

BUSINESS SWEDEN

INSIGHT SERIES 2019

MATERIALS OF THE FUTURE

TRUTH 6: BORN AT THE CROSSROADS

Materials engineers are always on the lookout for the next big thing. But customers are increasingly playing an instrumental role in shaping the innovation paths and materials that transform everyday life. In collaboration with Swerea, Sweden's world-class research group, and trend analyst firm Kairos Future, Business Sweden presents a special report in nine parts about the race for stronger, lighter, more sustainable, absorbable – and fully connected materials.

INTRODUCTION:
TRENDS AND TRUTHS IN THE
MATERIALS RACE

TRUTH 1:
DRIVEN BY CUSTOMERS FROM
HEAVEN AND HELL

Demanding customers who want more and pay less are a strong incentive for rapidly developing, new and better materials. This will lead to a future with higher degrees of collaboration with customers in order to understand their needs, ideally before they are aware of them themselves.

TRUTH 2:
ENVIRONMENTALLY FRIENDLY –
SUBJECT TO RESERVATIONS?
The materials of the future are obviously designed in environmentally friendly ways with lightweight, energy saving and low-carbon emissions at top of mind, but how simple will it be to recycle them? Complex, tailor-made materials place high demands on future recycling facilities.

TRUTH 3:
IN THE SHADE OF THE FOREST
The forest is a natural source of raw materials for much of what is made using oil today. Nations rich on forests have great potential for developing new, advanced materials industries based on raw materials.

TRUTH 4:
TOWARD A HYPER-DESIGNED
FUTURE
There is no reason to believe that the trend towards more intensively designed and customised products will slow down, quite the opposite. In future, materials may even be designed all the way down to atomic level in order to meet increasingly high demands.

TRUTH 5:
THE AGE OF CONNECTIVITY
Sensors can already be found on many products today, but in the future they will be embedded in materials to a far greater extent as woven fibres, smart coatings, conductive nanotubes or in other forms. The materials will be able to report fractures, overheating and other issues via the Internet of Things.

TRUTH 6:
BORN AT THE CROSSROADS
It is increasingly difficult for a single party to develop sophisticated and advanced materials. The materials of the future are therefore rarely born from a single company but in the interaction between several different parties, each with their own expertise, requirements and areas of strength.

TRUTH 7:
THE RISE OF NEW PIONEERS
New players from the IT and space industry, among others, are beginning to drive material developments to a larger extent. They can often afford to manage major collaborations or, if necessary, develop what they need themselves. Pioneers from other areas are entering the materials industry, both as partners and as competitors.

MATERIALS OUTLOOK 2020:
WHERE ARE WE HEADING?

IN THIS INSIGHT

Join us as we explore the seven truths about the materials race in depth. Go to www.business-sweden.se/en/invest/industries/new-materials

MATERIALS OF THE FUTURE, TRUTH 6

BORN AT THE CROSSROADS

The perception of the material researcher, like all researchers, is sometimes that of a lonely individual, most probably a man in a lab coat and glasses. He is bent over a microscope in a dark room, alone. Perhaps he is chewing the end of a pen or drumming distractedly on the table. Once he has invented something he will rush out to the waiting industry leaders who cheerfully take over and begin manufacturing the material.

VISITING THE LABORATORY WITH THE CEO

The above is of course a cliché and like many clichés it is a long-outdated idea. Industry leaders cannot afford to sit and wait for inventions – they need to be actively involved in the work, not only with the researchers but also with users who know what is needed. In the future this may be taken for granted. It is becoming harder and harder for researchers to independently develop new and better materials, especially with complex value chains and industrial realities that are distant and unknown to ordinary academics. The materials

of the future are born at the crossroads, in collaboration between industry, institutions, academia and government stakeholders.

Here, there is an opportunity to pre-adapt the materials for specific industrial needs: evaluate costs, uses, potential customers and suppliers. Different types of expertise and backgrounds open up rigid routines and preconceptions. Perhaps an independent inventor will still occasionally invent a new material, but there will be no guarantee that it is good enough, easy to manufacture or cost-effective enough for anything to be made from it. Materials do not exist for their own sake, they are there to be used.

