



## A sense of purpose

Aligning global R&D in today's fast-moving environment

12

Implementing a digital shift

28

Cyber-threat: Is your business prepared for an attack?

42

Shaping the oil company of the future

56

Demystifying robotics: A drone's eye view

74

Interview: Using innovation to create sustainable growth

91



# Arthur D. Little

*Arthur D. Little has been at the forefront of innovation since 1886. We help companies continuously Anticipate, Innovate and Transform to achieve sustained business success in today's disruptive business environment:*

- *Anticipate future trends and build resilient strategies that embrace complexity*
- *Innovate to deliver more, faster, cheaper products, services and business models, accessing the best external talent*
- *Transform organizations, processes and cultures to continuously adapt*

*We are problem-solvers and combine deep industry insight, functional skills and entrepreneurial flair to find and deliver new solutions. With our open consulting approach we bring the best global experts to every assignment, complementing our internal strengths. We are proud to be present in the most important business centers around the world, serving the world's leading corporations and public sector organizations.*

## The Prism Board

Ralf Baron	baron.ralf@adlittle.com
Rick Eagar	eagar.richard@adlittle.com
Juan Gonzàlez	gonzalez.juan@adlittle.com
Delphine Knab	knab.delphine@adlittle.com
Michael Kolk	kolk.michael@adlittle.com
Thomas Kuruvilla	kuruvilla.thomas@adlittle.com
Greg Smith	smith.greg@adlittle.com
Chulseung Son	son.chulseung@adlittle.com
Srini Srinivasan	srinivasan.srini@adlittle.com
Koji Uchida	uchida.koji@adlittle.com

**PRISM** is published biannually by Arthur D. Little, the global management consultancy.

We are eager to hear from our readers! Please address your comments to our editorial office at Arthur D. Little, New Fetter Place West, 2nd floor, 55 Fetter Lane, London EC4A 1AA, United Kingdom – Telephone: +44 7710 536 471. Copyright 2019, Arthur D. Little. All rights reserved.

Editing by Catalyst Comms, London: ad@catalystcomms.co.uk.

# Table of Contents

## *A sense of purpose*

### Aligning global R&D in today's fast-moving environment

12

Innovation is central to success for businesses today, yet many large, asset-heavy companies with decentralized business units struggle to combine R&D agility with common, clearly communicable corporate strategies. This article, based on experience at a large global energy company, explains how a purpose-driven approach to R&D can deliver innovation agility across the organization.

*Vincent Bamberger, Florent Nansé, Ben Thuriaux-Alemán, Michael Kolk, Rick Eagar*



### Implementing a digital shift

28

Today, every company wants and needs to become digital. However, what this actually entails will be different depending on the industry, size of the company, and competitive environment. Businesses essentially need to find the right degree of digitalization – their digital “equilibrium”. By exploring some of the key problems traditional businesses face on their digital journeys, and how to overcome them, this article outlines how every business can realize the digital shift and create equilibrium.

*Heike C. Wörner, Fabian Sempf, Dr. Fabian Dömer, Volker A. Pfürsching*

### Cyber-threat: Is your business prepared for an attack?

42

Despite the emphasis on and investment in cyber-security, traditional approaches, which tend to focus on either technology or risk, are failing to protect businesses and their customers. This article explains the benefits of adopting a new, unified approach that brings together technology and risk management processes. It enables organizations to better protect themselves against cyber-threats, thus safeguarding their businesses, data and revenues.

*Tom Teixeira, Jamie Gale, Mandeep Dhillon, Immanuel Kemp*



**Shaping the oil company of the future 56**

After over a century of growth, demand for oil is likely to peak and begin to decline by around 2035. This will lead to radical transformation of the industry, convergence, new entrants and new business strategies. What will this future ecosystem look like? Will existing players be able to survive and even benefit from these new challenges? We explore the options for the successful oil company of the future.

*Daniel Monzón, Rodolfo Guzmán, Jaap Kalkman, Stephen Rogers, Augusto Kinbaum*



**Demystifying robotics: A drone’s eye view 74**

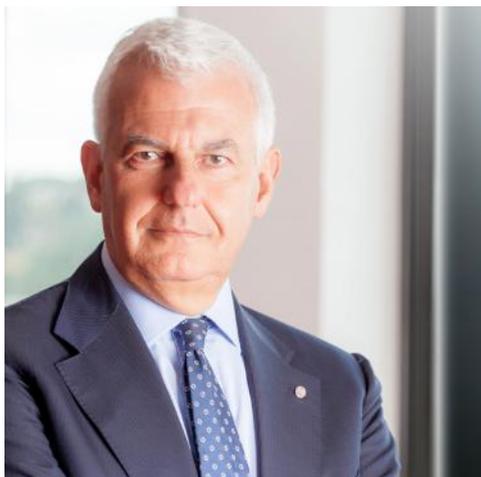
Robotics is transforming businesses in multiple industries across the globe. Already a \$100 billion market, it is growing rapidly thanks to improvements and declining costs in sensors and AI software. However, the robotics sector is not well understood by executives or investors. This article provides a primer to explain market dynamics and the key considerations businesses need to focus on if they are to successfully embrace the opportunities it offers.

*Ingrid af Sandeberg, Dr. Yingzhi Zhu Ryberg, Petter Kilefors*

**Interview: Using innovation to create sustainable growth 90**

Leonardo S.p.A. (formerly Finmeccanica Group S.p.A) is a major player in the aerospace, defense and security systems markets. At a time of disruption and rapid technological progress and change, Alessandro Profumo, Leonardo’s CEO, explains how its focus on innovation, combined with its One Company vision, is future-proofing the business across the world.

*Interview with Alessandro Profumo, CEO, Leonardo S.p.A.*





# Editorial

## Dear Reader

From time to time concepts that, at first sight, seem quite old fashioned suddenly get a new lease of life. For example, open innovation has been around for decades, but it's come to the fore again in recent years in the context of converging industries, start-up collaborations and the rise of the innovation ecosystem. Similarly, the idea of a "sense of purpose" has been around since the birth of industry: the first entrepreneurs of the late 19th and early 20th centuries, such as Henry Ford and John Cadbury, were both driven by a clear sense of purpose based around manufacturing products which would benefit society as well as create business value. A sense of purpose is much more fundamental than a mission, and therefore potentially more enduring, inspiring and powerful. In today's business world, in which companies can no longer be defined only in terms of their often rapidly changing products and services, a clear and inspiring sense of purpose has once again become essential. This is our theme for the first Prism edition of 2019.

In our lead article we look at how having a clear a sense of purpose can help solve one of the biggest challenges for large, decentralized organizations – enabling innovation agility and dynamism across a large R&D network with a complex and diverse technology portfolio. Based on a recent case example, we illustrate how to go about this difficult process.

Digital transformation is rarely off the agenda, and in our second article we explore the challenges companies face and how to overcome them. One of the keys is to have a clear idea of how far to go – the "digital equilibrium" – and ensure a solid foundation to build on, focusing on people, not just technology.

In our other articles we focus on specific topics relating to how to deliver growth, profitability and value in today's rapidly changing business environment. Cyber-threats are becoming ever more critical, and traditional approaches often fail to protect businesses. We examine a new, unified approach that brings together technology and risk management processes. A clear sense of purpose is also critical for today's oil companies, which face a volatile socio-political environment, a future of finite resources, and an obligation to address important environmental concerns. We take a look at what the oil company of the future may look like. And in our last article, we demystify the much-hyped world of robotics: how does the market work, and which segments are likely to be successful?

Finally, we are delighted to bring you an exclusive interview with Alessandro Profumo, the CEO of Leonardo, a major player in the aerospace, defense and security systems markets. Mr. Profumo explains how his focus on innovation, combined with his One Company vision, is future-proofing the business across the world.

As always, we hope you enjoy the insight from our experts at Arthur D. Little, and we wish you every success in fulfilling your "raison d'être"!



Rick Eagar  
Chief Editor, Prism  
Arthur D. Little







# Innovation purpose

## *Aligning global R&D in today's fast-moving environment*

Vincent Bamberger, Florent Nansé, Ben Thuriaux-Alemán, Michael Kolk, Rick Eagar

### Defining your innovation purpose

Innovation success for large companies in today's business world is increasingly reliant on how well they can respond



to global competition, fast-moving technology developments and threats of disruption. Agility and dynamism can be especially challenging for large, asset-heavy businesses with long investment cycles, such as global energy, chemicals, and industrial manufacturing groups. These often have decentralized business units (BUs), which makes it hard for the CTO to create synergies across them, maintain clear and transparent linkages between corporate strategy and BU R&D, and communicate

the value of R&D externally and internally. Traditional rigid and mechanistic, process-based approaches to setting R&D strategy often fail to address these challenges. In this article we look at a new, purpose-driven approach which has been successfully applied by a large global energy company.

### The challenges of aligning R&D

The CTOs of global industrial and manufacturing groups with technology-intensive products and services will tell you that despite the undeniable importance of start-ups and other external innovation ecosystem partners, internal R&D still needs to be at the core of the innovation effort. External parties are usually unable to make the necessary resource investments for long-term, core R&D, and in any case, maintaining leading competencies in core technology areas is usually vital to maintaining competitive advantage.

Innovation is central to success for businesses today, yet many large, asset-heavy companies with decentralized business units struggle to combine R&D agility with common, clearly communicable corporate strategies. This article, based on experience at a large global energy company, explains how a purpose-driven approach to R&D can deliver innovation agility across the organization.

However, there are multiple challenges in the traditional way of aligning R&D strategy and program activities, for example:

- **Technology mastery:** New technologies now often evolve at a faster pace than can be managed internally. The potential to combine innovations from different domains accelerates the pace of change, increasing disruption threats. A rigid technology strategy can become obsolete within months.
- **Business alignment:** The traditional “client/provider” relationship between business and R&D, based on annual (or biannual) alignment, is no longer effective. If the logic underlying investment decisions is not transparent, it becomes difficult to understand the value created by mastering a particular technology and how it supports the high-level strategic vision, particularly when technology is rapidly evolving. Fast and continuous alignment is needed on where R&D should focus and what level of performance should be attained. This can only be accomplished by providing decision-making autonomy to support clear product/service attributes defined by the business units.
- **Communicating the value of R&D:** Being able to clearly articulate and communicate the value of R&D internally and externally is essential, as with any business function. With few clear links between R&D activities and strategy, articulating value is difficult across a diverse and changing portfolio.
- **Legacy ways of working:** Internal R&D organizations often suffer from inefficient legacy management structures, inflexible working practices and cultures of suspicion, often fueled by histories of budget cuts. Over-reliance on “process” often leads companies to continue to work the same ways as they have in the past – but this may not be appropriate for the present and future.
- **Attracting and retaining the best performers:** Talent is more mobile than ever before. The new generation of scientists and researchers increasingly value their freedom to create and express themselves, and tend to place higher value on the “meaning” of their work and aligning with inspiring goals or missions.

These challenges mean it is increasingly difficult to use only operational, process-based approaches to prioritizing the R&D portfolio. Such approaches often result in poor resource allocation, inappropriate organizational structures and demotivated staff.

## **How to overcome the challenges: Company X and its purpose-driven approach**

To overcome these challenges, Company X, a global energy multinational, recently redefined its R&D purpose and innovation strategy, working with support from Arthur D. Little.

Company X had already embarked on a major initiative to strengthen its integration across its various business units by defining a common vision (across upstream, downstream refining, etc.).

The vision set out a common ambition for the group, and aimed at better coordinating the strategies and resources of each unit and the group, while maintaining a strong culture of entrepreneurship and improving agility.

### **Defining purpose**

A first step to enabling innovation synergies at group level was begun in 2016 via a new organization, which launched cross-unit transversal programs, coupled with a single, global R&D budget. However, R&D activities were still managed at business-unit level, without group-wide consistency and vision.

Company X then launched a project aimed at defining its innovation purpose in a clear and compelling way, and defining how this could be delivered through key assets such as technology, human capital, and ways of working. These were designed to be consistent with each BU's R&D, which allowed the R&D teams to focus on a common goal and align their program portfolios accordingly.

## **Creating the pyramid**

The building process was accomplished by first establishing “innovation purpose pyramids” for each BU, in which an innovation purpose was developed, including business attributes to be delivered, technology “bricks” on which the BU should focus, and ways of working to achieve the goals. Alternatives were then elaborated on for the group innovation purpose through an iterative process, taking into account BU and group strategy input, a company-wide survey, and external benchmarking.

The group innovation purpose was then selected based on criteria that ensured relevance, robustness and impact on key stakeholders.

## **Reaping the benefits**

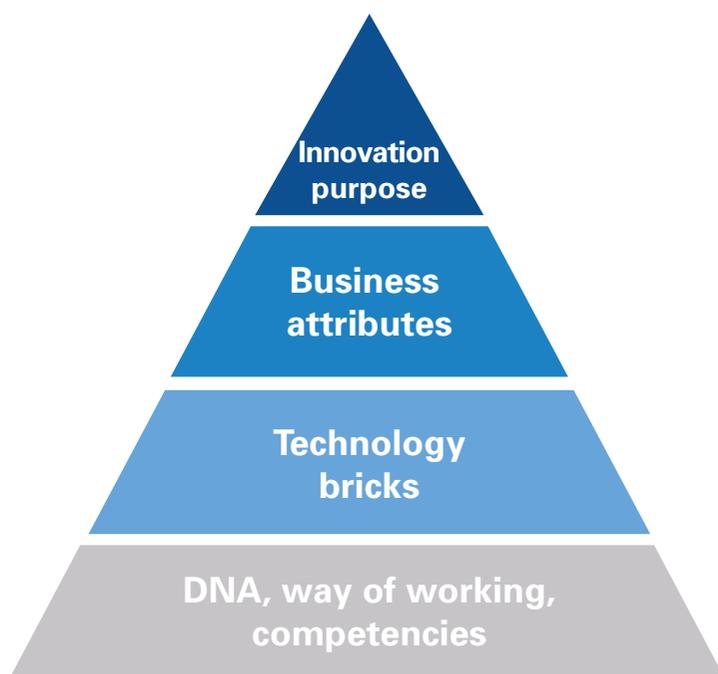
As a consequence, Company X:

- Now communicates internally and externally with a single, clear R&D vision and identity, and consistent, credible, sustainable, and impactful messages to its different stakeholders.
- Is assessing the impact of all its R&D programs in terms of their contributions to business attributes. This impact assessment is used as a key dimension for R&D program portfolio management.
- Benefits from a clear vision of the impact of its technology bricks and can refine its technology strategy accordingly. This allows for more dynamic, flexible and agile response to changes and disruption, while maintaining a coherent overall direction.
- Is now able to establish consistent governance, taking technology bricks as the most granular element to be monitored by the R&D executive committee.

## **Lessons for aligning R&D**

The key to the success of Company X’s approach is its use of a transparent model to align R&D efforts with a clear and compelling narrative around an innovation purpose. The model links R&D activities with differentiating attributes that can be deployed in the market, focusing resources and

investments, leveraging intangible assets, and ensuring coherence of activities. This provides structure and meaning, but at the same time allows for the flexibility, agility and rapid, autonomous decision-making that is needed in today's business environment. The model can be summarized in terms of four layers, as shown in Figure 1:



**Figure 1: Building “innovation purpose” should be based on solid and consistent layers; we will rely on our proven methodology to drive consistency**

### **Layer 1: Innovation purpose**

At the top of the pyramid, the organization needs to create an attractive and robust sense of purpose for R&D that is suitable for all stakeholders and differentiates the company from competitors. It has to be memorable, easily sharable by all employees, and communicable in a few words. The innovation purpose needs to:

- Give meaning to R&D: Clarify the “raison d’être” of R&D and create coherence within the department and beyond, empowering, motivating and inspiring staff.

- Ensure clarity and resilience: Create a common understanding to guide autonomous decision-making.
- Facilitate communication: Articulate a consistent message for different stakeholders, such as shareholders, employees, the R&D team, future recruits, clients and partners.

The relatively simple and lean output of this layer hides a delicate alignment process – each word in the purpose can eventually impact the nature of R&D. For example, positioning the R&D department as a “scientific leader” results in different choices and investments than if it were called a “solution provider”. A good “purpose” is much more than just a basic mission or set of aims – it forms the basis of an innovation narrative that both inspires and guides.

