too—and a central innovation team can help make sure that lessons learned get shared across the whole organisation, for example if a particular substance has raised red flags for toxicity.

PwC's Tom Waller and Elizabeth Montgomery spoke with Mike Walls, Director of the American Chemistry Council (ACC) about our survey results and his views on innovation in the industry. Here's a summary of their discussion.

PwC: How would you characterise innovation in the chemicals sector?

The chemicals sector is a highly competitive global industry. In a lot of commodity areas the barriers to entry are low. So process innovation becomes very important. The situation is much different in speciality chemicals, where there is a lot more differentiation in terms of products. We see many companies taking a step approach to innovation, building on past successes.

A solid strategy can help a company do a better job of focussing limited resources on the most relevant areas.

PwC: An impressive 95% of the chemical executives we surveyed say they'll innovate around technology over the next three years and over half expect breakthrough or even radical advances. Why such a strong focus on technology?

Technology can have a big impact on what's being produced and how. There are a relatively limited number of chemicals that make up the vast majority of production. If a new technology for producing a commodity chemical can help save even just .01 per pound in production costs it can have a significant impact on the bottom line.

For the chemicals sector, energy costs (power plus feedstock) are by far the single biggest cost factor. That means there is a natural incentive to increase efficiency. You see innovation driving that, for example when the science of chemistry is used to create catalysts that reduce the energy produced during the manufacturing process.

Here in the US, the advent of reliable, affordable natural gas is helping turn the US chemicals industry into a low-cost producer. Currently there are 135 new chemicals facilities planned. That adds up to US 90 billion dollars in investment, and more than half is coming from outside of the US.

PwC: How have you seen chemicals innovation changing over the years?

I recently took another look at the report on innovation from the Council for Chemical Research that was published back in 2000. It was fascinating to see what was happening then compared to where we are now. At the time of that report we were in a flat part of the technology cycle. There was a slowdown in the rate of innovation, but what they called the "impact index" was up significantly. Now as we look towards 2014, we're at a different place. We are seeing an increase in the pace of innovations compared to a decade ago—particularly around technology and business models.

PwC: And what about their impact?

That's stayed high. And chemicals is really a cornerstone industry—96% of all manufactured goods are touched by chemistry. So innovation in the sector really impacts the whole economy.

PwC: The ACC is helping facilitate research on nanotechnology. Can you tell us why this area is so exciting? And is it safe?

There are so many different dimensions. It's exciting because it allows you to use the same chemical and leverage the very different properties nanomaterials can have. Of course it's important to make sure it is safe, and we need to make some decisions on the regulatory impact.

PwC: How does regulation affect chemicals innovation?

You know, chemicals is one of the most highly regulated industries in the world. Here in the US, the Toxic Substances Control act actually creates some certainty for companies. Because they need to bring new substances to review early in the process and can get approval quickly, US companies have an "innovation edge" they can leverage to bring more products to market. The US actually brings three times more new chemicals to market than does any other region.

PwC: Many of the executives we spoke to also say they're innovating their business models, particularly around the customer experience and serving underserved customers. What evidence of new business models in the sector have you seen?

We're seeing a growing willingness to apply some different models to sales, marketing and technical support. And we're seeing manufacturers working to help customers to better understand chemicals and how to use them safely. That's part of an overall move towards sustainability driven not just by regulation, but also by the value chain. So if a large retailer decides it doesn't want a particular substance in the products if offers, for example, chemical companies will work with the value chain to respond to that concern.

We're also seeing companies more focused on providing solutions for customer problems, rather than focus on specific substances. That helps them create long-term business stability.

PwC: Taking ideas to market quickly and in a scalable way is the single biggest hurdle to innovation faced by the chemical executives we surveyed. Do you have any advice on how they can meet this challenge?

This is one area where technology can make a really big difference. For example, some companies are now using a technique called high throughput testing. That's an in vitro method of toxicity testing that vastly speeds up the process. By using sophisticated computational approaches, you can run large numbers of experiments in a very short amount of time. So that's really reducing the time to pilot new substances and test their safety.

Here in the US only about half of the new substances brought to the Environmental Protection Agency (EPA) for review are commercialised. The statutory framework encourages companies to come early in the process before manufacture. That's different from the EU or Japan, where regulatory approval comes directly before marketing a new product. In my view, this provides an advantage for US companies, because companies don't yet have as much to lose if a new substance doesn't meet regulatory requirements.

We're actually seeing some global chemical companies from other regions setting up new research facilities in the US, perhaps for just this reason.

Remember, chemical companies usually introduce a new substance at low volumes and need time to gain market share. So it's important to reduce the hurdles in the development stage.