A broad group of experts with many different skill sets will find it easier to meet future challenges. In fact, diversity is essential for progress. Six out of ten respondents in our survey stated that materials have become harder to manufacture and seven out of ten believe that the situation will get worse – both broader and more specialised expertise will be required to manufacture materials in the future, placing high demands on collaboration. No-one can be an expert at everything.

70%

of respondents to our survey stated that the materials of the future will be much more difficult to manufacture and require more specific properties. Just as many stated that materials will be more diversified and different from one another.



If we can get more powerful institutions involved we can improve applications and be quicker to integrate new materials in new products. As Sweden's business culture is less hierarchical, we can work with entire product cycles and with different players in the innovation system, which reduces development times and boosts creativity while improving customer value.

Open answer from the survey

BROADENING OF EXPERTISE NEXT ON THE AGENDA

Specialised expertise within specific fields will be a key necessity. According to seven out of ten respondents, materials are predicted to become more diversified and different from one another, which will result in high requirements for specialist knowledge within many industrial sectors.

When materials developers join forces at the intersection of different disciplines, the benefits only become greater and innovation picks up speed. Organisations that adopt the multi-disciplinary approach are already gaining major advantages, especially large companies that can combine materials knowledge with advanced IT skills, engineering skills and business acumen.

Tesla is a good example. It produces electric cars for normal consumers yet borrows materials knowledge, research and innovation in everything from space research, samurai swords and the backs of smartphones. In addition, four in ten respondents believe that materials will become harder to use and require greater knowledge among users.

Around half of the respondents also believe that material selection will become increasingly complex in the next decade – difficult for a single organisation and near impossible for individuals. This is because every aspect needs to be constantly monitored, from manufacturing processes to chemical compositions of materials to cost and application areas. Two heads are better than one, as the saying goes, but it is essential to ensure that they are the right heads.

THE GREAT COMMUNITY ERA

Materials development is moving into an era of community. Collaborations between companies and institutions, and between different countries, are likely to shape the future. An interesting example is the flagship project focusing on graphene, managed by researchers at Chalmers University in Gothenburg but with hundreds of participating universities and companies from no fewer than 17 EU countries. It illustrates the nature of the big, sweeping research initiatives that involve a great number of stakeholders and which we are very likely to see more of in the future.

Similarly, large collaborations are taking

Polycaprolactone, a popular material for 3D printing, recently became the basis for a new technology. Medical researchers from Texas A&M have discovered a way of making foam from the material in order to shape a "position" around which bone can grow.

LEGO in collaboration with WWF, initiated a project to develop more durable plastics and has established a "Sustainable Materials Centre" for this research.

The University of Gent has initiated a collaborative project with more than 30 universities and research institutions to improve the ability to simulate the different material properties of 71 materials. Collaboration was crucial as no single institution was knowledgeable enough for all of the materials.

The MAX IV-laboratory in Lund is planning to welcome 2,000 visiting researchers each year. It is the most modern synchrotron in the world and has been developed in collaboration with Vinnova, Lund University and Region Skåne.