**Layer 2: Business attributes**

These are key performance areas where the R&D department is aiming to bring improvement to the business; for example, lowering product cost or limiting environmental impact. These should be essential to implementing one or more axes of company strategy, on which the company is well positioned or able to position itself, and where technology-driven differentiation is possible – as shown in Figure 2:

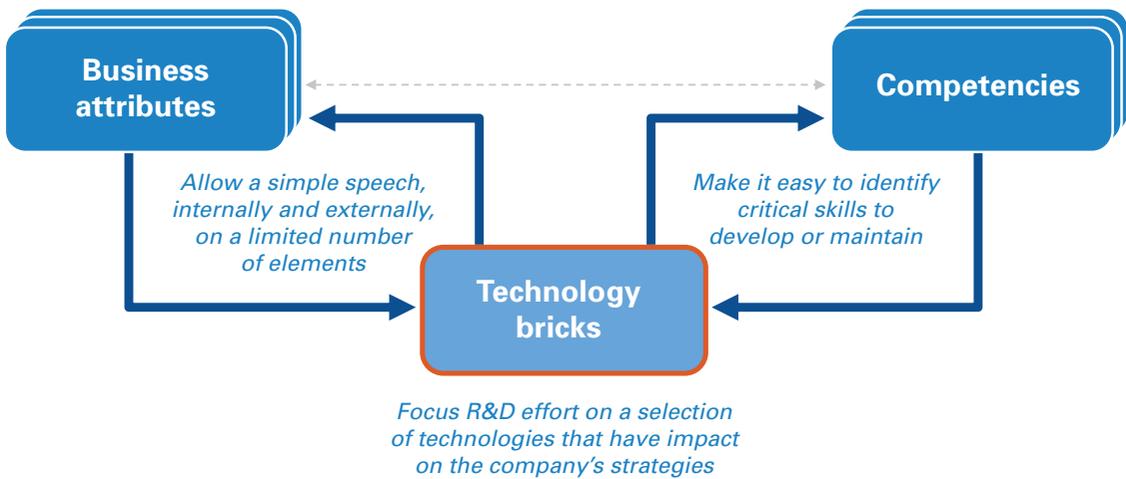


Figure 2: Definitions of business attributes

Making the business explicitly identify the key attributes needed to support it and differentiate its position is an exercise that often goes against the natural trend of asking for improvement in multiple, often conflicting, directions. Many R&D teams will have heard, “I want my R&D to provide first-class performance in differentiating our product’s environmental footprint,” and one sentence later, “I want my R&D to work to drastically decrease our product costs.” At the same time, the expected level of performance is an area where business and R&D struggle to clarify or quantify success. For example, “first-class performance on environmental footprint” might be better expressed as “decrease CO2 emissions by 20 percent”.

**Layer 3: Technology bricks**

These are technology areas in which the company has a strong and sustainable technological advantage. They relate to differentiating product components or processes and enable improvement on one or several business attributes (see Figure 3):



**Figure 3: The relationship between business attributes, competencies and technology bricks**

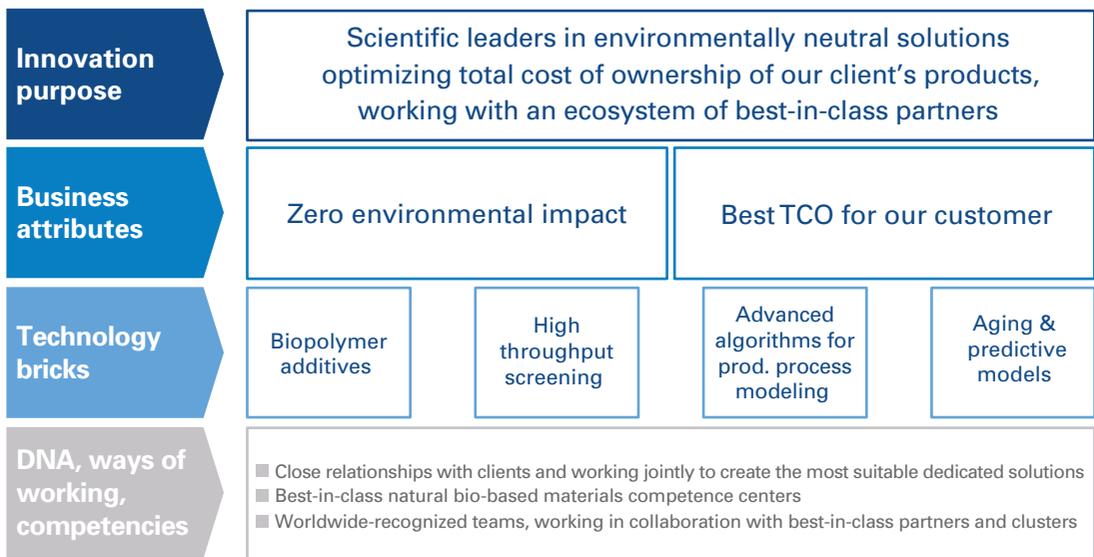
Selecting which technology bricks to support means choosing not to support others, which makes it particularly difficult for groups of curious and passionate researchers. Moreover, it requires deep discussions on the link between technologies and their business impact. This healthy dialog is all too often neglected or covered only at very high levels. Additional complexity lies in the sizing dilemma when defining the perimeter of each brick. A brick should not be too large, as this prevents focused effort, or is too limited, which can lead to a complex and unmanageable inventory of technologies.

Apple's iPod is a good illustration of this approach. It entered the MP3 player market five years after many of the early starters. This gave the company the advantage of both understanding the approaches of competitors and knowing that most of the necessary technology had already been created. Apple therefore focused on leveraging two technology bricks in its device – hard-drive technology that could store thousands of songs and a user interface that appealed to a larger portion of the consumer market. These two bricks allowed it to differentiate and eventually consolidate a fractured market, capture 70 percent of the business, and redefine what an MP3 player should be.

#### **Layer 4: DNA, ways of working, competencies**

These are the key intangible assets, know-how and ways of working (either existing or to be developed) that help to achieve company goals. Each company relies on its own processes, organization, and culture, with these characteristics providing the raw material for its innovation purpose foundations. However, the difficulty lies in understanding their complexity and drawing a clear distinction between the essential ones and those that lead to dispensable bureaucracy, self-justifying their existence.

The results of the innovation purpose exercise can be readily summarized at a high level for communication purposes, as follows:



**Figure 4: Example innovation purpose pyramid for a chemical company that provides plastic parts for the automotive industry**

How the purpose is formulated can have a big impact: for example, if the purpose statement in Figure 4 had instead been “Smart integrator of solutions enabling the best compromise between product recyclability and low cost for our clients”, the content of the three layers below it would have been different, even though the basic themes of “environment” and “competitiveness” would have been the same.

**Bringing the framework to life**

Applying this approach to a large organization requires close collaboration and input from management, business staff, and a range of R&D staff working at corporate and business-unit level. Typically, benefits can be delivered in eight to 15 weeks, including time to allow sufficient reflection and consultation.

There are typically four main tasks:

1. Assess current layers
2. Develop options
3. Choose options
4. Prepare for implementation

## **1. Assess current layers**

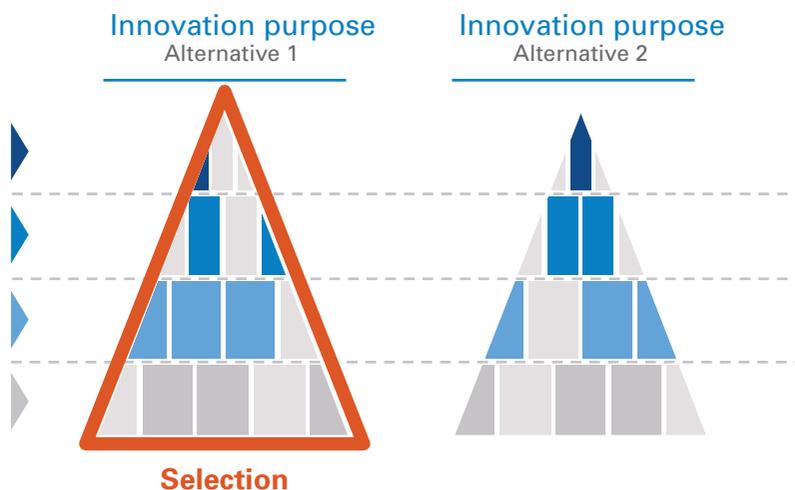
To ensure that the innovation purpose and business attributes are positioned to maximize competitive differentiation, information needs to be gathered on each layer of the innovation purpose pyramid – not just for the company, but also on its major competitors and related market trends. For the internal data gathering, it is helpful to use a structured format for each department to describe mission-critical business attributes supported by R&D, technology bricks to deliver these attributes, and key values. Being clear about terminology and establishing common vocabulary is an important prerequisite.

## **2. Develop options**

A balance between top-down and bottom-up approaches is needed to set out options for the innovation purpose. In general, the lower the layer, the wider the audience with which the company needs to engage. For example, at the DNA, ways of working, competencies level, a broad range of stakeholders is needed to ensure alignment between R&D and other functions. The technology brick layer is discussed with senior staff who can understand the relative contribution of one technology brick compared to that of another for the wider business. The business attributes layer is discussed with businesspeople who have a clear vision of high-level R&D impact on the market. Throughout the process, it is important to leverage and build on existing roadmaps and relevant linkages here, rather than redesign from scratch.

### 3. Choose options

The next step is to choose between innovation purpose options (Figure 5):



**Figure 5: Selecting between an internally coherent combination of options for innovation purposes**

For example, different top-level innovation purpose statements will give rise to different required business attributes, and in turn, different sets of technology bricks, and so on. In this way it is possible to create a limited number of alternative options, each comprising a combination of selections at each of the four layers. This is similar in nature to scenario-planning – the example shown in Figure 4 for the chemicals company illustrates what such an option could look like.

Companies should prepare for this phase by establishing criteria such as alignment, actionability, credibility, sustainability, uniqueness and relevance. Broader company strategies, external benchmarks and likely stakeholder impact are used to inform the options selection process, and typically finalized through senior management workshops. Involvement of business executives in the process is important to challenge the business attributes layer in order to ensure full alignment with business strategy.

#### **4. Prepare for implementation**

In the final step, action plans are developed for the full range of external and internal implementation levers, from recruitment and client communication through to portfolio management and technology development. For example:

- R&D program portfolio management: R&D programs can now be assessed on their contributions to technology bricks and business attributes, which sets the basis for strategic reviews of the R&D portfolio and enables direct monitoring of the R&D program's impact on business performance.
- R&D technology strategy: Priorities and levels of investment for each technology brick can now be easily agreed, and thus, suitable make/buy/partner strategies formulated.
- Communication: A coherent R&D communication program can now be set up, which will ensure consistency of messages for different audiences.

Engaging and aligning the organization behind the innovation purpose is key for enabling effective structuring of processes, systems and ways of working to implement these levers. The innovation purpose provides a backbone, a vehicle for engagement across different BUs and functions, a guide for decision-making, and a sense of momentum to drive change.

#### **Insight for the executive**

The fast-moving environment, a globalizing and digitalizing world, complex technologies, and evolution of R&D employee expectations are driving critical changes to innovation and R&D management. There is an increasing mismatch between today's needs and the traditional, heavily process-oriented ways of managing innovation and R&D.

To succeed in this new era, companies need to find platforms of stability and consistency to enable them to fully leverage their investments and resources in agile, flexible and dynamic ways. They must also be able to communicate this sense of purpose and direction to the markets and their own staff.

The innovation purpose approach provides a robust framework to help companies navigate uncertainty. It engages R&D in a natural transformation process, clarifies the benefits it brings to the business, and helps select the technologies required to differentiate and optimize resources, all while leveraging the R&D department's culture and ways of working.

The key elements that executives should focus on in adopting the innovation purpose approach are:

- Reinforce people's autonomy and inspire the current "meaning-driven" generation of scientists and researchers by clarifying the fundamental purpose of R&D and innovation.
- Ensure a common understanding of what is expected from R&D to support business success by defining the key business attributes, products and services which are impacted by technology.
- Focus R&D and innovation resources by selecting key differentiating technology bricks that support performance improvement of selected product or service attributes, ensuring that they are defined at the right level to promote agility and flexibility.
- Ensure resilience and acceptance by making clear the consistency and logical linkages between your company's guiding purpose, technology-driven strategic business attributes, key technology bricks, and intangible assets.

Embracing change is critical for today's large R&D organizations. Without a strong underlying sense of purpose, continuous change can quickly lead to complexity, uncertainty, inefficiency and low morale. Executives should consider whether they need to take appropriate action.



**Vincent Bamberger**

is a Managing Partner in Arthur D. Little's Paris office and a member of the Strategy & Organization Practice.

**Florent Nansé**

is a Principal in Arthur D. Little's Paris office and a member of the Technology & Innovation Management Practice.

**Ben Thuriaux-Alemán**

is a Principal in Arthur D. Little's London office and a member of the Technology & Innovation Management Practice.

**Michael Kolk**

is a Partner in Arthur D. Little's Amsterdam office and a member of the Technology & Innovation Management Practice.

**Rick Eagar**

is a Partner in Arthur D. Little's London office and leads the Technology & Innovation Management Practice.

Arthur D Little PRISM



# Implementing a digital shift

Heike C. Wörner, Fabian Sempf, Dr. Fabian Dömer, Volker A. Pfirsching

Every company today wants to become digital – but what does it actually mean to be digital? What does it mean for your industry, the size of your company, and the competitive environment you are currently operating in? Essentially, how can you find the right degree of digitalization – your digital “equilibrium”?

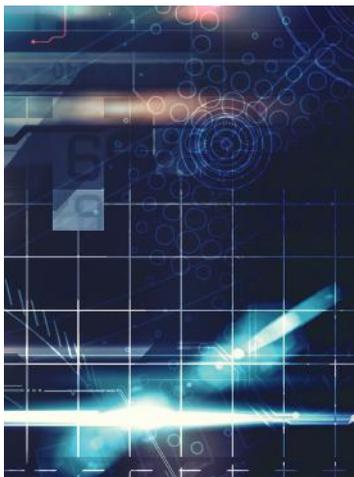
Many traditional companies have embarked on the digital journey and started to adapt to a more customer-centric environment by modeling themselves after companies

such as Amazon and other tech giants. However, this is unlikely to be the right approach – as evidenced from their internal processes and infrastructure, these legacy companies are far from the efficiency levels and effective structures that new entrants can build from scratch.

The management team of a company in an asset-heavy service industry pointed out to

us recently that their organization would never become a “digital company.” They had looked at Amazon and believed the company would need to only sell digital products, thus completely changing its business model. However, this is not necessarily the case – being digital takes multiple forms. This article sets out a roadmap to help companies understand what becoming a “digital company” means for them and how a digital equilibrium can be achieved, based on experience with traditional, “non-digital” businesses. The key question is, “What should your company look like in the age of digitalization?” We will explore some of the key problems traditional businesses face on their digital journeys, as well as share insight and outline ways to overcome them, in order for them to realize the digital shift and create equilibrium.

Today, every company wants and needs to become digital. However, what this actually entails will be different depending on the industry, size of the company, and competitive environment. Businesses essentially need to find the right degree of digitalization – their digital “equilibrium”. By exploring some of the key problems traditional businesses face on their digital journeys, and how to overcome them, this article outlines how every business can realize the digital shift and create equilibrium.



## **The theory: What makes a digital company?**

A digital company makes use of digitalization in a way that increases its value. Achieving this requires a holistic approach, which covers:

- The business model
- Processes and organization
- Digital enablers such as data and technology
- Employee skills and company culture

Equilibrium needs to be found for each category. The right degree of digitalization is the degree that optimally supports company goals. Most companies have many digital initiatives running, but several of these may be disconnected from corporate objectives. Finding out which add value and contribute to company goals is key to finding the digital equilibrium.

But how can companies start the digital shift? Moving from a few digital “lighthouses” to a digital company brutally reveals the complexity that every large corporation has accumulated over many years. To get some tangible impact, a lot of groundwork needs to be done. Many legacy companies also need to overcome severe structural obstacles. In Germany, for example, a logistics company wanted to equip its vehicles with GPSs and gather data to give customers better estimates of delivery times. However, employee representatives saw this as illicit staff surveillance and prevented it.