PwC: Our overall research found that top innovators collaborate more than the laggards. How do you think the chemicals sector is doing in this respect?

The chemicals sector has a very strong track record of collaboration, particularly when it comes to working together with academia, and also with customers. The Hertie Center for Advanced Materials at Georgia Southern University is one example of strong partnering between the chemicals industry, academia, and the forestry sector related to pine chemistry.

Focusing on culture and talent

Once you've charted your strategy and mapped out a good balance for innovation, you need to make sure you have the people on board who can make it happen. Finding the right talent can be a big challenge for chemical companies; around half of executives see it as a hurdle (see Figure 5).

Chemical companies will need to make sure they're well-positioned to compete when it comes to attracting and retaining workers with the right skills. But what do innovative people want from their employer? In our experience the best breakthrough innovators want to be recognised as someone who makes a difference—to their profession, to the company, and sometimes to the world. So companies with a strong innovative culture have an advantage when it comes to attracting, keeping and motivating key talent.

Developing a strong innovation culture

But even when the need is clear, creating an environment that supports innovation isn't easy. In fact 49% of chemical respondents say that establishing an innovative culture internally is a challenge for their organisation. They have a wide range of strategies for supporting culture in their organisations. Chemical executives see recognition and rewards as the highest priority (see Figure 4). In Germany, 60% of specialty chemical companies offer prizes for outstanding innovation.[10] Altana's Dr. Georg F.L. Wießmeier, Chief Technology Officer, calls the company's innovation award "an integral part of our innovation culture." [11]

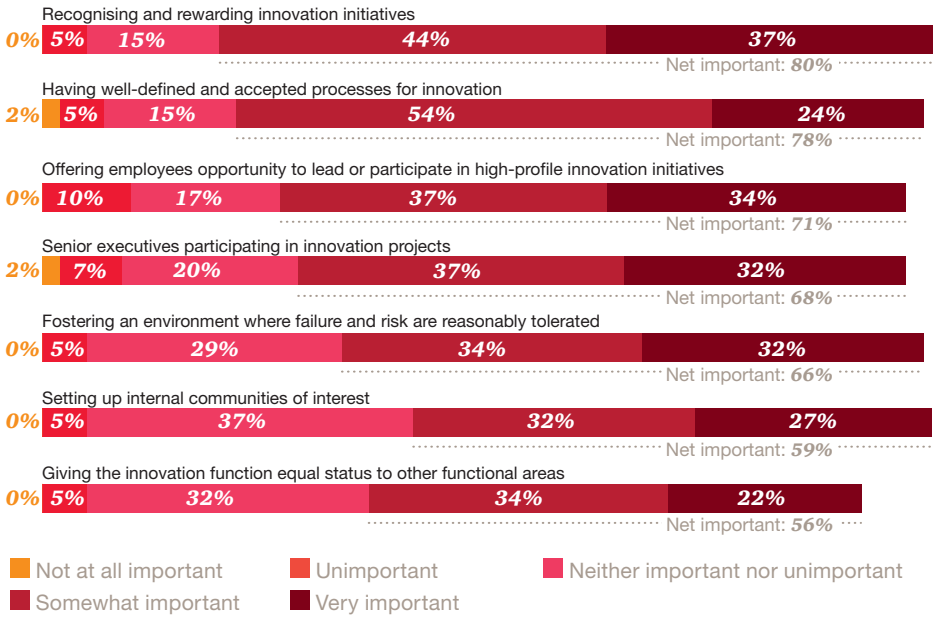
"Being part of innovation and R&D has become the most important role in our organisation—everybody recognises these people as crucial for future company success."

Jörg Unger, Head of Innovation, Performance Materials, BASF SE

Chemical companies are also committed to giving employees opportunities to participate in or lead high-profile innovation initiatives. Jörg Unger, Head of Innovation Performance Materials at BASF SE, told us that "Being part of innovation and R&D has become the most important role in our organisation—everybody recognises these people as crucial for future company success."

Chemical companies also place strong importance on well-defined innovation processes and setting the tone from the top'. Some companies are even giving innovation its own spot in the C-suite. Many of the industry's big players now have a Chief Innovation Office or Senior VP representing innovation at the board level.