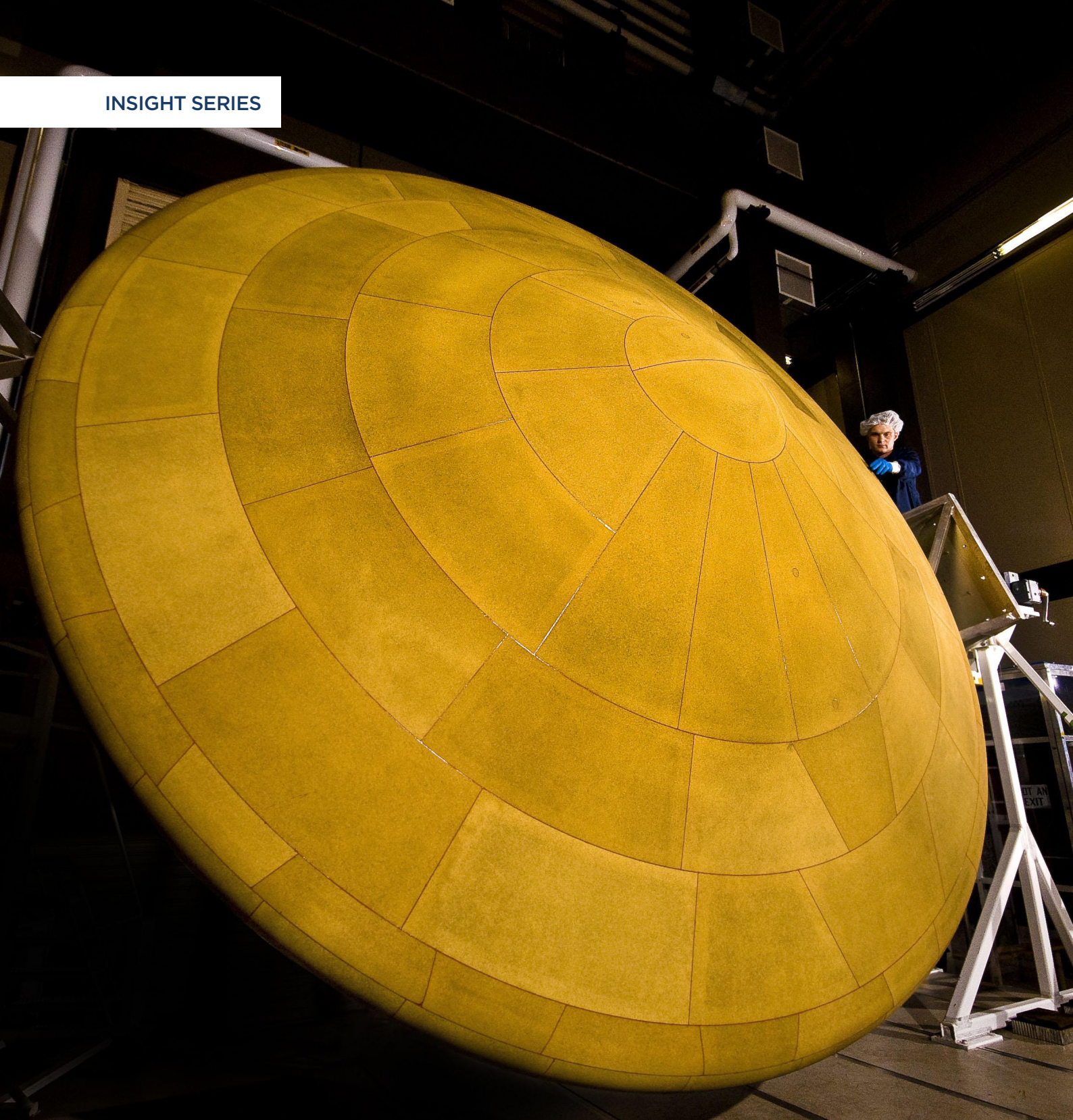
place in the United States. An initiative by The Materials Science Laboratory (MSL) at NASA was launched to collaborate on the research for materials aboard the ISS space station. The project means that various researchers around the world can collaborate on the experiments conducted at the space station and build on each other's research. We will probably see even more large projects such as these with multiple stakeholders in the future, which can bring both challenges and possibilities for smaller companies that have a lot to gain from participating and everything to lose by being left outside in the cold.

43%

of respondents to our survey stated that the materials of the future will be much more difficult to use and will require more from users.

66%

of respondents to our survey stated that increased collaboration between companies, academia and research institutions is an essential strategic opportunity for Sweden.



PICA, Phenolic Impregnated Carbon Ablator, was invented by a team managed by Dan Rasky at NASA. The material is used as a heat shield on the Stardust spacecraft, which re-entered the atmosphere in 2006 at breakneck speed – it was the fastest man-made material that had ever moved through the atmosphere without being completely destroyed. The material is exceptionally heat-resistant but it was left untouched for half a decade after its first assignment and was only used in small amounts. Until SpaceX discovered its existence. They employed Dan Rasky, scaled up production and constructed a heat shield for the Dragon spacecraft in less than four years, at a fraction of what it cost NASA. Traditional players may invent the materials of the future – but who will manufacture them?

A DIVIDED INDUSTRY?