We also witness a lot of “human interference” by employees or units that fear they will lose their power or status to new departments, or even to computers. In some cases, especially in manufacturing industries, employees are so trained and focused on continually delivering the highest-quality products, that the digital concept of failing and testing until a solution is established is against their very nature. In those companies, the only way to begin the digital shift is to start small and analyze where the most benefit is to be expected. On top of that, they need to heavily invest in digital competencies in these areas, as well as in changing overall company culture to make it more open and adaptive.

## Five areas to address to enable a digital shift

To help traditional organizations deliver digital shifts and achieve equilibrium, we have identified five key aspects that need to be incorporated into strategy and execution.

### 1. Worry about getting the data before introducing the technology

Digital shifts are mainly driven by new digital technologies. This means staying on top of the latest innovation is a basic requirement for all other initiatives. However, mastering most of those new technologies requires reliable data, which is a problem in many companies today. A good example is when a company employs artificial intelligence within some of its processes. First, it can prove to be very difficult to collect and access certain data pools, and second, the quality of data is still a major concern to many legacy companies. While human beings are often able to interpret fuzzy or even false data correctly, computers are not. Defining good data structures and supplying high-quality data is therefore a crucial foundation for successfully introducing new digital technologies.

### 2. Reengineer processes – Don't just digitalize them

One of the core tasks for a company when digitalizing its value chain is to digitalize its processes. This is the biggest driver for efficiency gains, as well as for forming the basis of new products and services. However, with many successful traditional companies, a lot of processes are driven by pre-digital ideas combined with some digital aspects. This results in gaps and a need for manual “repair steps” to patch processes. Many company processes would benefit from high automation with the least human interference possible – but achieving this often requires processes to be redesigned end-to-end, with clear focus on external or internal customers. Standardization is also key to establishing digital processes, which has more to do with focusing on the groundwork than with simply introducing digital technologies. Reengineering also needs to incorporate the previously mentioned acquisition of data, its analysis, and related value-adding process steps.

### **3. Smash the silos**

Another important pillar in realizing a digital shift is to invest in the company's governance and organizational set-up. Functional silos can be one of the biggest obstacles to digitalizing companies. End-to-end processes need to be the main drivers for creating the organizational structure. In the case of purely digital companies, this is built around the products delivered to the customer, not the functions behind the delivery. As part of this, the organization needs to be set up in a way that encourages collaboration, with clear focus on results and benefits. Building teams dynamically, with focus on the product, is a way to move forward and strongly supports the digital shift. Even though it is simple to form virtual teams, we have found that companies realize the highest impact when these are co-located. Another important success factor is to offer a lot of freedom to the teams and let them self-organize. However, this freedom does have limits – a small number of strict boundaries and guidelines should be defined, with teams free to operate within them.

### **4. It's all about the business model**

In the digital age, the business model moves center stage as companies innovate around how they offer value to their customers, the ways they have established their value chains and, in many cases, how they have set up their revenue models. Two trends have accelerated this change – customers now have a stronger role in the value creation of companies, and the range of potential business models is increasing through the advent of digital technologies and collaboration with digital companies or start-ups. New business models also need to complement existing ones if they are to offer full customer journeys, providing the client with an end-to-end experience. In the digital world, they also need to be flexible enough to adapt to changing environments. This is a big change – for most traditional companies, business models have been static for long periods. However, these are now in constant motion and should be expanded and re-evaluated regularly.

## 5. People first, technology second

Employees play a key – if not the most important – role in realizing the digital shift. If traditional companies do not manage the transition process for their employees and take them along on their digital journeys, employees can end up being one of the biggest obstacles to becoming (more) digital companies. Digital and IT competence therefore not only are required within IT departments, but also form an integral part of companies' core business processes and require all employees to develop their IT skills. Today's workforce needs to be more flexible and willing to invest and develop their capabilities constantly. In this environment employees take on more responsibilities, but in return are more demanding, selecting their employers based on the working environments they provide. The new leadership style required for the digital shift will be one of empowerment and servant leadership to enable employees to grow and thrive. In a world where it has become more difficult to switch off due to constant exposure to emails and apps, work-life balance will also be a decisive factor when staff choose employers.

### Case study: How to get there

A major player in the transportation and logistics industry recently conducted a digital shift over an extended period. The program was initiated by the IT department, with the clear goal of making the organization more digital and finding its digital equilibrium. This introduces a key question – is the IT department really the best place to start when it comes to digitalization? It does have advantages, as there can be a "natural" affinity between technological trends and technology expertise. However, the IT department is mostly known for its legacy role as an executor of strategy, or as a cost center, which makes it inevitably much harder to embark on such an important journey and take the organization along. Therefore, in parallel to the digital company shift, the major player started enhancing the performance as well as image of the IT department, increasing its collaboration with business units. From this starting point, it seemed logical to follow a bottom-up approach comprising four essential steps.

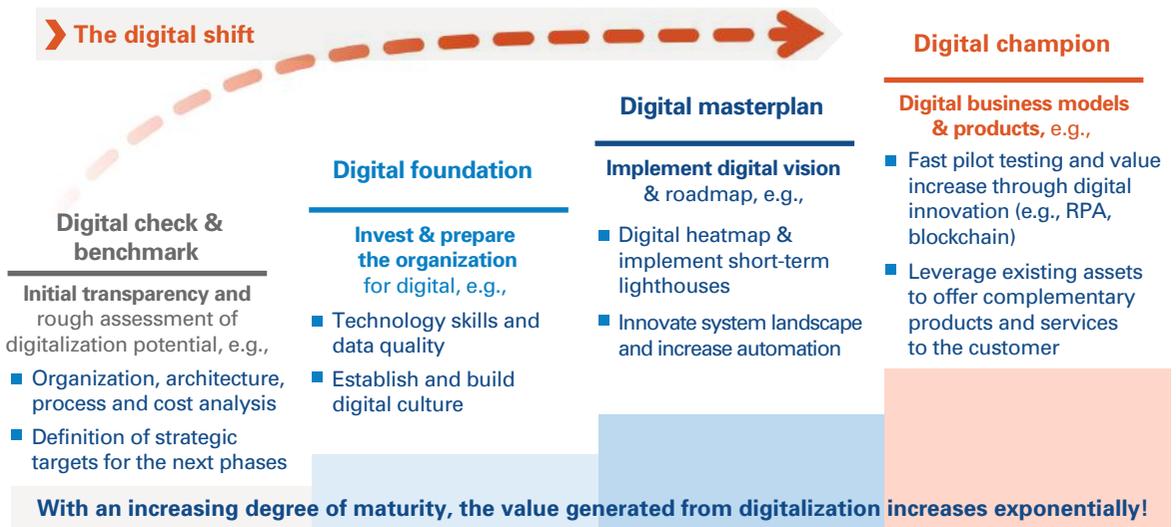


Figure 1: The digital shift: Four steps to becoming a digital champion

### Step 1: Digital check & benchmark

Initially, the company conducted a digital check & benchmark to gain greater transparency into processes, costs and innovation/digital projects that had already started. The goal of this first step was to define a clear starting point. This stage uncovered a great deal of complexity and a lot of potential for optimization. After a high-level analysis, the organization decided to initially focus on where it could get the most “bang for its buck”, especially compared to its competitors. It therefore dug deeper into both administrative processes (especially in finance) and asset maintenance. Before the start of the digital shift program, digitalization initiatives had primarily been launched opportunistically, which meant teams had trouble presenting convincing business cases. This benchmarking phase was therefore essential for the overall journey of building a digital company.

## Step 2: Digital foundation

When traditional companies move towards digital, they need what we call a “digital foundation”. Essentially, many companies start digitalization projects without solving basic underlying challenges. One of the most often experienced is data availability and data quality. In manual processes, humans are creative enough to interpret false or incomplete data correctly most of the time. For digital processes, this can be a death blow.

On the human side of the digital foundation, while many employees are experts in their areas of expertise, they do not possess sufficient skills to excel in digital companies. This is because company culture is more focused on doing the things employees have always done perfectly instead of thinking about how to achieve the same goals in very different, more efficient ways.

While training courses can help, in this case they had proven insufficient for this fundamental transformation of skills and culture. A more top-down approach had to be taken. The company therefore established multiple unofficial meetings in meeting rooms that were set up as “creative areas”, with cozy and inspiring environments. Preparing top management for the digital shift was a key success driver, as they would need to lead by example. The organization also began stand-up meetings, involving everyone in particular areas, irrespective of their seniority, in order to increase collaboration.

## Step 3: Digital masterplan

Once the foundation was in place, the next step was to establish a digital masterplan. This looked to answer these questions in the following order:

- Why? – Why are we doing this and what is the goal?
- What? – What digital levers do we need to use?
- How? – How will we achieve our goals?

The case study company went through this process with top management and employees in several workshops, and developed a “digital heatmap” that showed the biggest potential for digitalization. Some “lighthouse” projects were then strategically selected and mapped to implement the vision for the digital shift. It is critical to stress that this masterplan is not a general template, but has to be very specific to individual companies, as it is based on the current process landscape, as well as the organization’s strategic targets.

#### **Step 4: A digital champion**

After “fixing the basics” and defining the digital masterplan, the organization was mature enough to develop new business models and products to build on that digital foundation. This company developed a business model based on selling usage time on assets that the organization had not fully utilized. This new business model created a complementary product for customers, which enhanced their end-to-end usage experience.

The overall process took more than two years, and was accompanied by extensive change management. Many items from the agile tool box were used, such as a fixed sprint cycle with review meetings at the end, which were attended by all hierarchies up to board level. Extensive management support and involvement was a key success factor for the entire endeavor. In the end, the operational improvements resulted in an average cost decrease of 15 percent in the optimized processes, with increased quality at the same time. The new business model is projected to contribute substantially to the company’s revenues after full roll-out.

The case example organization experienced some of the typical barriers, which slowed down the speed and effectiveness of its digital shift:

- In the beginning, the company found that it was engaged in multiple projects with overlapping content. Though it proved to be beneficial to have an innovative spirit across the organization, too many initiatives that had started in different corners of the company had resulted in roadblocks due to a need for constant alignment meetings. This removed the focus from action and content. The leadership team assigned clear responsibilities, and then stepped back and let teams operate within their boundaries.
- Even though management realized that experimenting with digital technologies was essential and required some freedom, especially in the beginning, it was also crucial to steer and manage the digital innovation process. The company found that the best way forward was to implement decision and quality gates to ensure that investment was directed towards projects with the most impact on business value. If clear business value cannot be derived, attention should be redirected to more promising initiatives in the digital portfolio.
- In the case example, the cost of the digital foundation was spread across multiple business units and departments. This typically would result in long discussions about how funding for digital initiatives without direct business impact should be split. To counter this, the company set aside central funds to build modular platforms that could be used across the entire organization. Now that the company has invested in a common infrastructure, security standards remain high and synergies (such as around license costs) can be achieved.

## Insight for the executive

Operating in today's competitive environment, every company, whatever its industry, needs to make use of digital technologies and find its digital equilibrium. Across projects in multiple industries, we have seen that a digital shift is a journey, that can be fuzzy at first, but with a holistic and structured approach, can significantly exceed expectations in the end, with great impact on business value. A digital shift is no self-driving process – it needs a lot of groundwork and investment in a digital foundation to make the entire organization mature and ready to benefit from new technological possibilities. In our case example, we saw that the digital shift was a senior management task but needed to be taken forward by the entire organization. The IT department played an essential role by laying the digital foundation, supporting with its technology know-how and providing platforms and infrastructure.

Overall, leveraging digitalization is not a question of “if”, but “how”, and will be the key to survival. In order to move their companies towards becoming digital champions, leaders need to focus on three pillars:

- **Digital leadership and empowerment of the organization:** Establish a clear digital vision and ensure that employees are empowered to realize the digital shift. Invest in change initiatives to take the employees along, and introduce a “digital-friendly” culture and agile ways of working.
- **Unify digital and IT, but also strive for further fusion of business and IT:** We recommend avoiding separating IT and digital into parallel units. Moreover, business departments need stronger alignment with IT, while the company must invest in digital skills and competences across the entire organization.

- **Invest in a digital foundation and establish end-to-end processes:** The digital shift will not be possible without the underlying foundation. Investment in digital platforms, data infrastructure and end-to-end processes with clear customer focus is required to fully support and realize the digital shift. This will enable new business value and boost performance to a new level.

Senior leaders therefore need to understand that for a digital shift to be successful, they need to search for new ways of doing business, but equally invest in their digital foundations to further streamline and automate their processes. Special focus must be given to development of a company culture that is flexible enough to continuously adapt to new surroundings, whatever the sector.



**Heike C. Wörner**

is a Principal at the Frankfurt office of Arthur D. Little and a member of the Technology & Innovation Management and Travel & Transportation Practices.

**Fabian Sempf**

is a Principal at the Frankfurt office of Arthur D. Little and a member of the Technology & Innovation Management Practice.

**Dr. Fabian Dömer**

is Managing Partner at the Frankfurt office of Arthur D. Little and head of the Technology & Innovation Management Practice in Central Europe.

**Volker A. Pfirsching**

is a Partner at the Munich office of Arthur D. Little and a member of the Technology & Innovation Management Practice.



# Cyber-threat: Is your business prepared for an attack?

Tom Teixeira, Jamie Gale, Mandeep Dhillon, Immanuel Kemp

As constant news stories demonstrate, traditional approaches to cyber-security and risk are not protecting businesses or their customers. This is not for lack of focus on the subject. After all, no chief executive wants to find themselves facing fines of 4 percent of global turnover under the general



data protection regulation (GDPR) in Europe, as negative front-page news, or having to answer regulators' questions about how they were attacked, why they didn't know it was happening, or what they have lost.

This external impact is matched by internal and financial consequences, which affect trust in the brand, value in the company, and loyalty of their most prized assets, their customers.

In more extreme cases, such as with AP Moller Maersk<sup>1</sup>, costs can rise to over \$200 million, or lead to business failure, as in the case of Alteryx<sup>2</sup> after the details of 25,000 members of the Homeland Security department were stolen. Figures show that only 38 percent of global organizations claim they are sufficiently prepared to handle a sophisticated attack<sup>3</sup>, despite approximately \$1 trillion expected to be spent globally between 2017 and 2021.

The rate and complexity of attacks continues to increase – however, traditional approaches are not keeping pace. This is because they tend to focus on either technology (as sold by technology vendors and large systems integrators) or risk (as sold by risk management firms).

Despite the emphasis on and investment in cyber-security, traditional approaches, which tend to focus on either technology or risk, are failing to protect businesses and their customers. This article explains the benefits of adopting a new, unified approach that brings together technology and risk management processes. It enables organizations to better protect themselves against cyber-threats, thus safeguarding their businesses, data and revenues.

---

1. <https://www.cnn.com/2017/08/16/maersk-says-notpetya-cyberattack-could-cost-300-million.html>

2. <https://www.wsj.com/articles/alteryx-files-for-chapter-11-bankruptcy-1423446150>

3. [www.cybintsolutions.com/cyber-security-facts-stats/](http://www.cybintsolutions.com/cyber-security-facts-stats/)

In this article we will explain how a new, unified approach that combines technology and risk management processes can enable organizations to better protect themselves against these cyber-threats, safeguarding their businesses, data and revenues.

## **The evolving threat landscape**

There are two trends in the threat landscape, both of which substantially impact risk:

### **1. An increase in the frequency of unsophisticated attacks**

Cyber-attacks rose by 27 percent in 2017, with an average cost of \$12m, and according to AT&T, 323,000 new strains of malware are discovered each day.<sup>4</sup> That equates to three strains per second. Arguably, unsophisticated attacks have never been easier. In many countries, it is not illegal to hire a hacker, and there are no international legal agreements which would make it possible to prosecute cyber-criminals transnationally. At the same time, the Dark Web has become a channel for anybody (inside or outside an organization) to buy, download and deploy malware.

### **2. New, more sophisticated threats are emerging**

Other forms of attack are becoming more sophisticated. As the internet evolves, and cloud computing and the Internet of Things become increasingly commonplace, new opportunities for cyber-criminals open up. Examples include:

- Voice fraud: Consumers make 100 billion calls per month to enterprises, with trillions of dollars of transactions made over the phone. Criminals are targeting this channel, stealing \$10 billion a year by attacking call centers, impersonating genuine customers.<sup>5</sup>

---

4. Bindu Sundaresan – AT&T Cybersecurity Solutions. Masters of Scale Podcast  
22 Oct 2018

5. Voice interface is the future – <https://tech.co/future-10-billion-voice-fraud-industry-2017-05>

- **Crypto-mining:** Businesses have already reported being attacked by malware that infects their systems to create armies of cryptocurrency-mining machines. This consumes significant computing power at high cost, and acts as a launchpad for other attacks designed to steal intellectual property.