Figure 5: Recognition and rewards are the most important factors in developing a strong innovation culture



10 PwC, Erfolgsfaktor Innovation: Chancen und Herausförderungen für die chemische Industrie, 2011.

11 Altana corporate website, http://www.altana.com/innovation/altana-innovation-award/altana-innovation-award-2012.html

When it comes to getting the right culture established, lots of other factors are important too. Two-thirds of chemical respondents believe it's necessary to tolerate some missteps. This type of ability to tolerate failure and risk helps maintain what's sometimes called an "intrapeneurial" spirit. Intrapeneurs are enthusiastic, dedicated and fast, like entrepeneurs. But they also benefit from access to the facilities a big company can provide, like sophisticated research labs with high-end data crunching capabilities. Many innovators need creative freedom, something that can be difficult to find in a large organisation.

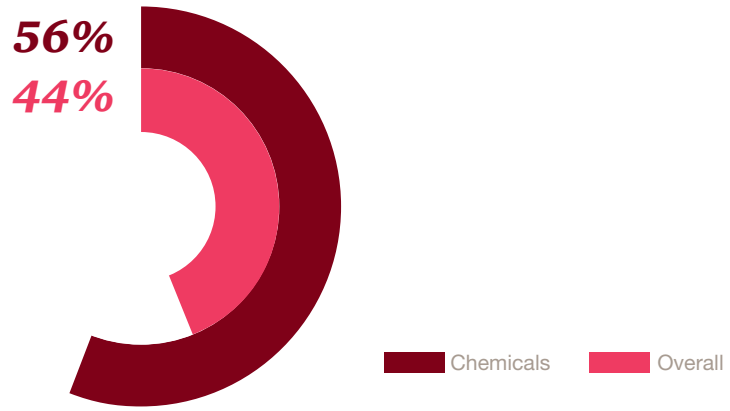
It's also important to make sure your most talented people are available for the projects that will bring the most value to your organisation—another reason why defining your innovation strategy is so critical. We've seen some companies revisiting their resource allocation to free up capacity and ensure their best talent is focused on the highest priorities, rather than day-to-day activities.

Talent across the global business

The chemical industry has become global, with most major players looking around the world—and increasingly to emerging markets—for revenues. In our 2013 Annual Global CEO Survey, we found that the chemicals industry was arguably the sector with the greatest focus on China.[12] Whilst their biggest priorities were growing the customer base and building manufacturing capacity, about a fifth of chemical CEOs said they were looking to build R&D and innovation capacity in China in 2013. That's not always easy, with competition for top talent increasing. Indeed, BASF's Jörg Unger told us that finding and retaining the right talent to drive innovation in Asia is particularly challenging.

Chemical companies are looking to other regions too—56% of chemical executives say they have innovation facilities in major markets, more than the average across the total sample. For example, DuPont recently opened its 12th Innovation Center in Johnston, Iowa. The company also has Innovation Centers in Turkey, Japan, Korea, Taiwan, Thailand, India, Brazil, Mexico, Michigan, Russia and Switzerland.[13] Chair and Chief Executive Officer Ellen Kullman says that "The Innovation Centers enable DuPont to harness its global science capabilities to create local solutions that are tailored to meet the most pressing market needs. In just two years, we have generated more than 225 active projects from this model."[14]

Figure 6: Companies with innovation facilities in major markets



12 PwC, "16th Annual Global CEO Survey: Key findings in the chemical industry", 2013.

13 DuPont corporate press release, "Inclusive Innovation in Action: New DuPont Innovation Center Launched in Iowa." http://www.dupont.com/corporate-functions/news-and-events/corporate-news-releases.html

14 Ibid

Talent for tomorrow

But today's market isn't the only challenge. Demographics are a factor too. There's a current generation of researchers and engineering getting ready to retire—and not enough new graduates in math and sciences coming to take their places. Some chemical companies and trade organisations have programmes in place to help increase the pipeline.

For example, German Chemical Industry Association (VCI) is giving 13 million Euros to schools, scholarships and scientists, as part of its efforts to support greater focus on the MINT (math, informatics, natural sciences, technology) fields.

And companies are getting into the act too. Dow Chemical Company is partnering with Saginaw Valley State University to establish The Dow Science and Sustainability Education Center on the university's campus. The Education Center will offer professional development for teachers—and classes and summer internships in a range of STEM (science, technology, engineering and math) fields. Programmes are available not just for college students, but for high school students as well.[15] It's a step in the right direction. But Dow Chemical's CEO Andrew Liveris acknowledges that it won't be enough on its own. He says "To make progress on a meaningful scale, we need to forge what I call a golden triangle of partnership: business, government, and society at large, working harmoniously together."[16]

"We must not subscribe to a philosophy of regimented risk aversion in our research, but rather must always have the freedom to take calculated leaps into the unknown. In other words, we must not hold back creativity and innovation through striving for unconditional success and perfection. Those who fail at an early stage can learn from this process and quickly start again—and thus ensure lasting success."