Will the materials industry succeed in collaborating to the extent required in the future? Possibly. But this radical change will not occur by itself – it takes both substantial investments and hard work which, it seems, is clearly worthwhile: two-thirds of respondents say that the most important strategy for improving Swedish materials research is to strengthen cooperation between companies, academia and research institutions.

Collaboration was by far the most favoured option in our survey. This, more than anything, suggests that materials development needs a great boost of strength – not just in terms of resources but also commitment from industry leaders and policy makers. In order to increase collaboration and boost innovation capacity, someone needs to take initiative both nationally and across borders. Those who position themselves in this key role and are able to coordinate many stakeholders have excellent prospects. Sandvik is one such example, having positioned itself well to monitor and collaborate with interesting stakeholders in academia, which is necessary for making a forward leap.

YEAR 2030: UNLIMITED RESEARCH

The material research institutions of 15 years ago are unrecognisable today. They have evolved tremendously from predominantly being laboratories to becoming agile and flexible

organisations that capture the knowledge of the research community, industry and individuals. We are now truly shaping the life of materials – from mine or land to recycling – and we are involved at all stages to observe, collect information and make improvements. Consumers who were previously far-detached from frontline research are now engaged as participants, helping material developers make improvements. The thick and heavy walls between research and society have crumbled and it is strange to think that we once did not even know they existed.

STRATEGIC RECOMMENDATIONS

Explore available skills for developing future materials beyond the confines of the organisation. In other words, look to suppliers, partners and customers and take an active role in their development processes. These collaborations are often where the magic happens. Encourage and drive collaboration between researchers and industry. Collaborative projects that lack commitment and resources are a waste of time.

947 mn Euro

in research contributions in ten years. This is the amount provided overall in European funding for the flagship research project on graphene, led by the Chalmers University in Gothenburg.



Collaboration has tremendous potential and I hope initiatives will become even more efficient. Is this a question of attitude or perhaps that CEOs need to meet with research managers and work together more symmetrically?

Lars Hultman, CEO, SSF Swedish Foundation for Strategic Research



SWEDEN – A NATION RICH IN FORESTS AND MINERAL RESOURCES

Sweden is Europe's leading mining nation and a global forest industry giant. These natural resources formed the bedrock for Sweden's industrialisation. And they remain important today. But times are changing. Digitalisation is eroding demand for newsprint and new technology is driving innovative applications for traditional metals and high-tech metals. Sweden hosts mineral deposits like graphite, lithium, rare earth metals.

The shift towards sustainable development and renewable materials is transforming the forest industry to a stronger orientation towards higher value products. Innovative companies are using Swedish wood to develop new bio-based materials such as barrier films, chemicals, carbon fibre, textile fibers and other applications with industry-changing potential.



ABOUT THE AUTHORS

Swerea (now RISE Research institutes of Sweden): In 2018 two thirds* of Swerea was acquired by RISE Research Institutes of Sweden (RISE), continuing its scientific work as a part of a total force of 2,700 researchers and experts with extensive industrial knowledge and experience of how to accelerate research results into innovation for practical use. RISE is a unique mobilisation of resources with the aim to increase the pace of innovation in our society. It is owned by the Swedish State and work in collaboration with and on behalf of the private and public sectors and academia, with the ability to take on a variety of roles in the innovation system.

** 1 third of Swerea created the new metal research institute Swerim.*

Kairos Future: Kairos Future is an international consulting and analysis firm that helps companies take leaps towards the future. Through trend and scenario analysis and support in innovation and strategy, we help customers with the big picture and the direction for the future. Kairos Future was formed in 1993, our head office is situated in Stockholm and we have partners worldwide.

Business Sweden: Business Sweden helps Swedish companies grow global sales and international companies invest and expand in Sweden. We ensure that international companies can rely on our knowledge, experience and extensive network to identify new business opportunities and achieve an accelerated return on investment. Business Sweden is present in 50 of the world's most promising markets and owned by the Swedish Government and the industry, a partnership that provides access to contacts and networks at all levels.



We help Swedish companies grow global sales and international companies invest and expand in Sweden.

BUSINESS SWEDEN Box 240, SE-101 24 Stockholm, Sweden
World Trade Center, Klarabergsviadukten 70
T +46 8 588 660 00 invest@business-sweden.se www.business-sweden.com