## **Traditional approaches have not protected businesses**

Against this backdrop of increasing threats, businesses have tended to follow a binary approach – deploying more technology or external audits. While these may deliver some benefits, neither has helped clients understand the real impact of cyber-risk to their businesses.

## **More technology and use of traditional technology practices**

Powerful security tools have entered the market as vendors have invested heavily to battle cyber-criminals. However, despite these advances, the basics are often ignored. For example, the infamous WannaCry<sup>6</sup> attack could have been minimized if more organizations had applied best practices, such as patching and setting appropriate incident response processes. Figures from Cisco showed that 93 percent of organizations had experienced security alerts, yet 44 percent of these had not been investigated.<sup>7</sup> And of those that had been investigated, almost half had not been dealt with, and those companies had been left vulnerable and exposed. Clearly, technology alone is not the answer – businesses need to realize that cyber-risk is also a human problem.

---

6. WannaCry cyber attack and the NHS, <https://www.nao.org.uk/report/investigation-wannacry-cyber-attack-and-the-nhs/>

7. <https://blogs.cisco.com/security/cisco-2018-annual-cybersecurity-report>

On 27 June 2017, the IT systems of multinational conglomerate AP Moller Maersk were affected by the NotPetya malware, which exploited security vulnerabilities in Windows and disabled IT systems across multiple sites and business units.

The recovery effort required 4,000 new servers, 45,000 new PCs and 2,500 applications, and took 10 days to implement, during which time staff reverted to manual systems to continue operations.

Maersk has estimated that the attack cost between \$250 and \$300 million in lost revenue due to disrupted operations across all its businesses.

The NotPetya malware attack has since been recognized as the largest cyber-attack in the history of the internet, with total worldwide impact estimated at over \$10 billion.

## More external audits

Understanding your organization's cyber-threat exposure has relied on sub-optimal, lengthy, and tedious questionnaire-based processes. These are resource intensive, requiring a small army of people to carry out the checks. At best they provide static, point-in-time vulnerability assessments, ignoring the increasing frequency and sophistication of attacks.

Additionally, this approach is the key source of "anec-data" – human interpretation of events, which is inevitably subjective and becomes disproportionately important relative to the real data. Essentially, businesses can be fooled into feeling safe as this has given them an audit process.

Neither of these approaches enables businesses to truly quantify and mitigate the financial impact posed by these attacks. In today's sophisticated world, organizations therefore need to adopt an integrated view that combines active threat prevention, total cost of risk models, and a shift in mind-set that is fit for the digital world.

## A new, holistic approach to cyber-risk

Given that traditional responses to Cyber-threats have been ineffective and risks are increasing, simply doing more of the same is not enough. A new approach is needed that successfully brings together technology and risk management to focus upon:

- A data-led method which can rapidly and continuously identify anomalies and attacks.
- Clarity of business risks and their underlying causes and impact, along with a means of mitigating financial and reputational consequences.
- Evolving the operating model and mind-set in order to protect the long-term interests of the company and its customers.

Businesses understand the inevitability of future attacks. With this new approach, they are better positioned to protect themselves. They can first identify vulnerabilities and related exposures early, and then prepare themselves due to clarity over the prioritized pragmatic steps that can be implemented in advance to support reduction in the overall total cost of risk (TCoR).

### Key definition:

.....  
Total cost of risk (TCoR) is a data-led approach to assessing the financial impact of risk. This allows active prioritization of remediation activities related to business value.  
.....

.....  
We use it with cyber-risk to understand which risks are manageable internally, and which have such severe impact that some of the financial risk needs risk-transfer solutions, such as insurance.  
.....

Underpinning this new approach are three central themes:

## **1. Defining the total cost of risk**

Traditionally, much cyber-risk analysis has focused on technical vulnerabilities. While these have then found their way onto risk registers at board level, their wider business impact has not been codified, and this results in little understanding of the levers that can be used to reduce the TCoR.

The TCoR calculation should be unique to every organization, dependent on its circumstances and priorities. However, the key dimensions remain consistent:

- a) Costs of consciously retaining risks, which incorporate the likely cost of claims and earnings volatility.
- b) Costs associated with controlling risks, such as re-engineering, value/supply chain risk management, and the management of continuity plans.
- c) Costs associated with new technology implementations and capability development.
- d) Costs of transferring risks through additional insurance premiums and associated administrative costs.
- e) Any internal and external risk management costs in the areas of human resources, treasury, audit, quality, etc., and the additional administration associated with these new dimensions.

The “assess” phase provides the necessary data for businesses to select the right risk exposure scenarios, based on vulnerability and frequency, or whatever the threat may be. For each scenario, a set of assumptions is co-created, and this provides a base financial case for each risk. This means understanding the size and scale of the potential threats, as well as the corresponding potential size and scale of the opportunity.

The executive team and board now understand aspects of impact, and can factor these into their financial planning, forecast models and cash flows. Essentially, they have the tools to leverage the upside of risk while mitigating the downsides.

## 2. Using technology and data to rapidly and continuously assess the threat landscape

Most large organizations have mixed technology estates combining cloud computing, on-premise and hybrid environments. Understanding the exposure level across all areas of infrastructure and applications is important. Deployment of physical devices on the network, such as router plug-ins, or deployment of software agents, such as user activity monitoring and next-generation firewalls within the technology estate, can and should be rapid (i.e., within a day). This enables organizations to begin gathering insight within hours, rather than days or weeks.

.....  
The San Francisco Municipal Transport Agency's (SFMTA's) computer systems were infected by ransomware in 2016.  
.....

Although trains remained running, the SFMTA had to open all ticket barriers, which cost \$50,000 in revenue over the weekend. Fortunately, the attack did not compromise passenger safety, although future attacks could target train signaling, which could cause delays or even derailment.  
.....

.....  
An investigation determined that an employee had opened a phishing email, which had resulted in covert installation of the ransomware. Lack of investment and aging systems had contributed to the organization's increased vulnerability to such an attack. This highlights the importance that senior leadership must place on having a strong cyber-security culture, adequate resourcing and robust infrastructure within the organization.  
.....

Rather than a “point-in-time” approach, these sensors and agents provide a continuous threat assessment capability. This means they will therefore not only continue to highlight new and emerging threats and vulnerabilities, but also begin to highlight changes in behavior of internal staff. Rapid implementation of appropriate technology solutions is important for two main reasons:

- Properly deployed and used, these tools go a long way towards protecting your organization.
- They can be used to help identify the underlying causes within risk exposure. This, in turn, will help identify leading key risk indicators (KRIs), which can be used to demonstrate to insurers that scanning mechanisms are in place. These aim to reduce risk by applying the right level of resources at the right time.

Alongside a set of these KRIs, insurers can analyze actual data and build findings into the limits and triggers associated with insurance policies and premiums charged to an organization. Working collaboratively and transparently with the insurer in this way can provide organizations with financial benefit in terms of realistic premiums and improved coverage, as relevant scenarios are incorporated into the wording. Ultimately, it should reduce the volatility of future earnings.

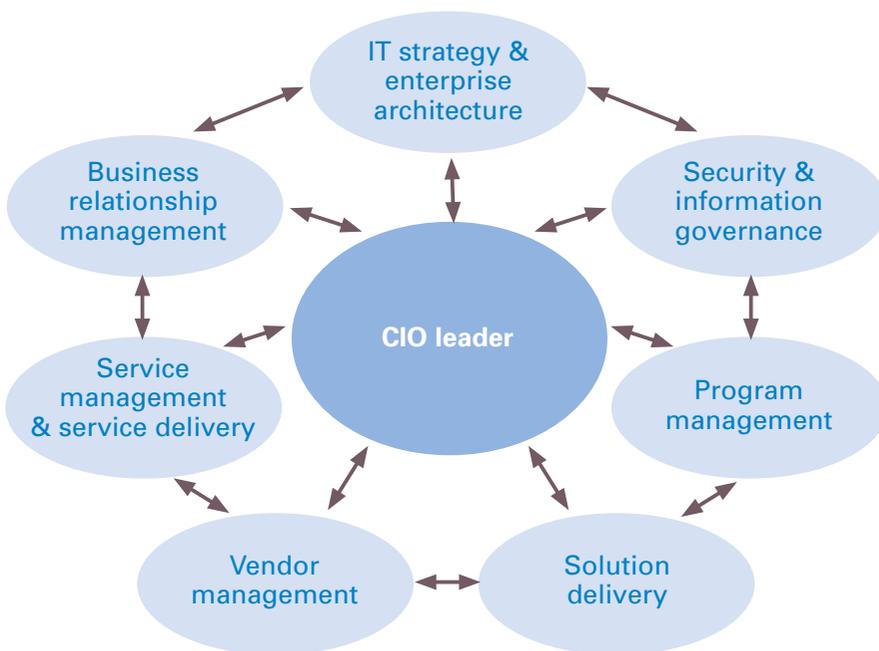
### **3. Ensuring the right technology operating model is in place**

Human and organizational elements can be barriers to safeguarding a business. Failure to address these factors will lead to little improvement in your ability to prevent attacks. Instead, understand the “seven voices of technology”<sup>8</sup> to highlight the tensions and weaknesses within internal operations. (See Figure 1.) For example, where the change team has a more dominant voice than that of operations,

---

8. Source: Greg Smith, Arthur D. Little

technology can be implemented without necessary controls being in place. Documenting these tensions and rebalancing the “voices”, alongside establishing a set of leading, rather than lagging, KRIs, will begin to drive a cultural and mind-set shift within the organization. This addresses an issue often missed by traditional approaches.



**Figure 1: The seven voices of technology**

It is critical to understand and address the perception and capability gaps between what the executive team believes is reality and what the operational assessment and data demonstrate to be the case. An example of this is around tolerance of failure. An executive team may believe that the company has robust plans to deal with failure, but the data associated with its technology or supply chain may show otherwise.

The benefits of taking this approach are:

- It drives quick results and does not require armies of consultants performing tick-box exercises. It delivers rapid, actionable results, which means quickly identified threats can be fixed, controlled or sandboxed. In addressing these first threats, it removes the tension between whether to focus on the urgent or the important.
- It is data-led, which means decisions are made around facts, not anecdotes. It is designed to be a sustainable way to assess threats, rather than to provide a point-in-time audit.
- Ultimately, it provides the executive and board with a business-led, rather than technology-led, set of issues and recommended solutions. This highlights ways of reducing the TCoR that are designed for that organization, and extends beyond a large, but potentially ineffective, technology implementation.

### **Insight for the executive**

With cyber-threats increasing, as well as sophistication and impact, organizations require a better way of managing these risks.

Investing the vast sums spent on cyber-security more effectively than has been done to date will be key. CEOs therefore need to change approach and focus on a more holistic method that brings effective use of technology together with risk management. Following this three-stage process will give them the tools to prepare operationally and financially for cyber-risks:

- **Assess and address.** Use technology to uncover and deal with immediate threats in a way which is sustainable over time, while defining the organization's total cost of risk.
- **Plan and analyze.** Carry out financial and operational analyses, based on real data, to inform the executive team so they can create a pragmatic plan that reduces the TCoR.
- **Do.** Act on your plan, such as by transferring elements of risk to insurance markets, creating appropriate internal controls linked to key risk indicators. Overall, look to create a mind-set that supports perpetual preparedness.



**Tom Teixeira**

is a Partner at the London office of Arthur D. Little and a member of the Risk Practice.

**Jamie Gale**

is a Partner at the London office of Arthur D. Little and a member of the Digital Problem Solving Practice.

**Mandeep Dhillon**

is a Principal at the London office of Arthur D. Little and a member of the Digital Problem Solving Practice.

**Immanuel Kemp**

is a Consultant at the Cambridge office of Arthur D. Little and a member of the Risk Practice.



# Shaping the oil company of the future

Daniel Monzón, Rodolfo Guzmán, Jaap Kalkman, Stephen Rogers, Augusto Kinbaum

## Introduction

Multiple trends are set to transform the oil industry. Within 20 years, demand is likely to peak and then decline, leading



to industry convergence which will undermine the competitive position of current players. The future oil industry will also see both energy and non-energy entrants, which means oil companies are already trying to adapt their business strategies to the forthcoming era.

The big question we explore in this article is what the future ecosystem will look like, and whether existing players will be able to leverage their core competences to survive and

even benefit from these new challenges. What will the oil company of the future look like?

After over a century of growth, demand for oil is likely to peak and begin to decline by around 2035. This will lead to radical transformation of the industry, convergence, new entrants and new business strategies. What will this future ecosystem look like? Will existing players be able to survive and even benefit from these new challenges? We explore what the successful oil company of the future will look like.

## Demand-driven peak oil calls for change

After over a century of growth in the industry, technological improvements, environmental concerns, social trends and government policies will all impact demand for oil. This will lead to a peak and decline, which is likely to happen between 2030 and 2040.

There are five key factors driving down demand:

- **The environmental push:**

Greater social awareness of the effects of fossil fuels, combined with CO<sub>2</sub> taxes and fiscal incentives for renewables, will contribute to alternative energy sources becoming more competitive than oil.

- **The technological race:**

Thanks to technology and innovation, renewables and energy storage are reducing costs much more quickly than oil extraction operations are.

Breakthroughs in battery technologies will favor electric vehicles (EVs) and electric power over fossil fuels. However, efficiency gains in internal combustion engine (ICE) vehicles will affect demand for liquid fuels even more.

Other breakthroughs, such as algae biofuels, fusion reactors and fuel cells, could also disrupt the energy industry.

- **The global electrification trend:**

Several countries are aiming to eradicate ICE cars, setting deadlines for new sales. At the same time, EV usage will grow as its total cost of ownership (TCO) decreases.

Nevertheless, expanded EV ownership will affect demand for liquid fuels less than is expected, since the additional electric power they require will be partially generated from gas or oil products. However, fossil fuel prices may suffer due to higher competition for generation.

- **The evolution of urban mobility:**

We are already seeing public policies to reduce emissions, such as banning ICE taxis, restricting parking, charging congestion fees in peak hours, and creating priority roads for public transport. These combine with social trends such as greater car sharing to decrease ICE traffic, and therefore lower fossil fuel consumption.

- **Oil-importing countries aim for energy self-sufficiency:**

The global oil supply is highly reliant on politically unstable Middle Eastern countries, and this is a concern to large oil-importer governments. In response, they are introducing a range of incentives, such as subsidies for alternative energy sources or higher carbon penalty rates to reduce hydrocarbon dependence.

These drivers will move the oil industry into an aging phase. This will be characterized by low levelized cost of energy (LCOE) for wind and solar photovoltaic generation, major cost reductions in energy storage, wide expansion of EVs in large cities, and aggressive CO<sub>2</sub> taxes to reduce greenhouse gas (GHG) emissions.

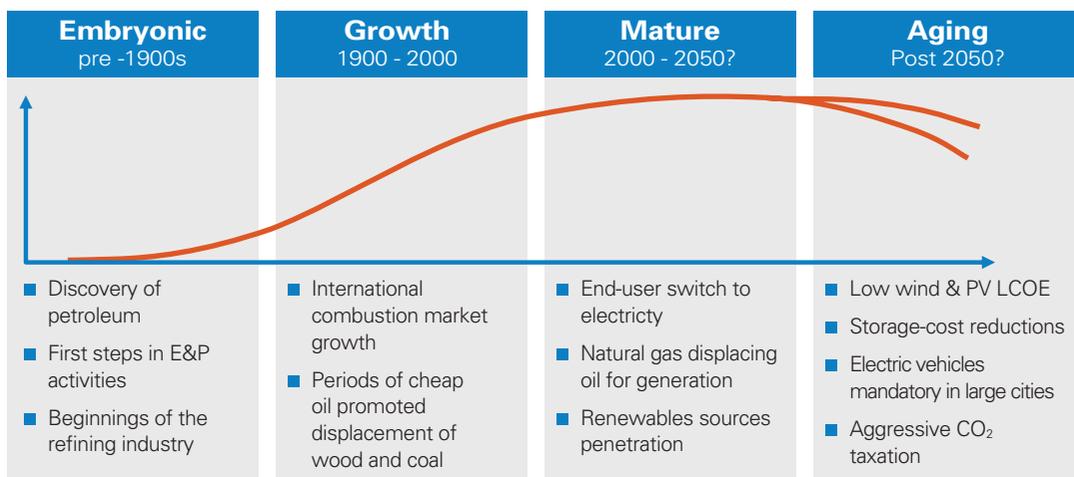


Figure 1: Oil industry maturity curve

## Mapping the future energy ecosystem

As we have explained, global trends will lead to a decrease in the share of coal and oil in the energy matrix, whereas demand for natural gas as both an energy source and petrochemical feedstock will continue to rise.