Prof. Dr. Wolfgang Plischke, Bayer AG, interviewed in Bayer research

15 Dow, "Liveris: STEM Talent Pipeline Key to Advanced Manufacturing Renaissance" http://www.dow.com/company/insights/multimedia/20131108a.html

16 Ibid

Expanding collaboration

Even if your company has a strong innovative culture and is attracting top talent, you'll still need to make sure that your smart people are collaborating with the talent outside of your organisation. More extensive collaboration efforts set the best innovators apart from the rest. Over 25% of executives from the top innovators say they're already co-creating innovative products and services with customers. That compares to 19% for chemical companies, in line with the overall average. But partnering with customers is increasingly becoming the norm. BASF's innovative partnership with Adidas on a new material for sport shoes (see *Better running shoes through chemistry*) shows how chemical companies can help their customers better meet the needs of consumers.

Examples like this are likely to increase if chemical companies follow through on planned initiatives. A full 88% of chemicals respondents say they have plans in place to collaborate with customers over the next three years to deliver innovative products and services. Evonik's Dr. Felix Müller told us that "Only 30% of all innovation projects are in close collaboration with customers but more than 50% of revenue results from these projects. This is due to guaranteed sales with these partners and the certainty of business need."

In our experience, the ways that sector companies are working together with customers goes beyond co-developing products. Some chemical companies are working with customers to develop new manufacturing processes too. And some are even looking at how their innovations could impact business models.

In our interview (see p. 18–19), the ACC's Mike Walls highlighted manufacturers' efforts to work together with customers to improve safety. He sees that as part of a broader move towards sustainability driven by partners across the value chain. His view echoes some of our past research, where we've found that the industry has a strong focus on helping its customers improve their sustainability.

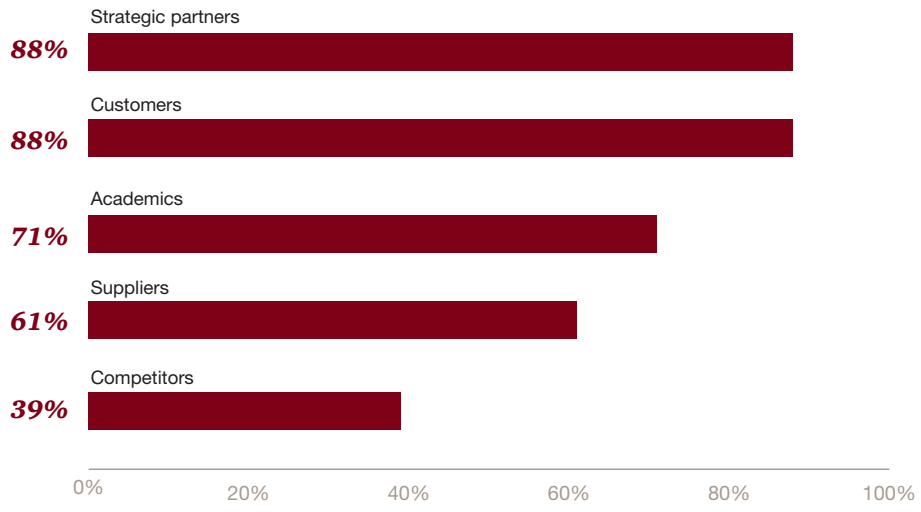
Relationships with strategic partners are also vital (see Figure 7). They're tied with customers at the top of the list for chemical companies. And compared to the global sample, more chemical companies are working with academia too. Seventy-one percent say they're planning to collaborate over the next three years, compared with just 56% of the total sample. And 61% are working with suppliers.

Sometimes, projects may involve collaborating across these groups. Evonik's Dr. Felix Müller told us that his company's "partners are often customers, competitors, and suppliers at once, depending on the product and its application."

But working together with partners isn't just a plan for the future—22% of chemical companies say they're already co-creating products and services with external partners. That's around the same as the global average, but significantly less than the 34% of top innovators across industries. We've seen that the most successful eventually become the "Partner of Choice" in their innovation ecosystem. That helps them attract the best ideas from strategic partners and suppliers alike, giving them access to faster, better, and cheaper innovations—a major competitive advantage.

Figure 7: Customers, strategic partners top the list of collaborators

With which of the following do you have a plan in place to collaborate over the next three years to deliver innovative products and services?



Better running shoes through chemistry

When you talk to runners, you're likely to hear about their need for "good cushioning." In running shoes, this is the function of the midsole: in just a few milliseconds, it absorbs the kinetic energy generated by the runner as the foot lands-and returns some of it to the runner while the foot is pressed down. High elasticity and deformability in the material that is used will increase the efficiency with which this happens.