Massive reserves of gas in unconventional reservoirs and lower field-to-customer supply costs will drive a “gas-prone” trend. This will be reinforced by a cleaner image of gas; long-term supply contracts for petrochemicals; larger gas liquefaction, regasification and generation capacity; and detachment between natural gas prices and oil-price volatility.

Renewables will partially displace hydrocarbon demand, while other energy sources plateau. For example, China’s nuclear expansion program will be compensated with declining nuclear activity in Europe, and hydroelectric generation will not expand due to its limited potential to add capacity.

Even though oil demand will peak in the next 20 or 30 years, fossil fuels will still represent a significant business segment. However, the ecosystem will change. Thanks to their control of reserves, national oil companies (NOCs) will produce the most oil globally, with significant integration throughout their refining and petrochemical value chains.

International oil companies (IOCs), with limited access to fossil resources and high exposure to environmental topics and customer preferences, will lead the “surpassing petroleum” trend. They will penetrate the utility market, generating and selling electricity to end users, as well as harnessing their current fuel-station networks to provide “all the energy you need”.

Competition will grow. The oil industry will soon collide with sectors such as utilities, automotive, telecoms, technology, agriculture and petrochemicals. These are progressively converging into overlapped ecosystems, altering competition by blurring traditional boundaries.

Convergence will disrupt all these industries' architectures, undermining the competitive advantages of established firms and providing opportunities for new entrants, start-ups and well-established players from other segments.

This will enable new competition and cooperation opportunities. Oil companies, even those with large reserves or strong core competencies, will have to rise to the challenge.

### **Analyzing the traditional core competencies of oil companies**

Many of today's IOCs have grown into truly global players. They have the geopolitical skills to operate in dozens of countries and the muscle to manage several multi-billion-dollar capital projects every year, all while maintaining complex arrays of alliances and partnerships with host governments and competitors. Along their growth journeys, these players have excelled in multiple dimensions, mastering core competencies that include:

- Management of large and complex projects
- Relationships with local communities and governments
- Geological interpretation and modeling
- Dynamic portfolio management
- Joint venturing
- Creating international brands with geographic reach
- Management of complex supply chains and global trading systems

Competition will emerge from multiple energy and non-energy players, intensifying the pressures on traditional businesses. To survive in this new competitive landscape, oil companies will have to further strengthen and leverage their traditional core competences, while developing new skills to navigate in an increasingly uncertain environment.

## Five dimensions to strategically reshape oil companies

Traditional oil companies recognize that the market is changing, and have not been idle. Since the beginning of the 21st century they have been attempting to reshape their business models in order to strengthen their competitive positions. These initiatives focus on creating value through five different strategic angles:

### 1. Diversification:

Besides the “gas-prone” trend, in the last 15 years oil majors have spent more than \$6 billion on clean-energy ventures. Smaller companies are starting to follow in their footsteps. Both Shell and Total have been betting on small projects and companies in the renewables sector. Statoil was renamed Equinor, rebranding itself as an “energy company” strongly positioned in offshore wind farms, as well as expanding to solar and onshore wind. At a different pace, BP and Chevron have also expressed their commitment to renewables.

Most investments have focused on solar and wind power. However, other segments have also attracted significant interest from oil companies, including biofuels, carbon capture & storage (CCS) and batteries.

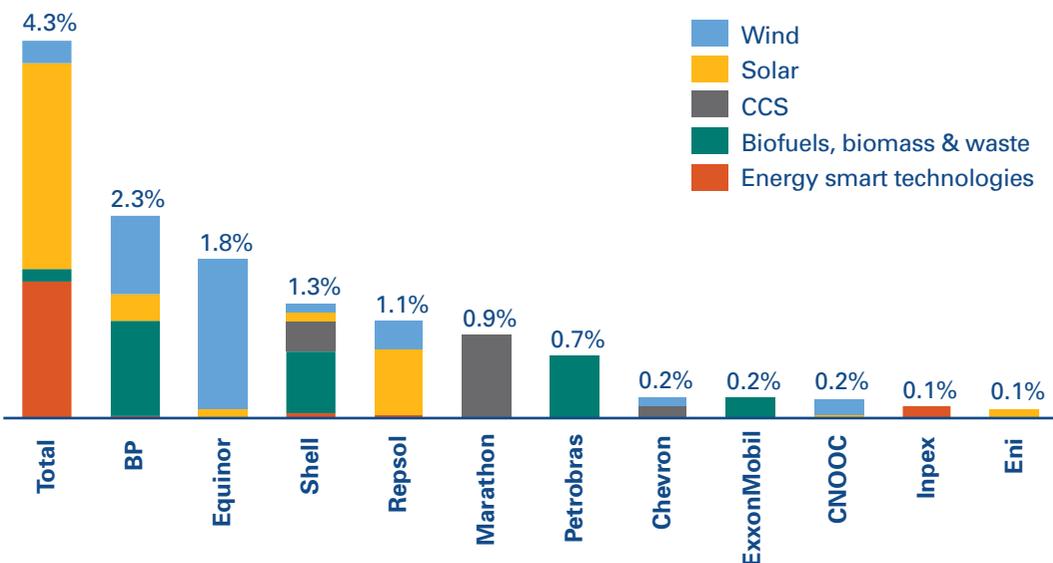


Figure 2: Disclosed low-carbon investments as a proportion of total CAPEX (2010–Q3 2018) Source: Reuters

## 2. Integration:

While many IOCs have been divesting from downstream and fuel distribution, several NOCs are investing in refining and petrochemical capacity to secure outlets for their crude oil and industrialize their home countries. These new, large-scale refineries will displace small ones, and may frequently be built alongside petrochemical complexes.

## 3. Specialization:

Numerous small, independent companies have succeeded in specialized niches. The most remarkable examples are independent US companies active in the shale/tight oil & gas, and enhanced oil recovery (EOR) segments, as well as Canadian firms specializing in tar sands. These pioneers have led the way in best practice and technology development for their own niches, in many cases leaving big oil companies behind.

## 4. Partnerships:

Partnerships offer the opportunity to combine capital and hydrocarbon resources in order to develop projects that could exceed a single company's budget or affect its portfolio's risk profile. They also allow companies to benefit from indirect access to partners' creditors, acquire new technologies and operational practices, and learn about the management of large-CAPEX projects, cost efficiency, people management and relationships with communities.

NOCs, with their generous access to sub-surface resources, are therefore increasingly partnering with IOCs and oil-field services companies (OFSCs) for technical/operational matters, funding and financing.

## 5. Resource portfolio:

Oil companies are retargeting their investments into unconventional and deepwater fields, which offer much potential for expanding their reserves. In 2017, majors dedicated almost 70 percent of their global budgets to offshore and unconventional assets.

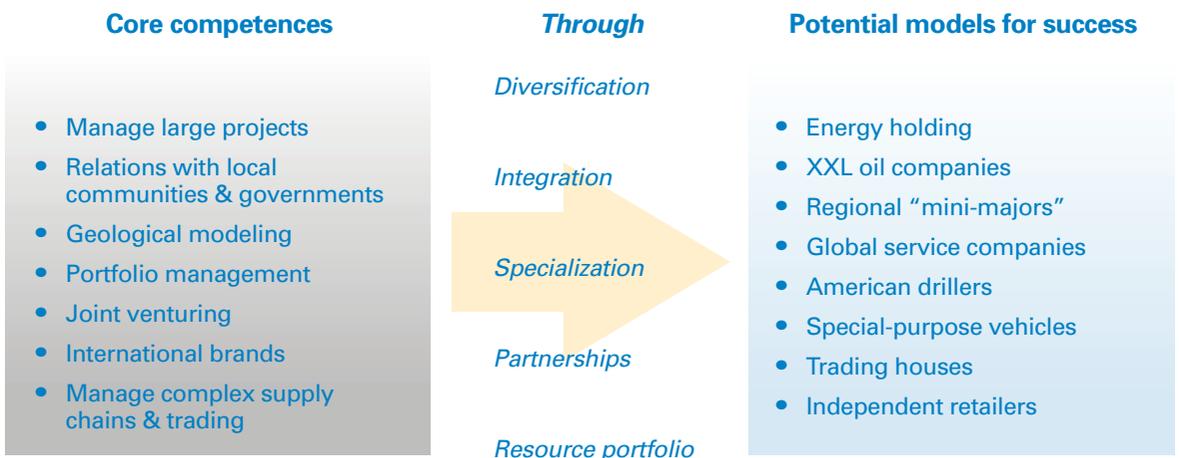
Additionally, the expected shifts in the energy matrix are pushing some oil companies to increase their bets on natural gas, as part of the above-mentioned “gas-prone” trend.

### Beyond oil? Emerging business models

Current players face a dilemma. They understand the imperative for change, but have to balance how long they stay within the fossil window with when and how much they should move towards embracing a broader energy scope. Given the value that their scale and global branding delivers, they also need to define their geographic reaches.

Broadly speaking, we expect that the following eight business models will co-exist in the hydrocarbons sector in future decades:

- **Energy holding:** A regional or global company producing diverse energy sources, with multiple ventures in non-traditional oil segments. It will generate electricity from its own hydrocarbons and offer a broad portfolio of energy products and related services.



**Figure 3: Emerging models for the oil company of the future**

*This model would be robust in an accelerated energy transition scenario, since it would provide growth opportunities beyond hydrocarbons, allowing oil companies to maintain or expand their shares of the energy matrix business, despite its evolution towards cleaner energy sources. On the other hand, the diversification efforts needed to build an energy holding present the risk of distracting focus and diverting resources from the hydrocarbon business during high-returns time windows.*

- **XXL oil company:** These will be NOCs or super-majors producing more than 5 million barrels of oil equivalent per day (MBOED), integrated with world-scale refining and petrochemical complexes. However, they will have limited energy diversification. XXL NOCs will prioritize monetization of resources for their home countries, and only a few will have substantial international presence.

*The XXL model seems to be more suitable for the agendas of large national oil companies that are looking to prioritize scale and efficiency in monetizing resources. This approach could also play well for super majors, which, through skillful geopolitical tactics and partnering strategies, could gain access to massive low-cost hydrocarbon resources in regions such as the Middle East or Russia.*

- **Regional “mini-majors”:** Integrated companies with regional focus, processing their own crude oil and gas to offer refined and petrochemical products. They will help accelerate the gas-prone trend, as well as development of cleaner energy sources such as biofuels and other renewables.

*Regional integration and diversification will, to some extent, protect these companies enjoying political, cultural, logistical and commercial advantages from larger or more specialized and efficient global players. However, growth opportunities for mini-majors will be limited by the geographic scope of their regional markets.*

- **Global service companies:** With deep technology and digital know-how, these will increasingly take responsibility for performance improvement initiatives within oil & gas operations. They will tackle pending operatorship when acquiring IOCs, but face challenges from risk-seeking competitors when developing globally operated portfolios.

*Even if every barrel produced demands more application of technology and services than before, this business model will be strongly challenged by the energy transition if its scope of assets and services is not broadened through rapid innovation and development of new solutions for energy producers and consumers.*

- **American drillers:** These lean organizations are highly efficient, fast adopters of new technology and operational know-how. They will have access to cheap financing and be able to idle wells as soon as prices make production unattractive.

*Easy access to land, resources, capital, services and infrastructure are the key competitive advantages for these players, which are mainly focused on efficient exploitation of non-conventional resources in North America. Replication of this model in other countries would be challenging, and potentially limit the scope of availability with the competitiveness of the US resource base.*

- **Special-purpose vehicles:** These lean corporate organizations will be able to facilitate capital investment in selected hydrocarbon-business opportunities, managing continually changing asset portfolios. They face a challenge in balancing risk-taking with the need for continuous growth.

*Agility is a strength of this business model, and returns can be high when combined with low financing costs, but high exposure to hydrocarbons will eventually limit the growth potential for these types of investors.*

- **Trading houses:** These will progressively take positions throughout the value chain, although they will pursue fewer opportunities in oil and gas exploration and production. Their main objective will be to gain more optionality and benefit from regional imbalances in supply and demand.

*This is a business model under challenge if it remains “as is”, since traditional arbitrage opportunities are disappearing and an increasing share of renewable energies will be consumed where produced, which will limit opportunities for profitable international trading. On the other hand, regional hydrocarbon imbalances and trade flows will increase, and new data analytics may help extract higher value.*

- **Independent retailers:** These will include regional or global companies commercializing fuels, LPG and/ or electricity, increasingly together with non-energy products and services. They will not necessarily be involved in production activities.

*The limited value of an international brand for fuel retailing, as well as the competitive barriers to capturing margins from new products and services at stations that are largely owned by third parties, will represent major challenges for players aspiring to maintain their growth rates and levels of return on capital employed. Strong innovation capabilities will be needed to develop differentiated and viable customer-centric solutions in this sector.*

While there won't be a single business model that drives success, we predict that many IOCs responding to decarbonization threats will move in the direction of “energy holding” companies, while some of the largest NOCs may try to prolong their existence through the scale advantages provided by the model of an “XXL oil company”.

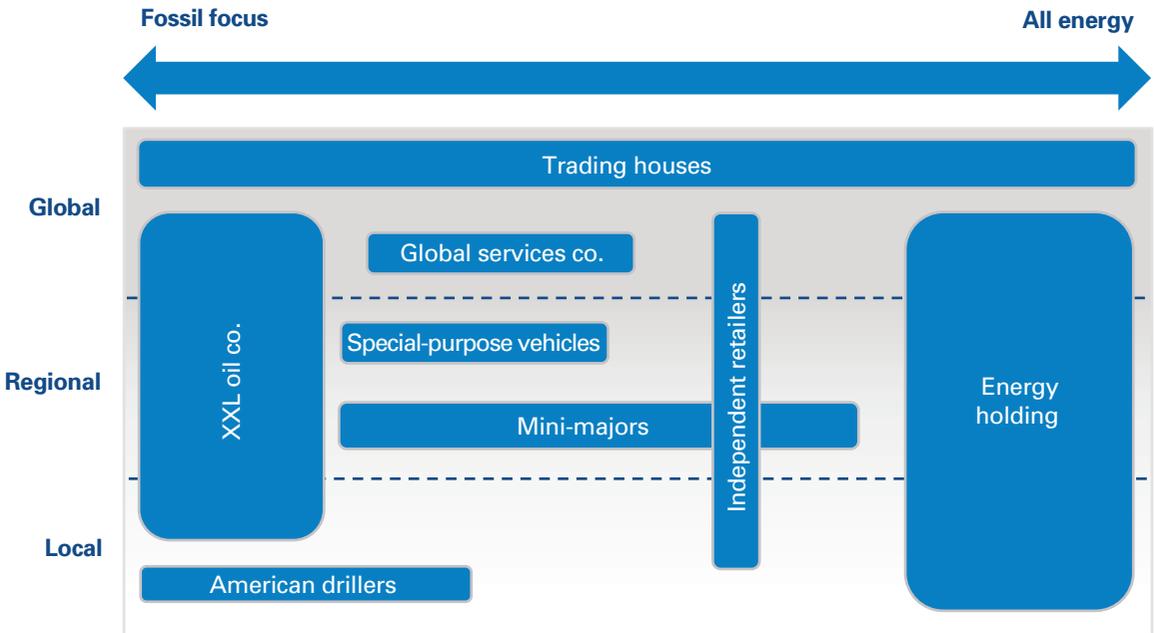


Figure 4: Oil companies of the future ecosystem

### Outlining opportunities for expansion

Regardless of its chosen business model, the oil company of the future will find that opportunities for growth and value creation will increasingly be outside the traditional hydrocarbon spectrum. As the global energy transition intensifies, oil companies are therefore scrambling to find new business spaces, often competing against utilities, mobility players or emerging energy technology firms.

Oil companies are already exploring opportunities including:

- **Energy systems:** Energy storage and participation in distributed and non-distributed energy.
- **Renewables and clean energy:** Generation of solar and wind power and investment in other renewables.
- **Hydrocarbons to chemicals:** Covering the complete value chain in order to capture the higher value of petrochemicals against refined fuels. Example initiatives include “crude to chemicals” or “methane to olefins”, alongside greater refining/petrochemical integration.

- **Bio-sourced:** Taking positions in biofuels and co-processing crude oil and bio-feedstock at refining facilities.
- **Mobility business:** Capturing value by moving from selling fuel for transportation to a services model, i.e., charging customers per kilometer, irrespective of the type of energy supplied.
- **Disruptive energy sources:** Taking early positions in development of innovative technologies such as fusion or hydrogen sources.

#### Case example: Shell New Energies



To play its part in creating a low-carbon future, Shell has set up its New Energies business, with projects in biofuels, biomass, hydrogen-fueling stations, EV charging, gas-to-liquid (GTL)/liquefied natural gas (LNG), onshore and offshore wind, thermal and photovoltaic solar, and power distribution and electricity supply from renewable energy sources. The company is planning to spend between \$1 billion and \$2 billion annually in the New Energies divisions until 2020. Even though this represents less than 1 percent of revenues, it still positions Shell as one of the largest investors behind the “energy transition”.

#### Case example: Equinor New Energy Solutions and Energy Ventures fund



Equinor is also betting on developing non-traditional sources of energy under its New Energy Solutions division. It has become a significant innovator in offshore wind technology and a world leader in carbon capture and storage (CCS) technologies. According to Equinor, its Energy Ventures fund is one of the world’s largest corporate venture funds dedicated to investing in attractive and ambitious growth companies in renewable energy; it has earmarked more than \$200 million in total investment capital.

### **Case example: Total's commitment to renewable energy**



Convinced of the opportunities renewable energies have to offer, Total is focusing its main ambitions on solar power generation, targeting production capacity of five gigawatts by 2022. Other areas of focus are wind and hydraulic power generation technologies. Total also believes optimizing energy storage is key to expansion of renewables, which is why it has acquired Saft, a world leader in battery technology. A further area of interest for Total is bioenergy, in which commercial biomass production has allowed it to produce biofuels including ethyl tert-butyl ether (ETBE) and hydrotreated vegetable oil (HVO) for diesel.

### **Insight for the executive**

The journey towards the “oil company of the future” requires companies to constantly rethink their business models and adopt transformation strategies to respond to global trends and prepare for an uncertain and changing world. They need to think carefully about their long-term survival paths, identify growth options, and take deliberate, meaningful and strategic actions to protect themselves against the very real risk of obsolescence. They need to balance efficiency and agility, maintaining high productivity and capital returns in traditional business segments, while exploring diverse options for potential future growth in non-traditional areas through a combination of ventures and own and third-party-led pilots. This will allow them to benefit from emerging technologies, products and services in the new energy ecosystem.

They will also need to display new attributes, such as entrepreneurship, innovation, agility and adaptability to sudden market changes, which are qualities not typically found among traditional petroleum industry players. This means oil companies will need to undergo deep transformation of their cultures, skills and capabilities if they are to survive and create long-term, sustainable competitive positions. They will need to be smarter, more innovative, more digitally adept and more agile, with radically different relationships with clients, suppliers, and society as a whole. The challenges are huge – not all of today's oil companies are likely to be successful.



**Daniel Monzón**

is a Partner at the Buenos Aires office of Arthur D. Little and a member of the Energy & Utilities Practice, and leads the Global Downstream Oil Competence Center.

**Rodolfo Guzmán**

is a Partner at the Houston office of Arthur D. Little, Managing Partner for Americas, and a member of the Energy & Utilities Practice.

**Jaap Kalkman**

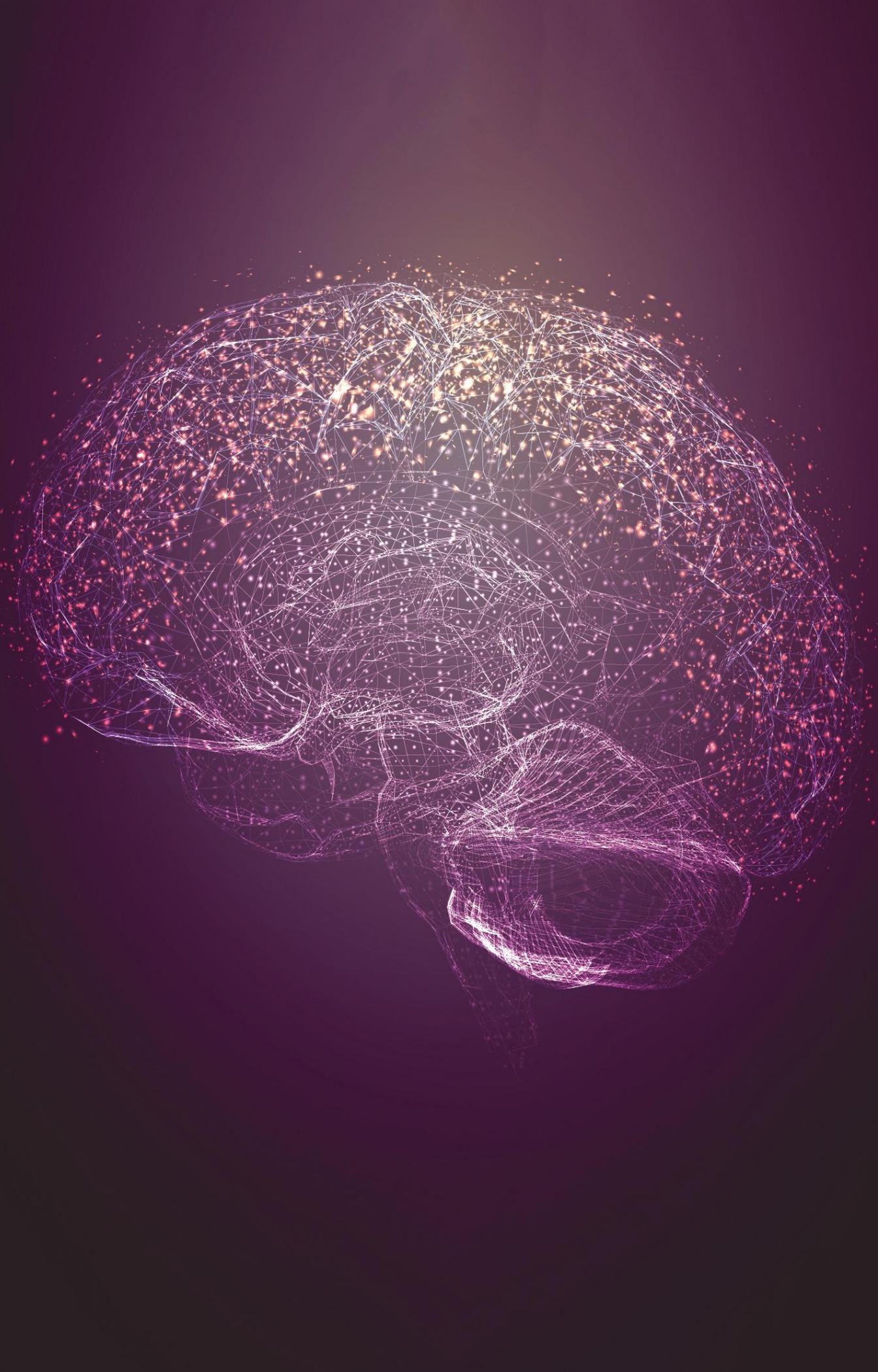
is a Partner at the Dubai office of Arthur D. Little and Global Head of the Energy & Utilities Practice.

**Stephen Rogers**

is a Partner at the London office of Arthur D. Little and a member of the Energy & Utilities Practice, and leads the Global Upstream Oil Competence Center.

**Augusto Kinbaum**

is a Business Analyst at the Buenos Aires office of Arthur D. Little and a member of the Energy & Utilities Practice.



# Demystifying robotics: A drone's eye view

Ingrid af Sandeberg, Dr. Yingzhi Zhu Ryberg, Petter Kilefors

## A high-level perspective of a vital ~ \$100 billion market

Robotics is transforming businesses and sectors across the globe, and one of the key drivers of the fourth industrial revolution. There are already over 30 million active service robots and close to 2 million industrial ones, numbers that are expected to rise dramatically

thanks to ongoing improvements and price declines in software and hardware, e.g., sensors and actuators. Enormous investments from governments (notably China), sovereign wealth funds, and companies such as Softbank's Vision Fund have brought the sector to the forefront of business and public consciousness.

As robotics moves center stage, understanding its market dynamics is becoming a business imperative for more and more industries. This

can be difficult for the outsider – to begin with, there is no one robotics market: traditional industrial robots are a mature sector with established rules and players and stable growth – while new segments are emerging fast, with prospects for future technology that are difficult to predict. Rules are undefined and ethical implications yet to be fully understood. The process of definition and understanding will be a bumpy ride.

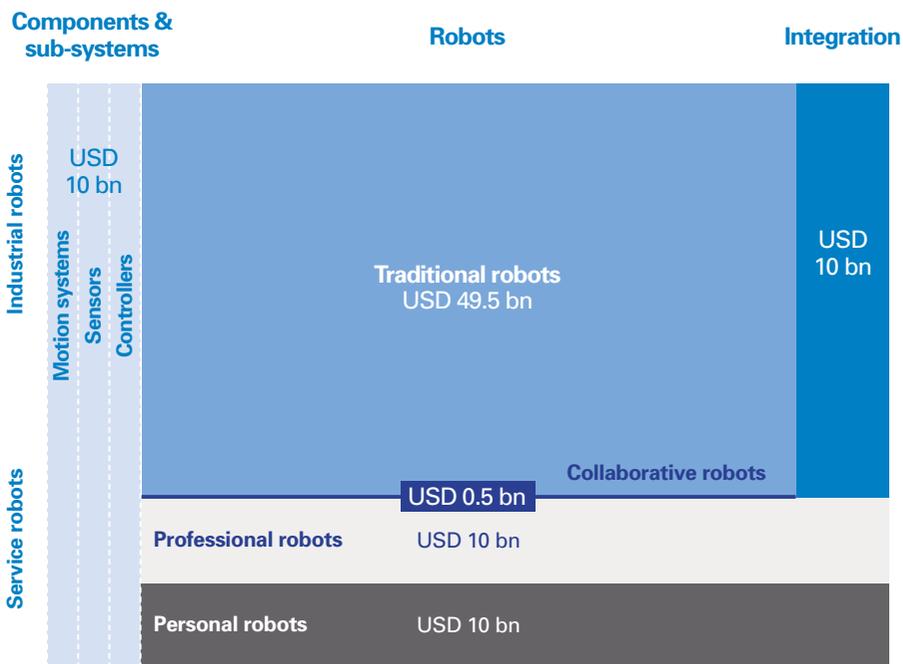
Given technology complexity, the fast pace of change and differing business models, understanding the robotics market can be hard for investors, executives, and customers alike. This article aims to provide a high-level, "drone's eye" view of the sector, identifying some key considerations to help make sound decisions in this challenging environment.

Robotics is transforming businesses in multiple industries across the globe. Already a \$100 billion market, it is growing rapidly thanks to improvements and declining costs in sensors and AI software. However, the robotics sector is not well understood by executives or investors. This article provides a primer to explain market dynamics and the key considerations businesses need to focus on if they are to successfully embrace the opportunities it offers.



## The robotics market: From industrial to personal

It is helpful to segment the robotics market based on two axes – user purpose and application-agnostic value chain components. In this user-based perspective we include suppliers of software and components, end-user robotics producers and end-user robots.



**Figure 1: Matrix of the robotics market**

Source: Arthur D. Little estimates, 2018

Our matrix shows a vast market that will soon hit \$100 billion in revenues, which can be further organized into sub-segments. It will be apparent that technology and algorithms may be applicable across multiple segments. For example, perception systems for autonomous wheelchairs, as well as unmanned demolition and nuclear decommissioning robots, may face similar environmental challenges. These challenges may include discriminating between objects to either avoid, shove, or otherwise manipulate, and coping with artificial lighting, flat/shiny surfaces, etc.

Traditional industrial robots are sizable with stable, comparatively low growth rates but good profitability level, largely resulting from a capital-intensive operating model. The industrial co-bot segment is rocketing size-wise thanks to flexibility that enables new applications, as well as its affordability to new segments with smaller customers attracted by lower capital needs, less demanding integration and more software-oriented offerings. As in any emerging segment, the risk-reward trade-off is more uncertain than in mature markets. A recent example of an, according to most observers, attractive-looking company that fell flat was the pioneering Rethink Robotics.

Professional robots cover many segments, such as surgical robots in healthcare. The market has high profitability thanks to the specificity and high-end features. The market benefits from rapid technology development of components, such as high-precision actuators, smart sensors and computer vision. Personal robots are increasingly popular and consumer demand has risen notably in recent years, but market fragmentation thanks to a plethora of new entrants, and subsequent price pressure, are eroding margins. In the remainder of this article, we will focus on the end-user-based segments of industrial and service robots.

## Industrial robots: Moving out of the cage

With \$50 billion of revenue, industrial robots represent the largest segment in the market. It is forecasted to grow at 12 percent CAGR until 2021, driven by increasing productivity demands and digitalization trends in manufacturing, such as Industry 4.0, digital twins, and smart manufacturing.

The sector can be split in two. Traditional robots, known from production lines, have limited interactions with humans and are placed behind fences or in cages. By contrast, newer, collaborative robots – “co-bots” – are designed to work safely alongside people. In general, co-bots have lower costs, weight, and footprints, and are fence-free and easier to program and integrate. However, payload limits and accuracy are significantly lower compared to those of traditional industrial robots.

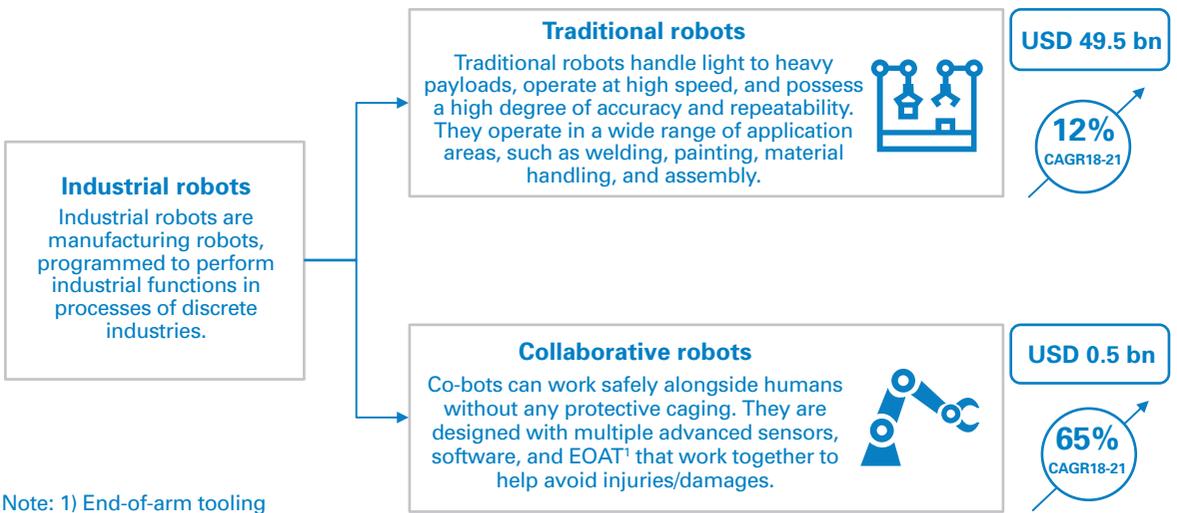


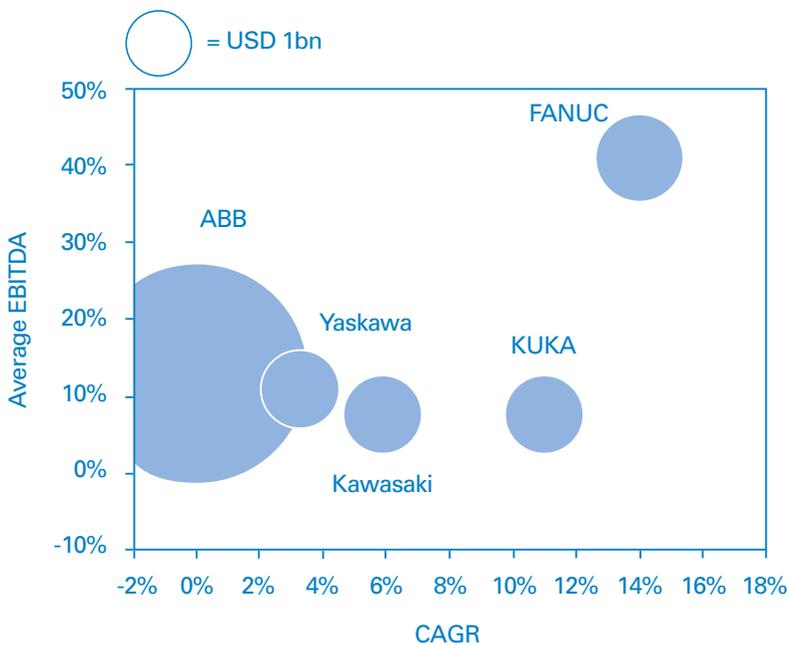
Figure 2: Definition and segmentation of industrial robots

## The rise of the co-bot

Technological development and price declines have driven rapid growth for industrial robots in three areas:

- Developing countries are using them to industrialize, satisfying end users' desire for cost reduction.
- Lower prices enable robotics businesses to target new segments, such as SMEs, with innovative technologies (e.g., co-bots).
- Government initiatives, such as "Made in China" and the EU's "Horizon 2020", are contributing to greater robotics investment.