Historically runners have had to choose between wearing hard, elastic competition shoes or very soft training shoes that offer a lot of cushioning. In less than three years, by working together, Adidas and BASF succeeded in resolving this dilemma. In a close partnership, the two companies developed the adidas BOOST™ technology. It's the world's first application of a new material, expanded thermoplastic polyurethane (E-TPU), which BASF is now marketing under the name Infinergy™. BASF used its process excellence to drive development of the innovative new foam plastic, which combines the benefits of thermoplastic polyurethane (TPU) with the typical properties of foams.

Source: BASF company press release, http://www.basf.com/group/pressrelease/P-13-301

Using open innovation and corporate venturing to spur growth

One way to collaborate with external partners is through open innovation. Across industries, open innovation stood out as the innovation process that executives felt was most likely to drive growth. It tops the list for chemical companies too—one third of respondents say it's the approach with the most potential to drive growth through innovation. Eastman Chemical, Dow and BASF are all proponents. Dr. Felix Müller at Evonik told us his company is increasing its efforts in this area too (see Interview, p. 12–13).

Governments and academia are actively involved. In 2012, an EU-sponsored pilot project "Open Chemical Innovation" brought together participants from the Netherlands, Spain, Germany and Italy.[17]

DSM has also been a vocal advocate of open innovation for nearly a decade.[18] The company's strategic commitment to open innovation was cited as a key factor in DSM's selection as Outstanding Corporate Innovator by the Project Development and Management Association (PDMA) in 2009.[19] For DSM, corporate venturing also has an important role to play in driving innovation.[20]

Compared to open innovation more generally, fewer chemical companies are turning to corporate venturing, but 15% see it as the most promising path to driving innovation. Some other major chemical companies with high-profile venturing activities include Dow, BASF and Evonik.

Corporate venturing is already the norm in the Technology sector, where 30% of executives ranked it as their top approach. Other research suggests that start-ups that went public after receiving at least one investment from corporate venture capital had better rates of return than those funded exclusively by independent venture capital firm.[21] Investing in small start-ups can help sector companies increase their exposure to a wide range of technologies. And they offer a chance to invest in potentially disruptive technologies without committing extensive internal resources.

17 Chemical Cluster Development in European Regions, Final Implementation Report: Pilot Project "Open Chemical Innovation", July 2012. http://lsa-st36.sachsen-anhalt.de/files/OI_Final_Implementationreport.pdf

18 See DSM's corporate website, https://www.dsm.com/corporate/about/innovation-at-dsm/open-innovation.html

19 DSM Corporate press release, https://www.dsm.com/corporate/media/informationcenter-news/2009/11/49-09-dsm-receives-2009-outstanding-corporate-innovator-award.html

20 Gaule, Andrew. "Gaule's Question Time: DSM Ventures and Licensing", Global Corporate Venturing website, 3. April 2012. http://www.globalcorporateventuring.com/article.php/3576/gaules-question-time-dsm-ventures-and-licensing

21 Harvard Business Review, "Corporate Venturing", October 2013, Josh Lerner

Where next for your business?

Product and process innovation have been transforming manufacturing for decades. The future will hold many more advances, as research around nanotechnology, analytics and additive manufacturing starts to influence applications.

Companies with an innovation edge will have a strong competitive advantage. What can you do to make sure your company is a leader and not a laggard?

- ***Know where you want to go and how you'll get there.*** Innovation requires careful planning and a clear vision. According to our survey, chemical companies lag behind the top innovators when it comes to having a defined strategy
- ***Look beyond R&D.*** Investing in research and development on products is an important part of innovation, but it's far from the whole story. Chemical companies need to build on innovation programmes in areas like technology and the customer experience. And business models should get a closer look too.
- ***Use strengths across your whole organisation.*** Chemical companies need to make sure they're investing enough and getting real value. Technological advances can help speed up the review process to get new products to market faster. Organising business units help keep innovation focused on customer needs, but don't overlook the ways a cross-enterprise innovation function can help improve performance too.
- ***Focus on people.*** The executives we surveyed say it can be hard to get and keep the right people on board to make innovation happen. Developing and maintaining a strong innovation culture that supports top talent is critical. And so are looking to new markets and supporting initiatives to the build the talent pipeline.
- ***Work together with the right partners.*** Finding the right external partners is a challenge for many of the executives we surveyed. But it's vital. In countries around the world, new research institutions are emerging to help bridge the gap between academic research and practical application. And new operating models around open innovation are enhancing collaboration potential. Chemical companies need to make sure they're reaping the benefits.

Want to find out more?

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We look forward to speaking to you.