The market is dominated by well-established traditional players such as ABB, KUKA and FANUC, as shown in Figure 3.



Note: EBITDA margin of the whole company and CAGR for net sales from robotics from '14-'17

**Figure 3: Competitors in the industrial robots segment**

Co-bots will see the largest growth, albeit from a low, \$0.5 billion base. This sector is projected to grow at 65 percent CAGR until 2021. This is partially due to their lower purchasing price compared to that of traditional robots, which extends the robotics market to SMEs. Additionally, as opposed to traditional “co-opetition”, in which traditional robot players struggle for power with third-party integration solution providers, suppliers of co-bots tend to cooperate more closely with consulting/service-oriented integrators.

Five mutually reinforcing trends underpin the overall growth forecasts for industrial robots:

- Automation/Industry 4.0 is driving demand for agile, collaborative robots, while the flexibility of the ecosystem enables efficient adoption. For example, KUKA’s high-precision robot, Agilus, played against former table-tennis world champion Timo Boll, which showed the trend towards improved flexibility, speed and agility.
- Developments in the IoT enable the smartization and connection of tools, driving adoption in medical and farming.
- Innovations in the field of software and hardware, e.g., sensors, AI, and lightweight actuators, make performance both affordable and value generating.
- Declining hardware prices and easier integration make robots more affordable for SMEs. Automation levels in China are expected to increase, with the Chinese government investing heavily in robotics.

## **Case examples**

### **FANUC – Collaboration with system integrators**

FANUC specializes in robotic automation for manufacturing. FANUC offers 100+ industrial robot models with a range of flexible, application-specific options, handling payloads ranging from 0.5kg up to 2.3kg, reaching from 0m up to 4.7m, with 2–6 axes. FANUC also provides an extensive authorized system integrator network, which helps customers find and deploy robotic solutions that meet their

needs in terms of quality, throughput, productivity, and budget. Using a professional system integrator well versed in FANUC's product range can be a key success factor for a user to get maximum return on their often sizable investment in an industrial robot solution.

### **ABB – YuMi**



ABB's first range of co-bots was introduced to the market in 2015, and is named after the collaboration it enables: YuMi, for "you and me". The dual-arm, small-parts assembly robot solution

includes flexible hands, parts-feeding systems, camera-based part location, and state-of-the-art robot control. Thanks to accurate vision, dexterous grippers, sensitive force control feedback, flexible software and an easy-to-use programmable interface, YuMi can be instructed in multiple ways, such as to assemble small parts on an assembly line, fix part positions, or even serve coffee. Its sensor set-up enables situational awareness that, paired with built-in safety features, qualifies it for cage- and fence-free work side-by-side with humans.

## **Key considerations for investors and executives**

Investors and executives looking to enter the industrial robot market should focus on these considerations:

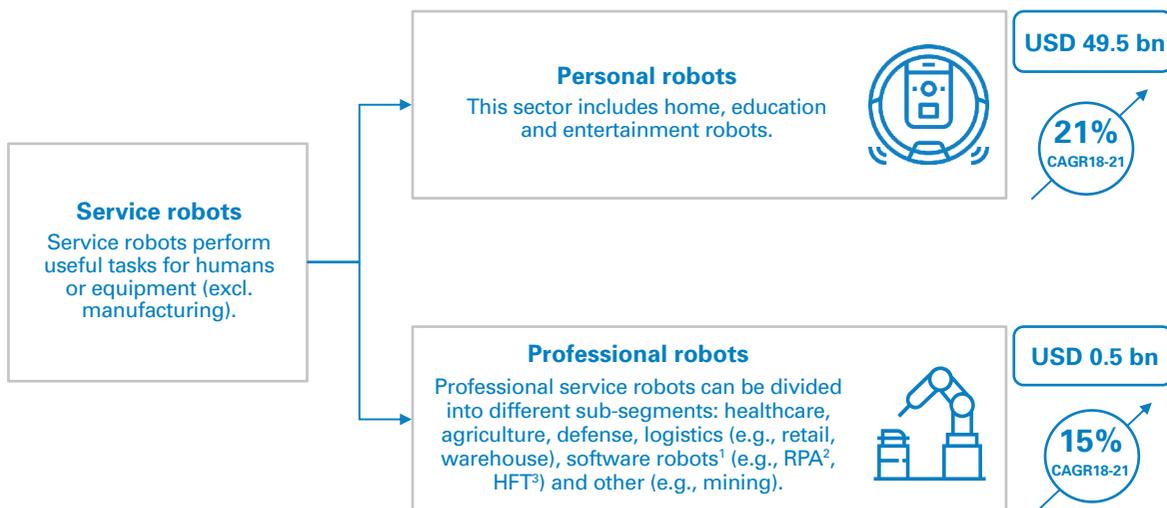
- **Geography:** Technological development and the economic and political environments strongly affect regional market attractiveness. For example, 70 percent of robot-related patent applications between 2014 and 2017 were filed in Japan, the US, Germany, or South Korea. Add China, and these five countries account for 75 percent of industrial robot sales. Therefore, the location, focus and footprint of a prospective business will be an important indicator of future performance and growth.

- **Industry:** The use and progress of robotics has developed at varying speeds across industries. In the automotive industry, robotic assembly overtook manual labor in the middle of the 20th century, with the electronics industry following a few decades later. However, other sectors, such as food processing, have still to become as mature. In fact, the effect of robotics on these industries promises to deliver a similar transformative impact to that of the Spinning Jenny on the 18th century textile industry. Consequently, the characteristics and maturity of the customer industries being targeted will greatly impact the success of prospective investments.
- **Technology and business offering:** Impressive technology cannot fly without a viable business offer. Take Rethink Robotics: not long ago, its innovative technology was a source of awe and envy from other players within the co-bot market. However, extraordinary technological features could not be translated into a workable solution, and the company was forced out of business in late 2018.
- **Ethical considerations:** Industrial robots, especially co-bots, are bound to make many manual tasks redundant. Investors and executives will need to consider what responsibility they have for retraining and/or redeploying affected employees – and to what extent they are able to stand up to public scrutiny on these topics.

## Service robots: Innovation and fragmentation

As the Silicon Valley Robotics Association says, the role of robots in society is moving from “doing dirty, dull, and dangerous work to improving lives of ordinary people”, i.e., from industrial to service robots. While growing from a lower base, the number of industries in which service robots are popping up is expanding rapidly, with sub-segments growing quickly. This immaturity means the market is defined by innovation and fragmentation, and driven by technological advancements combined with increased demand. Continuous improvement in the performance and flexibility of service robots is encouraging their widening adoption in new areas such as the home, the education sector, and offices.

As Figure 4 shows, service robots can be split into professional and private use.



Note: 1) Revenue of software robots is not included in the total revenue of professional services. 2) Robotic process automation. 3) High-frequency trading.

Figure 4: Definition and segmentation of service robots

### A service robot in every home and office?

In 2018, both the personal and professional service robot segments were similarly sized, at about \$10 billion each. The personal robot segment growth of CAGR 21 percent is driven by changing consumer behaviors, in which consumers accept and demand more solutions to simplify everyday life. On the professional side, the growth rates differ between sub-segments and industry. For instance, robotics for handling financial services is growing faster than robotics in health care, in which regulations can slow down growth.

Adoption of professional and personal service robots is being accelerated by multiple trends, including:

- People are increasingly using “virtual assistants” such as Apple’s Siri on their smartphones and Amazon Alexa/Google Assistant at home. For example, Amazon’s Alexa already has a penetration of ~20 percent of US households.

- Consumer robots such as vacuum cleaners and lawn mowers are becoming default components of smart living and smart homes.
- Medical, educational, and logistics robots are rapidly changing traditional business operations.
- Supply and demand for autonomous vehicles and drones is rapidly increasing.
- The e-commerce boom is stimulating and driving greater adoption of logistics robots.
- Robotics-as-a-service (RaaS) is increasingly available, which lowers the barriers to entry as robotics systems can now be rented on a monthly or quarterly basis, including technical support, real-time monitoring, and other services.
- “Robots invest in robots”. The rise of robotics and AI has spurred development of exchange traded funds (ETF) investment, which often leads to robotic systems investing in the sector and technology that created them.

## **Case examples**

### **Fendt – Project Xaver**

Agri-tech company Fendt launched the Xaver solution in 2017, which enabled automated targeted seeding using swarm technology. Utilizing a swarm of battery-powered, cloud-controlled, high-precision field robots that collaborate autonomously, seeding can be performed at exceedingly low cost – for both the environment and the farmer. With few sensors and a clear hardware structure, each Xaver is highly reliable and can leverage the swarm’s collective sensor park. The “modularized” seeding set-up is scalable and avoids single point of failure, and the robot’s light weight ensures improved safety and negligible soil compaction.

### **Sophia – A physical chatbot?**

In 2016 Hong Kong-based Hanson Robotics launched a humanoid robot named Sophia, which has received extraordinary attention in media across the world. Sophia can make more than 60 facial expressions, and is known for her human-like behavior. In 2017 “she” was made a citizen of Saudi Arabia and named UNDP Innovation Champion. Sophia uses AI, visual data processing, and voice and facial recognition, and is designed to get smarter and ultimately gain social skills. The inventor has said Sophia (or a clone) may be used as a suitable companion for the elderly in nursing homes, or to provide customer service.

### **Pan Capital – The Swedish finance wonder**

In less than a decade, Pan Capital, founded by a former manager at Swedbank, revolutionized the electronic stock market and achieved profits of over 4 billion SEK. It leveraged high-speed



connections, using sophisticated algorithms to make enormous numbers of transactions in global finance markets at previously unseen frequencies. In

September 2008, the company traded with more money than the sum of the entire stock market in Stockholm and received international recognition, with the CEO of Goldman Sachs flying its managers to New York to personally thank them for their business. However, increased competition and stronger regulation eventually eroded its profits, which exemplifies the volatile nature of the business.

## Key considerations for investors and executives

Investors and executives looking to enter the service robot market should focus on these considerations:

- **Platforms:** A high-potential platform enables a diverse customer base and underpins new applications, such as warehouse automation platforms that can be applied in different verticals. Reusability of the underlying platform of a product or technology is a vital input aspect to executive and investor decisions.
- **Hyped segments should give rise to caution:** A hot and hyped segment normally receives attention for justified reasons, such as groundbreaking technology or potential for business disruption. Still, they are often inhabited or targeted by giant players, which means you need deep pockets to compete. The virtual assistant sector is the perfect example – consumers are eager to adopt these solutions, but the presence of Apple, Alibaba, Amazon and Google will create obstacles for other actors looking to build viable businesses.
- **Possible calamities and liabilities:** When dealing with a delicate and high-stakes field, it is necessary to recognize that reliability, regulation, and potential liabilities could have crucial impact on products and companies. Intuitive Surgical's Da Vinci Surgical Systems provides a case in point. Its path to both medical and commercial success seemed to be set until the company suddenly found itself having to set aside \$100 million to fight over 80 lawsuits within 22 US states.
- **Ethical considerations:** AI is fueling improved performance for service robots, be it medical image analysis to identify tumors or the smart voice assistant through which you control your vacuum cleaner and order groceries. The very improvement stems from the notion of machine learning – i.e., that an algorithm improves its decision-making and actions based on data from new experiences. Nevertheless, there is a trade-off between big data and quality-assured data. Executives and investors must remain cautious on the quality and use of data, not only to comply with applicable regulation (such as Europe's General Data Protection Regulation – GDPR), but also to avoid perpetuation of biases.

## Insight for the executive

Interest in the robotics market has never been higher, with executives and investors from multiple industries seeing the potential benefits that innovation in the sector delivers. However, it is a vast and complex market, partially obscured to many of those peering in from the outside, looking to enter. Regulatory, legal, and ethical concerns must be carefully managed. As these factors, to a large extent, relate to end-user applications, our matrix can act as a starting point to orient the corporate executive and investor alike:

### **Making life easier for a corporate executive entering robotics**

- Any corporate executive who has witnessed the start of the Industry 4.0 revolution realizes the potential of robotics.
- Typically, NPV or payback time is used when contemplating investments, considering the benefits versus costs of replacing labor with robots, along with factors such as improved quality and precision. However, without understanding the context, such investment rules can easily be misleading.
- Understanding the ecosystem of suppliers, software integrators and end-user robots is key to making the right bets and creating the right assumptions in business cases. Our matrix provides guidance.
- Inspiration can be found from robotics companies that practice what they preach: hardware manufacturers and software engineering companies alike are all robotizing their own R&D, manufacturing and customer support by deploying AI and machine learning. Use cases include FANUC's and ABB's automated production of industrial manufacturing robots, Kia seeing a three-fold increase in car sales conversions through its sales chatbot compared to through its website, and cybersecurity companies using generative adversarial networks (GANs) to stress test their solutions.

## **Making life easier for robotics investors – Traders, stock pickers, and sector bettors alike**

- An active private or public equity investor in robotics companies must distinguish between a fascinating technology, a well-managed company, and a good investment.
- Timing is key, alongside a fundamental understanding of robotics ecosystem dynamics, an area on which our matrix and insights provide guidance.
- A good understanding of the regulatory environment, including predicting its changes and risk dynamics, is key to success in robotics markets.
- An investor who believes in the robotics sector, but is less knowledgeable and confident in picking the winners, has a more passive option in robotics-focused exchange-traded funds (ETFs).
- Robotics trading, like high-frequency trading or automated algorithms for fund management, is improving returns and lowering risks for investors in general, and for knowledgeable robotics investors in particular.

### **Ingrid af Sandeberg**

is a Manager in the Oslo and Stockholm offices of Arthur D. Little and a member of the Automotive & Manufacturing Goods Practice, with a special interest in robotic perception systems.

### **Dr. Yingzhi Zhu Ryberg**

is a Manager and Chinese native located in the Stockholm office of Arthur D. Little and a member of the Technology & Innovation Management Practice.

### **Petter Kilefors**

is the Managing Partner of Arthur D. Little in the Nordic region, former global head of the Strategy & Organization Practice, and a member of the Life Sciences and TIME Practices.



# Interview



## Interview: Using innovation to create sustainable growth

### *How Leonardo is preparing for future market challenges*

An interview with Alessandro Profumo, CEO, Leonardo S.p.A. (formerly Finmeccanica Group S.p.A.)

*Francesco Marsella, Giancarlo Agresti, Andrea Visentin*

Alessandro Profumo is the chief executive officer of Leonardo S.p.A., a role he has held since May 16, 2017. He has also been the honorary chairman of AIAD (the Italian Industries Federation for Aerospace, Defense and Security) since July 2017 and chairman of the Fondazione Ricerca & Imprenditorialità since February 2018.

Born in Genoa, Italy on February 17, 1957, Profumo holds a degree in business economics from Bocconi University. In 1977, he began his career in banking, in which he worked for 10 years, before joining the consulting sector at McKinsey & Company in 1987. In 1994 he joined Credito Italiano, starting out as the deputy general manager, and in 1997 he was appointed chief executive officer and led the transformation of Credito Italiano into UniCredit Group. Under his leadership, UniCredit Group became a leading European banking player, growing from 15,000 to over 162,000 employees, with branches in 23 countries.

***Leonardo is active in many business areas, from helicopters, aircraft and space to electronics, defense and security systems. What do you see as the main market trends that will most affect your diverse business?***

Three global megatrends will sustain the development of the aerospace, defense and security (AD&S) sector over the next few years: security and geopolitics, with growing geopolitical instability in different parts of the world, such as Asia, the Middle East, North Africa and Sub-Saharan Africa; the globalization of the world economy; and the advent of new technologies. These dynamics will cause the majority of countries to increase their investment in the AD&S sector, budgeting additional resources for the period 2021–2027. Global defense budgets are also steadily growing, and will be over \$2,100 billion in 2027, a 31.4 percent increase compared to 2008. In Europe, we foresee opportunities not only due to the European Defence Fund (EDF), but also thanks to spending increases in many NATO countries, which are investing to hit the stated target of budgeting 2 percent of GDP for defense by 2024. We also expect to see the US market growing, as well as the Middle East and Asia. In the aeronautic sector, we see sound growth in civil markets as well, with a positive trend for both turboprop aircraft and outsourced aero-structures.

*“Global defense budgets are also steadily growing, and will be over \$2,100 billion in 2027”*



***Among disruptive technologies, such as AI, robotics, the IoT and autonomous flight, which may influence Leonardo the most?***

Leonardo is a company built on the latest technology and is deeply, but not exclusively, rooted in Italy's industrial fabric. We know how to combine our skills with intensely innovative technologies, enhanced through a balance between research that is open, self-financed, and financed by third parties. In 2018, Leonardo employed 9,000 people in R&D activity, such as our engineering and CTO divisions, equal to about 20 percent of all staff. Our high rate of technological innovation and strong R&D expenditure mean we hold a wide patent portfolio. In 2017 Leonardo spent EUR 1.5 billion on R&D activities, 13.4 percent of group revenues. We are at the leading edge of the latest disruptive technologies for dual use: civil and military applications. For example, don't forget that unmanned vehicles have been employed for more than 20 years. Applications began in the military, with the unmanned revolution spreading to the civilian world. Now all robotics technologies flow both ways. We deal constantly with Big Data for civil, dual and defense applications. You have not mentioned cyber, but cyber is again a technological area in which we are fully active and committed, for both security and defense applications. Even the IoT has civil, government and defense applications – there is an Internet of Battlefield Things, for instance. And there is much more, from advanced, even exotic, materials to new-generation microelectronics. Since we are involved in different business sectors, we must master a broad range of technologies and leverage them across

*“In 2017 Leonardo spent €1.5 billion on R&D activities, 13.4 percent of group revenues”*

multiple domains. As a matter of fact, the latest disruptive technologies will also enable different business models and new ways and methods of creating Leonardo's products.



***How is the competitive environment changing? Which are, in your opinion, the sectors in which new entrants are threatening the status quo?***

New players are indeed entering the market, but this is not due to any lowering of technology barriers. The very basic entry barrier may actually remain stable, therefore allowing newcomers to join. They are usually strongly supported by local government investments and

programs, at least in the defense domain. Meanwhile, the technological edge is constantly moving higher. This is the key to remaining competitive: continue to invest to renew know-how and competencies in order to cope with new requirements, which demand innovative technologies that most newcomers cannot provide. At the same time, these new solutions need to remain reasonably affordable; otherwise, a relevant part of the market will be lost. All of this means new markets are opening up due to technological advances and the latest customer needs, while mature markets can be abandoned as they shrink or stop being attractive. Just to mention one example, the “privatization” of space is an ongoing revolution.

***The unmanned aerial vehicle (UAV) revolution is considered the “next big thing” in the aerospace industry. What is the Leonardo view on the market? What are the key issues to solve?***

The hobbyist UAV is now a commodity, while heavier and more advanced UAVs (the so-called “prosumer” UAVs) are being exploited for a variety of roles, which will grow further. We still need to see larger and more capable, expensive and complex air vehicles enter the market. These systems will provide both new capabilities and a cheaper and more effective replacement for traditional solutions. There are, nevertheless, barriers in terms of technology, certification, safety, security and air-space management. We cannot believe that an unmanned aircraft would be allowed to fly directly over our heads, accepting lower safety and security standards than for manned ones. The opposite is true. Safety requirements



are being constantly increased, and this demands new technologies and solutions, which bring additional complexity and, to some extent, weight and costs. The path is clear, but it will take time, starting with lighter vehicles and specific roles and missions, before moving on to heavier air vehicles, and ultimately travel and transportation. You will probably first see a single pilot in the cockpit, then unmanned cargo, and only then, unmanned passenger vehicles.

***The space sector is increasing in importance, as these technologies are integrating more and more with terrestrial applications. Do you see upside market opportunities in this area? Are you going to expand the space division's importance and programs?***

In 2022 the expected total value of the space sector, including manufacturing and services, will be approximately EUR 114 billion, with a CAGR of 4.3 percent. Leonardo intends to strengthen its services with Telespazio by exploiting the potential of the "Space Alliance" in multiple ways. We will look at consolidation in some specific geographies and vertical markets in the sector of satellite telecommunications and geo-information, expand its role as a supplier of ground segment and systems operations, increase involvement in space economy projects, and adopt new business models – also by exploiting key innovations such as Big Data, data analytics and LTE. The European space strategy is laying the groundwork for solid future growth in European space activity. The European industry has been called



upon to contribute to the definition of the strategy, becoming recognized as an important stakeholder. We expect this to continue in the delivery phase of the strategy itself. We are also primed to take advantage of new business models that are emerging in private spaceflight, an industry called "new space". The protection of space assets, from satellites to orbital space stations, is also a priority issue, one to which we as an industry can make a very important contribution. Leonardo, as an international group, has a leading role in the European Commission's Galileo and Copernicus space programs. Through Spaceopal, a joint venture between Telespazio and the German Space Agency, Leonardo is responsible for managing the entire Galileo system and its performance, including providing some of the constellation's cutting-edge technologies.

*“In 2022 the expected total value of the space sector, including manufacturing and services, will be approximately €114 billion, with a CAGR of 4.3 percent”*

**What do you think is the best strategy to drive additional growth for Leonardo?**

We are entering a new phase in which our core markets are going to grow at about 6 percent, and we have a number of quality products that are highly valued by customers, which positions us well in light of key trends. Our enhanced business approach will increase Leonardo’s penetration in key markets to boost international business development. We also need to continue to rationalize and strengthen the portfolio, reshaping the focus on core products and technologies, and reinforce ourselves through partnership or M&A activities. All three key Leonardo businesses – helicopters, aircraft and electronics for defense and security – will contribute to our growth, including, of course, our customer support and service offerings. At the same time, Leonardo 2.0, the full deployment of our “One Company” model, will continue the essential redevelopment of the organization to leverage our key strengths. We must make Leonardo work as one company, leveraging cross-divisional technologies, with a new approach to support best-in-class innovation. Approximately 12 percent of revenues will be invested in R&D in 2018, 95 percent of which will be dedicated to product development to help us better meet customer needs.

We are also performing continuous portfolio management and assessment: in some cases, we are ending products and product lines, and leaving segments which are not profitable enough. This enables us to concentrate our resources on the most promising areas, those that guarantee long-term business sustainability.

**What are the strategies outlined in your recent industrial plan to increase operational efficiency and cash generation?**

Leonardo is carrying out an integrated cost transformation program as part of our 2018–2022 industrial plan. This targets full exploitation of inter-company synergies and aims to drive widespread understanding of where spending can be reduced, in terms of both external and labor costs. Cost transformation initiatives are currently under way in areas including direct procurement costs, engineering, production, logistics and overheads. Investing in sustainable growth and the latest technologies is a key target. We foresee making selected, market-driven investments, at a level 150–200 million times higher than our 2015–2016 average. These will allow us, on the one hand, to increase our emphasis on key technologies and products for long-term sustainability, while making short-term investments, such as around digital transformation, for the full deployment of

the One Company vision. Implementing the latest technologies, such as the IoT and Big Data analytics, is a fundamental part of Leonardo's activity, as I have already said. We are operating at the leading edge of innovation across multiple areas, from the space sector to unmanned vehicles, for civil, dual and defense applications, including Earth observation and monitoring of critical infrastructure.

***What is Leonardo going to do to anticipate changing market needs and avoid a passive strategy?***

We are surely not passive at all – quite the contrary! We aren't sitting idle, waiting until a potential customer knocks on our door asking for a specific solution to meet its requirements. Instead, we do our own internally funded research, and are constantly assessing which technologies are most promising and

need to be exploited in order to ideally position Leonardo to meet future requirements. We are frequently proposing new technologies and applications to potential customers, before they start thinking about them or their possible uses. This process can uncover new requirements and needs. But it is obvious that, in many cases, we cannot develop these technologies without government investment. This is different to civil aerospace, in which we are very active. In this domain you first have to develop the technology, the product, and the service, and only then will customers eventually come and buy.

***Cyber-security is gaining more and more importance, as traditional and new products require connection with the external environment and third parties. Will cyber-security become a relevant business line for Leonardo?***



Leonardo is at the forefront of cyber-security, offering sophisticated intelligence systems and dedicated, real-time network information analysis to police forces, government agencies and private companies, thanks to our security operations centers in Chieti in Italy and Bristol in the UK. These operate 24 hours a day, with teams of cyber-experts. Leonardo's main projects include the ongoing NATO Computer Incident Response (NCIRC) program, the largest initiative in the cyber-security field outside the United States, which protects the information and ICT infrastructure at more than 70 NATO sites in different member countries.

***How does Leonardo address corporate venture capital initiatives? To what extent do you think this practice could contribute to the innovation cycle?***

Thanks to our participation in European research programs, Leonardo has developed a solid network of research institutions, universities and SMEs, alongside our own investments in research & development. The company is increasingly oriented towards creating an "ecosystem of innovation", based on implementation of technological R&D initiatives focused on open innovation, through creation of synergies between universities, research organizations, institutes and SMEs. This strategy aims to build the critical mass necessary to compete in international markets, contributing to the progress of the ninth United Nations Sustainable Development Goal around a multi-annual financial framework. Also, in terms of corporate venture capital, Leonardo is among the prime movers in Italy, contributing to strengthening the AD&S supply chain.

In line with the development guidelines expressed in our new Industrial Plan, in 2018 we began work on a CVC fund that could contribute towards implementing our technological roadmap. Leonardo is the largest Italian manufacturing company, measured by revenue, to have launched a CVC fund.

***Do you plan to treat new embryonic businesses, such as UAVs, through dedicated and vertically integrated entities? What is the Leonardo view on this?***

We are currently assessing what could be the most efficient and effective organizational structure for the "unmanned" sector. This technology has ramifications in the air, on the ground, above and below the sea, and even in space. We are ascertaining how to best manage this area, in which Leonardo has significant experience and capabilities. The idea is to cross-leverage capabilities and technologies that are spread between several divisions, but that could probably be better coordinated and exploited. And we also understand that, in some cases, we should allow businesses a degree of independence and autonomy: this is what we did when we acquired full control of Sistemi Dinamici, a small company which develops and builds unmanned rotary air vehicles. Another example is in the cyber domain, for which we want to concentrate our activities under a single roof to allow the division to cope with a faster technology-to-product-to-market cycle.

*“...thanks to our security operations centers in Chieti in Italy and Bristol in the UK. These operate 24 hours a day, with teams of cyber-experts”*

***Is the recently implemented “One Company” organization model flexible enough to cope with Leonardo’s different businesses and customer needs? What are the benefits you expect on the commercial side, and on the operational one?***

The “One Company” model allows us to take advantage of synergies while, at the same time, preserving specific features of divisional businesses. Through this framework, Leonardo set up a “single and decentralized” model based on divisions and support functions. Divisions are the basic elements in this organization, and are in charge of the main businesses.

The “One Company” organizational model also sees harmonization of business support activities to ensure more uniformity through single rules and processes and, at the same time, better and more accountable control over the single businesses. This allows divisional management to better focus on business core processes. The model facilitates a united approach to customers at group level through the “one voice” logic, based on well-defined and separate roles under the coordination of the corporate center.

***What are, in your opinion, the skills and competencies that will be key in the near future? How do you plan to attract, develop and retain talent and skills?***

As set out in our New Leadership Framework, Leonardo has recently introduced focus on skills and competencies, in order to combine technical capabilities, values and behaviors. In this framework, technical knowledge of products and processes is relevant, and involves working together with a distinctive managerial style that ensures sustainable growth in the medium and long term. The global aim of our training and learning activities is to successfully face the challenges of a fast-changing business environment. This is why the key skill we expect from employees, now and in the future, is life-long learning agility.

*“We are frequently proposing new technologies and applications to potential customers, before they start thinking about them or their possible uses”*

***In conclusion, in an era of increasing automation, do you feel that the human factor will remain relevant in the future?***

Digitization is impacting, and will continue to impact, our organization in many ways, and its effects relate to our products and services both directly and indirectly. Digitization is changing the way employees live and act within the organization, such as through more connections, more agility, wider access to information, and more efficient processes. These can all be enabled by new technologies and new ICT paradigms.

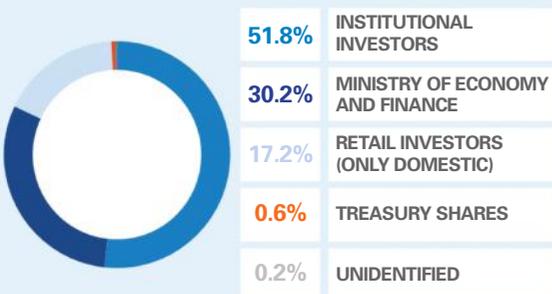
This implies a new way of innovating, which involves reducing inefficiency to remain competitive. For these reasons the human factor needs to be encouraged, in order to meet the needs I mentioned before. Firstly, we need the entire company to undergo a cultural shift to meet our new organizational paradigms, with training to ensure a minimum level of relevant skills. Secondly, we are looking to drive vertical cultural enrichment for professionals and middle management working on products and service design and implementation, as well as an upskilling process which will enable us to pursue excellence.



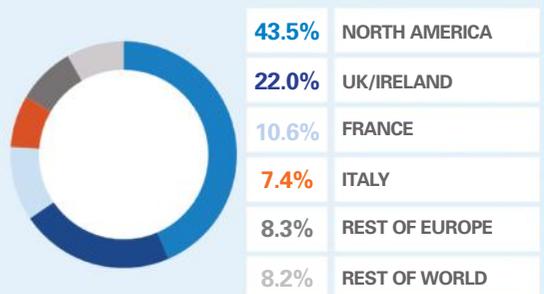
Leonardo is a global high-tech company and one of the key players in aerospace, defense and security, highly diversified in five divisions: helicopters, aircraft, aerostructures, electronics and cyber security, plus joint-venture activities in the space sector. Headquartered in Italy, Leonardo is a global company with more

than 45,000 employees, and has several strategic partnerships in high-potential international markets. In 2017, Leonardo achieved a turnover of €11.5 billion, with EBITA of €1 billion. The company's actual order backlog is around €33 billion, equivalent to nearly three years of revenues.

**DISTRIBUTION OF SHAREHOLDERS**



**GEOGRAPHICAL DISTRIBUTION OF SHAREHOLDERS, FLOATING RATE**







Abu Dhabi  
Amsterdam  
Bangkok  
Beirut  
Bogotá  
Boston  
Brussels

Buenos Aires  
Cambridge  
Chennai  
Dubai  
Frankfurt  
Gothenburg  
Hong Kong

Houston  
Istanbul  
Kuala Lumpur  
London  
Luxembourg  
Madrid  
Mexico City

Milan  
Moscow  
Mumbai  
Munich  
New Delhi  
New York  
Oslo

Paris  
Prague  
Riyadh  
Rome  
San Francisco  
Seoul  
Shanghai

Singapore  
Stockholm  
Tokyo  
Vienna  
Zurich

